PECAN GROWING

BY

STUCKEY

AND

KYLE

The Rural Science Series

L. H. Bailey *Editor*

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FARM CREDITS IN THE UNITED STATES AND CANADA. *Morman.*
PECAN-GROWING. *Stuckey and Kyle.*

PLATE I.—A well-developed pecan orchard.

PECAN-GROWING

BY

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PREFACE AND EXPLANATION

THE commercial growing of pecans in the United States is comparatively a new industry. Dependable pecan literature is notably scarce, except as it appears in bulletins of the United States Department of Agriculture, southern experiment stations and other state institutions, in proceedings of nut-growers associations, and in nut journals.

In preparing this book an effort has been made to include the latest summary results of scientific investigations on pecan-growing. A large part of the material has never been published before. In addition, the important practical phases of the work, including the latest methods and practices of pecan-growing, have been emphasized. Consequently, it is hoped that this volume will be useful not only to students, instructors, and investigators in pecan culture, but also to the growers, amateurs, and others interested in the subject.

The amount of detail in some of the chapters will lack interest to the experienced pecan-grower; but the authors' conception of the book, based on a rather wide experience gained from field observations, personal contact, and correspondence, leads them to think that this is necessary to make the book serve its greatest purpose.

It is difficult to acknowledge full credit for all the assistance received. Due acknowledgement is made of illustrations loaned by the United States Department of Agriculture, and by a number of the state institutions. The journals and other

publications have been freely drawn on, and assistance has been received from a number of teachers and investigators.

Dr. B. W. Hunt, of Eatonton, Georgia, in addition to supplying much of the historical data, has been an inspiration in the preparation of the entire volume. Dr. J. J. Skinner, Biochemist, Soil Fertility Investigations, Bureau of Plant Industry, United States Department of Agriculture; Dr. T. H. McHatton, Horticulturist, State College of Agriculture, University of Georgia; Dr. S. W. Bilsing, Professor of Entomology; Dr. G. S. Fraps, State Chemist, Agricultural and Mechanical College of Texas, and Prof. W. F. Turner, Assistant Georgia State Entomologist, gave helpful suggestions in the preparation of the manuscript.

In literature the terms "pecan groves" and "pecan orchards" are used more or less synonymously or at least interchangeably. This is probably due to the fact that when pecan nuts began to receive attention in the native forests, the underbrush and other species of trees were cleared away just before harvest time so as to facilitate the work of gathering the nuts. Such groups of pecan trees were very properly spoken of as groves.

H. E. Van Deman, at the third annual convention of the National Nut Growers Association in 1904, made the distinction between "pecan groves" and "pecan orchards" by designating those trees set in their natural position by nature as "groves" and those planted in definite form, by man, as "orchards." In other words, nature plants groves and man sets orchards. The term "grove," however, has followed the pecan industry, and today is frequently used interchangeably with "orchard" even when applied to plantings made in definite form by man.

The term "paper-shell" is most commonly used for improved or commercial varieties of pecans. The two rather broad divisions of pecans are "paper-shell," meaning the improved varieties, and "seedling," including the large supply of nuts in the trade coming mostly from native seedling trees.

The original intent of the term "paper-shell" was to signify a variety of pecans having a very thin shell, as the Schley or the Frotscher. If the original meaning was adhered to, such commercial varieties as the Stuart, Pabst, and Moneymaker, which have rather thick shells, could not be included. Quality, however, is as important as thinness of shell, and these, together with very thin-shelled varieties, as the Schley, Frotscher, San Saba, and Haven, are called "paper-shell" pecans. The term is really a misnomer, since it applies to commercial value rather than to thinness of shell. It would seem advisable that growers and nurserymen, in dealing with their trade, specify varieties rather than employ the term "paper-shell." As a result the general public, through the regular channels of trade, would be compelled to standardize pecans in some definite way.

THE AUTHORS.

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PECAN-GROWING

CHAPTER I

GEOGRAPHY AND COMMERCIAL IMPORTANCE OF THE PECAN

The pecan is indigenous only to certain sections of the United States and Mexico. It is not native in any other country in the world.

In the United States, the species is indigenous throughout most of the valley of the Mississippi and its principal tributaries, especially on the lowlands along the river and creek bottoms. Farther west, it is found along most of the important rivers in Texas and Oklahoma. In Mexico, in the northern and central parts, the pecan is native over a considerable area. Very little is known of this section, except that it exports annually from one to four million pounds of inferior pecans into the United States.

In the main valley of the Mississippi, the pecan is native as far north as Davenport, Iowa; in the valley of the Ohio as far north as Covington, Kentucky, and in the valley of the Wabash as far north as Terre Haute, Indiana. In this northern belt is located one of the largest solid blocks of native pecan trees in the United States. It is at the mouth of Green River, on the banks of the Ohio, in Henderson County, Kentucky. There are between 300 and 400 acres of a solid stand of wild pecan trees with only an occasional swamp maple or hackberry scattered here and there. A number of these trees are sixteen feet in circumference and over 150 feet high. On both

sides of the Wabash River there are a number of unusually large native pecan trees.

In Texas, where the greater part of the native trees are found, with the exception of the Rio Grande and Pecos Rivers, the pecan is distributed in great abundance along most of the principal streams and their tributaries, including the Red, Trinity, Brazos, Colorado, San Antonio, Guadalupe, and Devil's Rivers. Of these, the Colorado and its tributaries are by far the most important, both in the number of trees and in production of nuts. In the eighteen pecan-producing counties bordered or passed through by this river, there are estimated to be over five million native pecan trees which in 1919 produced 5,219,242 pounds of nuts. Along the streams in west Texas, the native pecan timber usually ends abruptly with the termination of the alluvial soil. As the valleys are mostly narrow, the pecan timber is seldom found more than a few hundred feet from a running stream. Even in the regions of abundant rainfall native trees seldom grow on uplands, except in protected places where deep rich soil has been collected.

The sections in the United States in which the pecan is indigenous are shown in Fig. 1. This area includes all or portions of Indiana, Illinois, Iowa, Missouri, Kansas, Oklahoma, Arkansas, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, and Texas. The general impression that the pecan is indigenous to all the southern states is not correct, for it is not native to Georgia, Florida, South Carolina, North Carolina, or Virginia.

CULTURAL RANGE OF THE PECAN

The cultural range of the pecan, as is usual with most fruits and nuts, is much larger than its native habitat. Pecans have

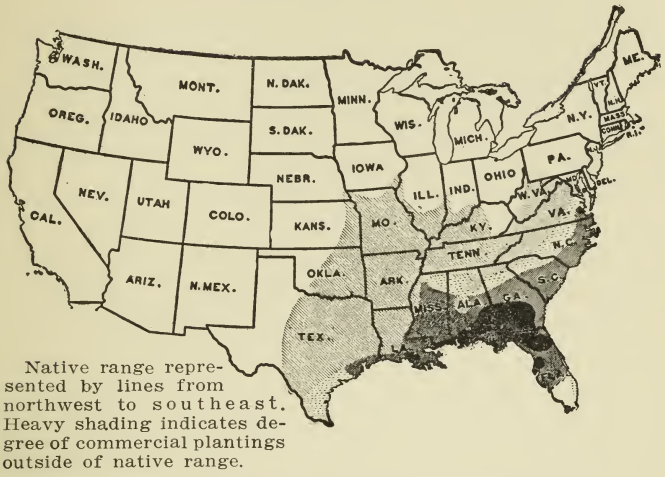


FIGURE 1.—Showing the range of the pecan.

been planted and thrive from the Atlantic coast to the western part of Iowa, Oklahoma, and west Texas, from the forty-third parallel on the north to the Gulf on the south. In addition, successful trial plantings have been made in the Pacific states, especially California.

This area, east of the Rockies, can be divided into four belts, the northern, middle, southern, and western, according to the type of pecan varieties that will thrive therein. P. T. Littlepage of Washington, and Meredith Reed of Vincennes, Indiana, worked out the approximate boundaries of the northern, middle, and southern belts. They made a careful study of the native pecan trees in their habitat from Indiana through Missouri, Arkansas, and Tennessee, to Alabama and the Gulf coast. They found that the trees on the Gulf coast differed radically from the northern pecan, while those in Missouri,

Arkansas, and Tennessee differed somewhat from both. The material difference in all three cases was in the length of the growing period, the Gulf coast trees requiring from 270 to 290 days to mature their fruit and the northern pecans from 170 to 190, while the middle belt needed from 180 to 200 days. Consequently, only those regions having a growing season of 270 to 290 days are adaptable to the Gulf coast varieties such as the Schley, Stuart, Delmas, and Frotscher. Those sections with a growing season of 180 to 200 days are suited to the Evansville group, such as Major, Greenriver, Kentucky, and Warrick. Those localities that have a growing season of 170 to 190 days are adapted to the northern pecans, such as the Posey, Butterick, Indiana, Busseron, and Niblack.

The approximate northern limits for the southern belt run from Wilmington, North Carolina, westerly about fifty miles north of Augusta and through Atlanta, Georgia and Birmingham, Alabama, bearing on southwest almost to Jackson, Mississippi, thence northward, crossing the Mississippi in the vicinity of the twenty-fourth parallel, continuing on through Pine Bluff, Arkansas, and McAlester, Oklahoma. The depth of this area is about one hundred miles on the eastern side, but gradually increases until a distance of from three to four hundred miles from the coast is reached in Arkansas, Oklahoma, and central Texas.

With the exception of a few orchards in western Texas, all of the large commercial plantings have been confined to the southern belt. A number of these orchards contain from 2,000 to 5,000 acres. The states ranked according to the number of orchards planted to improved varieties are Georgia, Florida, Alabama, Mississippi, Louisiana, South Carolina, Texas, and Oklahoma. The position of the states, according to the num-

ber of native seedling trees, is Texas, Oklahoma, Arkansas, Mississippi, and Alabama. It is interesting that Georgia and Florida, where the pecan is not indigenous, rank first and second in the planting of commercial orchards to improved varieties, while Texas and Oklahoma, standing first and second in native seedlings, are seventh and eighth in the list of those states planting orchards to improved varieties.

In the southeastern states, the nuts of the Gulf coast varieties decrease in size as the plantings advance northward through the piedmont country and approach the Appalachian highlands.

The approximate northern limits for the middle belt run from Newport, Rhode Island, southward almost to Asheville, North Carolina, coming around the Cumberland Mountains, bearing almost due north to Louisville, Kentucky, on through Vincennes, Indiana and Bellevue, Illinois, thence northward, crossing the Mississippi at Hannibal, Missouri, and dropping southward around the Ozarks in southern Missouri, and again northward through Moberly and St. Joseph, and on southwest in a line with Sante Fe, New Mexico. This belt includes north Georgia, north Alabama, north Mississippi, the upper piedmont South Carolina, piedmont North Carolina, coastal Virginia, as well as Tennessee, western Kentucky, southern Illinois, southern Indiana, and southern and middle Missouri. Commercial plantings here and there indicate that the pecan industry could be developed commercially if the proper varieties were selected. There is a pressing need for experimental work in breeding better varieties for this region.

The approximate limits of the northern belt for pecans run from Portsmouth, New Hampshire, almost south to Cumberland, Maryland, turning northward through Pittsburgh and

Bradford, Pennsylvania, Auburn, Syracuse, and Watertown, New York, skirting the northern shore of Ontario, through Detroit, dipping down to the northern edge of Indiana, thence back to the forty-third parallel through Grand Rapids and Milwaukee, bearing a southwesterly direction in a line with Trinidad, Colorado. This belt embraces a large section of the Middle West. While this region will never, in all probability, be used for large commercial growing of pecans, plantings for home orchards and ornamental purposes are advisable.

The western belt, which is embraced in west Texas, is in a class by itself. Its physical conformation and semi-arid climate give conditions for pecan-growing somewhat different from those in the other belts. East Texas belongs to the southern belt, and the Gulf coast varieties thrive there. However, in the western pecan section of Texas, varieties that originated in that semi-arid climate, such as Burkett, Halbert, Oliver, San Saba, Onliwon, Texas Prolific, and Western Schley, seem to grow best. Central Texas shades from the southern belt on the east to the western belt as it approaches the ranges of hills on the west. A large percentage of the pecans that Texas furnishes the world come from the western belt. There are eighty-one pecan-producing counties in this belt. Rising in Young and Jackson counties and extending southward to San Antonio are broad ranges of hills often having the dignity of the term mountain. It is in the little valleys between these hills that the pecan delights to grow. Here the soil is very rich and of great depth, having been built up for thousands of years by erosion from the mountains. The altitude is from 800 to 2,500 feet and the annual rainfall from 18 to 30 inches. The trees are low in stature with short internodes and low branching heads.

A comparison of the eighty-one counties in the western belt with eighty-one pecan-producing counties east of the line will give some idea of the great adaptability of the former to pecan-growing. The altitude in the main producing area east of the line ranges from about 50 feet to near 800, and the rainfall from 35 to 50 inches. (1) There are no counties east of the line that produce over 200,000 pounds. (2) There are twenty-six counties west of the line that show a production of over 200,000 pounds, one of which yielded 1,290,000 pounds. (3) The total output of the eastern counties was 3,359,729 pounds, while that of the counties west of the line was 13,432,714 pounds. The census report gives considerably more native trees west of the line than east. Undoubtedly this apparent difference is greatly exaggerated, because many persons in eastern Texas fail to report their native trees as they do not consider them of any commercial value. There is little doubt also that the total of native trees given in the census report is far below the actual number to be found in the state. For example, the census report gives only 1,412 trees for Brazos County, though 14,000 would be more nearly correct. Even the total yield of nuts as shown by the census report is far below the actual production because of the very crude way of gathering the pecans.

In Texas, the type of the native pecan seedling varies with the altitude and rainfall. Along the streams near the coast where the altitude is low, only a few feet above the sea level, and where the rainfall is heavy, often exceeding 50 inches, the tree is tall and slender in comparison with the spread of its top. The bark is smooth and light in color. The branches are few, strong, and straight, and the foliage thick and heavy. Crop failures are frequent and the nuts are small. In regions

in which the altitude is high, from 1,500 to 2,000 feet above the sea level, and the rainfall low, from 18 to 25 inches, the tree is not so tall and the top is more spreading; the bark is rough, the branches are more numerous, slender and willowy, and the foliage is a light green color. As the altitude increases and the rainfall decreases, a larger percentage of the trees produce annual crops of nuts. The nuts are larger and the crop failures are less frequent until the altitude becomes over 2,000 feet and the rainfall less than 20 inches, when the crops become less certain and the nuts smaller. It is evident that, as far as the native trees are concerned, the most regular and the largest yields and the best nuts are secured where the altitude is from 1,000 to 1,800 feet, with the annual rainfall from 20 to 30 inches.

Records compiled over a series of years show that the size of the nut is markedly influenced by the seasonal conditions. The size and weight of Texas native seedlings are often reduced to one-fourth or one-third of normal by protracted drought. Dry weather affected very similarly a number of named varieties that were under observation in Georgia. In addition to reducing the size of the nuts, extremely dry weather has a tendency to shorten the axes or length out of proportion to the thickness of the nut. Records from the Georgia Experiment Station show that the growing seasons of 1911 and 1914 were extremely dry, while those of 1912 and 1913 were normally moist. As a result, the axes of the nuts grown during the two dry years were much shorter than those of the pecans yielded in the normally moist seasons on the same trees. The thickness of the nuts was not materially affected by dry weather. This seasonal influence was

especially pronounced on the Moneymaker and Russell No. 3 varieties.

COMMERCIAL IMPORTANCE OF THE PECAN

The pecan does not rank very high in the United States in commercial importance when contrasted with some of the older and more important horticultural crops. However, when compared with other nuts its ranking is exceptional, especially when one takes into consideration the limited time it has been under cultivation.

It is significant that the native pecans are more valuable and require less expense to growers to produce and harvest than any other wild or uncultivated horticultural crop. In addition, thousands of acres planted to improved varieties now coming into bearing will within the next decade compete strongly with the native product even on a basis of tonnage. The commercial status of the pecan may be seen from a study of the following tables taken from the United States Census report for 1920:

TABLE I

TOTAL NUT PRODUCTION IN UNITED STATES

(pounds)

	1909	1919
Almonds	6,793,539	15,852,965
Pecans	9,890,769	31,808,548
Walnuts	22,026,524	59,840,470

This table shows that the pecan easily ranks next to the walnut in commercial importance, and that it is gaining on that important nut.

Table II gives the imports of nuts into the United States. These figures clearly indicate that there is little danger of serious foreign competition in the domestic market for pecans.

TABLE II

IMPORTS OF NUTS
(pounds)

	1919	1920	1921
Almonds—			
Not shelled	7,482,538	6,703,181	4,402,271
Shelled	28,007,908	18,150,678	20,873,872
Cream or Brazil	43,076,348	13,998,138	40,539,897
Filberts—			
Not shelled	16,747,304	14,095,930	14,729,108
Shelled	3,778,986	5,034,009	3,854,169
Marrons, crude	5,012,194	29,480,008	23,340,988
Palm and palm nut, kernels	5,613,056	8,329,034	230,194
Walnuts—			
Not shelled	21,235,078	16,072,807	33,414,118
Shelled	10,260,899	15,818,025	13,330,600
TOTAL IMPORTS IN DOLLARS			
	$57,510,164	$59,559,019	$36,501,682

The unshelled pecan is still practically unknown in most large domestic markets, while it is not found on any of the world markets outside of America. It is, therefore, evident that the opportunity for the development of new markets is almost unlimited, especially when one considers that the pecan has been more than able to hold its own whenever and wherever brought into open competition with other nuts.

TABLE III

PRODUCTION OF PECAN NUTS IN POUNDS FOR 1909 AND 1919

	1909	1919
Texas	5,832,367	16,755,421
Oklahoma	894,172	4,297,752
Georgia	354,046	2,544,377
Louisiana	723,578	2,242,859
Mississippi	637,293	1,599,245
Alabama	228,341	1,179,735
Florida	307,632	1,025,673

TABLE III—*Continued*

	1909	1919
South Carolina	159,823	525,783
Arkansas	249,995	348,382
North Carolina	74,861	145,753
Tennessee	25,581	70,594
Kentucky	28,577	50,352
Virginia	10,568	33,927

Table III gives the production of pecans by states according to the 1920 census. A considerable part of the yield east of the Mississippi River is from orchards planted to improved varieties, while a large percentage west of the Mississippi is from native seedling trees.

CHAPTER II

HISTORY OF PECAN-GROWING

Pecan is an American Indian word, originally *pâcan,* and was used by the Indians to designate all nuts that were so hard as to require a stone to crack them. This name was appropriated by the French settlers of the Mississippi basin for one nut in particular, *Hicoria Pecan.*[1] The word hickory, from which Hicoria is derived, is likewise from the Indian, *powcohicora,* being the name applied to the liquid obtained by pounding the kernels of the nuts and throwing them into boiling water. This *powcohicora* was used to thicken venison broth and to season hominy or corn cakes, and in some instances was allowed to ferment for an intoxicating drink.[1]

The first appearance of the pecan on this continent is unknown. In Texas, fossil remains of trees have been found embedded in the lower cretaceous formation in Lampasas County.[2] E. E. Risien, of San Saba, Texas, has in his possession a perfect pecan fossil which was found thirty feet below the surface in the San Saba Valley, being thrown out by a blast from a well.[3]

This would at least indicate that pecan trees were growing in the western section of the country during the cretaceous period. However, many are inclined to believe that the pecan

[1] Trans. Amer. Philological Soc., 1872, p. 25.

[2] Pecans and Other Nuts in Texas, Bull. No. 2, Tex. Dept. Agric., p. 17.

[3] American Nut Journal; Topic, Pecan Pollen, by E. E. Risien.

originated in the region around southern Illinois, where the nuts were found in quantities by the explorers and fur traders who called them the Illinois nuts from the name of the Indian tribes in that region. From this point, the theory is that the trees could easily have been distributed southward along the Mississippi Valley by the natural flow of the water. Since it is well known, however, that the Juglandaceæ, of which family of plants the pecan is a member, appeared on this continent in the cretaceous period, it is very probable that the pecan originated at that time. An examination of a geological map of that period shows the shore line of the Gulf of Mexico extending as far north as the mouth of the Ohio River, thence dipping in a crescent shape to the northwest of Texas, thus putting the northern parts of both the Mississippi and the Pecos valleys on the same Gulf shore line. It would, therefore, have been easy for the pecan to be carried from one part of the coast to the other by the wash of the waves. It is reasonable to suppose that, as the shores of the Gulf receded, the pecan followed and remained where it found congenial surroundings. (See Fig. 2.)

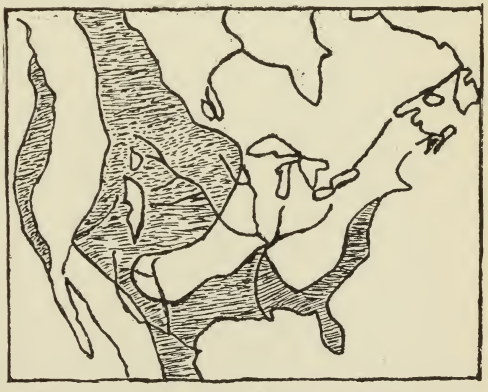


FIGURE 2.—A map of North America in cretaceous times. The shaded areas show parts of North America submerged at that time.

According to Bancroft, DeSoto, the discoverer of the Mississippi, also found the pecan.

This was in 1541. "After leaving the land of the Chickasas, DeSoto and his party ascended the Mississippi * * * until at length they came, as it would seem, upon the district of Little Prairie. * * * The wild fruits of that region were abundant; the pecan nut, the mulberry, and two kinds of wild plums, furnished the natives with articles of food." [1]

Following the above, there seems to be no reference to the pecan again until 1704, when Jean Penicaut made note of it in his "Annals of Louisiana" which covered the first twenty-eight years of the settlement of that province, namely from 1694 to 1722. Penicaut accompanied the first expedition of d'Iberville, famous in early French-Canadian history, to the wilderness of the lower Mississippi as a ship's carpenter. He was employed in various capacities in the colony and was one of the few Frenchmen who escaped at the time of the Natchez massacre in 1729.[2] Penicaut in his description of Natchez, an Indian village on the Mississippi, said, "The natives have three kinds of walnut trees; some whose nuts are as big as the fist from which bread for their soup is made; the best ones, however, are scarcely bigger than the thumb and are called 'Pacane.'" [3]

In a history of New France, published in 1744, Xavier Charlevoix, a French missionary and traveler, who first descended the Mississippi to New Orleans in 1722, gave one of the best early descriptions of the pecan.

"The pecan is a nut of the length and of the form of an

[1] Bancroft—History of U. S., Vol. 1. p. 47.

[2] Dunbar Rowland's Mississippi, Vol. 2 p. 348.

[3] "Ils ont de trois sortes de noyers; il y en a dont les noix sout grosses comme le poing, et qui servent a faire du pain pour leur soupe, mais les meilleures ne sont guere plus grosses que le pouce, ils les appellent pacanes."—Margray, Memoires et Documents, Vol. 5, p. 445, Description du village de Natchez.

acorn. There are some whose shell is very thin; some others have it harder and thicker, this is to the detriment of the fruit; they are even somewhat smaller. All have a very fine and delicate taste. The tree which bears them grows very high; its bark, the odor and form of its leaves have appeared to me similar to those of the European walnut trees."[1]

In 1758, in a history of Louisiana, Le Page du Pratz, a French explorer in America who visited New Orleans in 1720 and who spent eight years exploring the Mississippi Valley, also described the pecan very accurately and in praising its flavor mentioned the very delectable pralines that the French colonists made out of the kernels. This confection is still made extensively around New Orleans.[2]

It was not until peace was declared with the French and Indians in 1762 that the pecan was known to the English colonists on the Atlantic seaboard, some of the nuts being carried to New York by fur traders from the Mississippi Valley. William Prince in 1772, so it is recorded, planted thirty nuts and succeeded in raising ten plants, eight of which he sold in England for ten guineas each.[3]

In 1782, a Frenchman serving with Washington, DeCourset by name, brother of the famous botanist, left the record that "the celebrated General always had his pockets full of these

[1] "Le Pacane est une Noix de la longueur & de la figure d'un gros gland. Il y en dont la coque est fort mince, d'autres l' ont plus dure & plus épaisse, & c'est autant de défalqûe sur le fruit; elles sont même un peu plus petites. Toutes sont d'un goût fin and delicat; l'Arbre, qui les porte, vient fort haut: son bois, son ecorce, l'odeur & la figure de ses feuilles m'ont paru assez semblables aux Noyers d'Europe." Journal d'un Voyage fait par ordre du Roi dans l'Amerique Septentrionale, Vol. 1, p. 141.

[2] Historie de la Louisiane, ii. 26.

[3] Brendel, Amer. Nat., xiii., p. 575.

nuts and that he was constantly eating them.'' [1] In his diary, under date of 1794, Washington mentioned planting around his place at Mt. Vernon, ''several Poccon or Illinois nuts'' that had been sent to him.

In 1785, the pecan was classified botanically by an early American botanist, Humphrey Marshall, as *Juglans Pecan.* Marshall, a Quaker of Pennsylvania, trained as a stone mason but took up farming, and finally, when considerable property was left him, cultivated his scientific tastes and became a botanist. From his description of the pecan tree published in his work ''Arbustrum Americanum,'' it is evident that he had never seen the tree in its habitat. On page 69 of this publication under *''Juglans Pecan—The Pecan or Illinois Hickery,''* is the following description: ''This tree is said to grow plenty in the neighborhood of the Illinois river, and other parts to the westward. The young plants raised from these nuts, much resemble our young Pig-nut Hickerys. The nuts are small and thin shelled.''

The next botanical account was that of Captain Wangenheim in 1787. He was one of the Hessian troopers sent to this country in the Revolution, and during his eight years of service made a study of the timber trees. His description of the pecan was drawn up from a small cultivated tree in the nursery of William Prince at Flushing, New York. He named it *Juglans illinoensis.* This tree was one of those planted in 1772 and had not yet borne fruit. See page 215.

In the southern colonies on the Atlantic coast, the pecan was described by Thomas Walter in his publication ''Flora

[1] Du Mont de Courset, Le botaniste cultivateur, Ed. 2, Vol. 6, p. 237. "Mon frere, qui servoit dans l'armée de Washington, en 1782, me dit que ce célèbre général avoit toujourns sa poche pleine de ces noix, et en mangeoit continuellement.

Caroliniana'' in 1787. He was an Englishman who had a plantation in St. John's Parish on the Santee River, South Carolina, where he made an extensive collection of southern plants which are preserved in the British Museum. After describing the foliage of the pecan tree, evidently a nursery specimen, he ended with the words ''fructus non vidi''—the fruit I have not seen.

Thus, from the beginning of the eighteenth century to the opening of the nineteenth, the pecan was scattered from its habitat in the Mississippi Valley to the Atlantic coast by Indians, travelers, and by men like Washington who loved a beautiful tree. From Texas to the Carolinas there are numbers of huge seedling pecan trees that must date from pioneer days and whose majestic and hoary beauty has graced the southern landscape for over a hundred years and whose fruit has been treasured by all the succeeding generations. They are fitting monuments to some one's interest in trees and the planter is ''blest in that he has blest many.''

The nineteenth century witnessed a different sort of development of the pecan. Between 1800 and 1900 the pecan was changed from a wild nut to an improved orchard product of great commercial value. The story of this progress is again that of venturesome spirits, men who dared to tread unknown paths, explorers in science and industry. The first of these was A. E. Colomb, of St. James Parish, Louisiana. His persistence demonstrated that nut-trees, and especially pecans, could be propagated by grafting. Until this time and for nearly half a century afterward, it was generally supposed that nut-trees could not be reproduced asexually, and writers on forestry and orcharding seemed to acquiesce in this theory. Consequently until 1890 the public planted nuts from a

favorite tree if they wished to propagate it. Dr. Colomb, however, finding an exceptionally fine tree on the Anita plantation of Amant Bourgeois, in St. James Parish, Louisiana, attempted to propagate it by grafting, early in the forties. Failing in this, he later cut cions from the tree and carried them to the late Telesphore J. Roman, owner of the Oak Alley plantation, whose slave gardener, Antoine by name, succeeded in grafting sixteen trees near the mansion and quarters during the winter of 1846 or 1847. Later 110 trees on the same plantation were grafted. The variety was the Centennial and this was the first commercial orchard, i.e. the first planted with the definite view of producing nuts for sale. Shortly after the close of the Civil War (1865) nuts from this orchard were selling at $50 to $75 a barrel.[1]

This incident is epochal in pecan history, for without the perpetuation of certain choice seedling trees by budding or grafting, the industry never could have been standardized, and the nuts, even in the best cultivated orchards, would have been no more uniform and valuable than the greater part of wild seedlings now on the market. However, during the stormy reconstruction period following the Civil War, the Anita plantation changed owners and the orchard was cut down although it was at the height of its bearing, only a few trees around the house being left. The propagation of pecans by grafting was left undeveloped and unadvertised, and it was nearly half a century later before asexual propagation of these nut-trees became a general practice among growers.

The next impetus to the pecan industry was given by Texas. When that state was opened for settlers, the pioneers found

[1] Wm. A. Taylor, Promising New Fruits, Yearbook Dept. Agr., p. 408.

great forests of these trees along the river valleys of the western and central sections. The nuts were gathered and sent to the eastern markets in such quantities that their very numbers impressed the general public, and seedling orchards were planted from Texas to Maryland. Koerber said, "But for this industry of nut gathering, the people of some localities must have starved for lack of remunerative labor. Hundreds of both white and colored people go out with horses and wagons to gather these nuts." In 1880 San Antonio, Texas, was the most important center of the pecan trade, and during that year over 1,250,000 pounds of nuts were marketed, the price ranging from 5 to 6 cents a pound in wagon-load quantities. The commercial value of these wild seedlings aroused the public to the advisability of growing pecans in commercial orchards.[1]

In 1871 a pecan orchard of 150 seedling trees was planted in Hinds County, Mississippi, by George Whitfield. In the next twenty years orchards rapidly increased in number. W. R. Stuart of Ocean Springs, Mississippi, set out 100 trees, and Chas. E. Pabst of the same place also planted an orchard. Capt. Sam H. James, of Mound, Louisiana, started the first large commercial orchard of seedling trees about 1879, and T. W. Oliver set out a seedling orchard near Montgomery, Alabama, in 1882. G. M. Bacon of DeWitt, S. W. Peek of Hartwell, J. P. Gill and James Tift, both of Albany, were pioneers in Georgia. F. A. Swinden of Brownwood, Texas, planted 400 acres to seedling trees in 1888. Large nuts with soft shells were selected and set where the trees were to grow. Louis Biediger, Idlewild, Texas, planted 500 trees, using the

[1] Nut Culture in the United States, U. S. Dept. Agr., Division of Pomology.

nuts of the varieties Biediger, Grant, and Idlewild. John S. Horlbeck, of Charleston, South Carolina, set out 1,000 acres to seedling trees in 1890. An orchard of 150 seedling trees was started at Federalsburg, Maryland, and in Illinois plantings of fifteen to twenty-five acres were common. At Danville, New York, an orchard of forty or fifty trees was attempted and at Martinez, California, 600 trees were planted on the farm of the late Richard J. Strentzel.

Fortunately for the pecan industry, Emil Bourgeois of St. James Parish, Louisiana, revived in 1877 the idea of propagating pecans by grafting, and inaugurated a new era in the industry. Bourgeois cut cions from a highly valued tree growing on the plantation of the late Duminie Mire, and succeeded in getting eleven cions to grow out of the twenty-two that he set as top-grafts on seedling trees. When these grafts began bearing, he commenced propagating young trees for planting in orchards and for sale to the nearby planters. This variety was later named the Van Deman.[1]

It was William Nelson, however, who first propagated pecans on an extensive commercial scale. He first offered them for sale in 1882. He was associated with Richard Frotscher, of New Orleans, in the nursery business. Centennial, Frotscher, and Rome were the first budded and grafted varieties offered for sale. All three of these were catalogued by Frotscher in 1885.[1]

In 1883, Chas. E. Pabst, of Ocean Springs, Mississippi, established the Ocean Springs pecan nursery, and was the first in his state to sell grafted stock. He was followed by W. R. Stuart and about ten years later by G. M. Bacon of DeWitt, Georgia, by P. J. Berckmans of Augusta, and later

[1] Wm. A. Taylor. Promising New Fruit, Yearbook, Dept. Agr.

by J. H. Girardeau of Monticello, Florida. E. E. Risien of San Saba was the pioneer nurseryman of Texas in budded and grafted pecans, having been the first to perfect the ring-bud method.

Grafted and budded stock, however, was high in comparison with seedling stock. This was due to lack of skill in propagation, a low percentage of successful grafts, and the length of time required to grow them large enough for orchard planting. Grafted stock was selling as high as $2.50 a tree, and the average grower was not sufficiently convinced of its superiority over seedling stock to make much of a venture in it. In 1887, H. S. Kedney, of Winter Park, Florida, planted an orchard of 4,000 trees covering 100 acres, near the town of Monticello, Florida. His varieties were of the class called "Mexican papershell." They were grafted in Texas on the order of Kedney and to secure the 4,000 trees about double that many seedlings were worked.[1]

Thus slowly but surely the idea of planting choice grafted trees of pecans in cultivated orchard plats was adopted. From 1890 to 1893 it received a great impetus from a number of choice varieties put on the market by the nurserymen and widely advertised. The Stuart, Van Deman, San Saba, and Pabst were among these early sorts. The Russell was introduced in 1894. In addition, many of the seedling orchards were coming into bearing and both the growers and nurserymen were convinced that no dependable percentage of the seedlings would come true. Hence many of the older trees in the orchards were top-worked. Notable among these were seedling trees on the Pabst, the Stuart, the Risien, and the

[1] Nut Culture in the U. S., U. S. Dept. Agr., Division of Pomology, p. 51.

Bacon estates. While there were still a number of seedling orchards planted, the more progressive growers and nurserymen were advising grafted or budded stock.

About 1900, the pecan was launched into a speculative crop. Individuals as well as corporations went into pecan-growing on a large scale, and in many localities in southern Alabama, Georgia, and Mississippi lands were quadrupled in price. Hundreds of acres were set to pecans and sold in units of one acre or more. In this as in all other new and promising industries, big holdings were purchased and partially developed by persons whose chief aim was not to grow nuts, but to profit by selling orchards, large and small, to the unsuspecting public at fabulous prices. In spite of such instances, however, the general progress of pecan-growing was not seriously affected, so that at present it ranks as one of the foremost horticultural industries of the South.

In the northern part of the pecan belt, very little interest has developed in the pecan as an orchard crop. Although the nuts from the wild seedlings are still harvested and put on the market, where they command a ready sale, the public is too skeptical of the commercial possibilities of the grafted or budded pecan to make a trial of it on a large scale. Scattered groups of the named varieties in numbers up to ten have been planted practically all over the section, but most of them are not yet old enough to bear fruit. W. N. Roper, of Petersburg, Virginia, was a pioneer in propagating varieties suitable for the middle and northern pecan belts. To him is due the Major, the original tree standing in what is known as the Major or Green River groves, in Kentucky and Ohio. W. C. Reed of Vincennes, Indiana, T. P. Littlepage of Washington, R. L. McCoy and J. F. Wilkinson of Rockport,

PLATE II.—Grave of Ex-Governor James Stephen Hogg, Austin, Texas, showing pecan and walnut trees planted to carry out his wish.

Indiana, despite the general apathy, have done valiant work in perpetuating choice varieties and in arousing interest in pecan culture.

By 1901 the industry in the South had grown to such an extent that a number of the men interested felt the need of an organization for the purpose of coördinating and disseminating reliable information on the subject of pecan-growing. Consequently on November 21, 1901, Robt. J. Bacon, of Baconton, G. M. Bacon of DeWitt, J. M. Tift of Albany, and J. F. Wilson of Poulan, met in the office of R. H. Warren, on Broad Street, Albany, Georgia, and constituted themselves the "Southern Nut Growers' Association." Robert J. Bacon was chairman and J. F. Wilson was secretary. The "Nut Grower," published at Poulan, was made the organ. Very soon this organization was expanded into the National Nut Growers' Association. With its development there was felt the need of subsidiary state or sectional associations to deal with local problems. As a result, the Georgia-Florida Pecan Growers' Association was organized at Thomasville, Georgia, in 1906. Among those present were H. C. White of Putney, J. B. Wight and W. C. Jones of Cairo, B. W. Stone and W. M. Parker of Thomasville, R. C. Simpson and H. K. Miller of Monticello, Florida. W. C. Jones was elected chairman, with R. C. Simpson as secretary.

In Texas, the first organization of nut-growers centered around a bit of sentiment and patriotism. On March 2nd, 1906, Gov. James Hogg, of Texas, realizing his approaching end, said in conversation to friends: "I want no monument of stone or marble, but plant at my head a pecan tree and at my feet an old fashioned walnut * * * and when these trees shall bear, let the pecans and the walnuts be given out among

the plain people of Texas, so that they may plant them and make Texas a land of trees.'' In order to carry out more fully this generous wish of Gov. Hogg's, his friends called a meeting at Austin, May 29th and 30th, 1906, of all growers of pecan and walnut trees in order to decide on the varieties to plant at the grave. The result was the organization of the Texas Nut Growers' Association. Those instrumental in calling this meeting were E. W. Kirkpatrick of McKinney, F. M. Ramsey of Austin, J. S. Kerr of Sherman, and C. Falkner of Waco. It was due to the efforts of this body that the pecan was adopted as the state tree of Texas. After five years, however, the aim of this association was found to be so similar to that of the Texas Horticultural Society that it was merged into that organization.[1]

In 1920 there was organized at Brownwood the Texas Pecan Growers' Association, with J. W. White of Mason, as president, J. H. Burkett of Clyde, as secretary, and Joe Burkett of Eastland, as attorney. In August, 1921, it chartered the Texas Pecan Growers' Exchange, and appointed C. D. Jarrat as sales manager.

During the period between 1900 and 1922 a great mass of detailed study on the pecan was done, that had necessarily been overlooked in the rapidly expanding industry of the preceding decades. The investigations have been along the lines of propagation, pollination, nomenclature, varietal and soil adaptation, cultural practices, fertilizers, and the protection of the tree against the various pests. Much of this work has been conducted by the United States Department of Agriculture, by workers of the southern experiment stations, and by nurserymen and practical pecan-growers.

[1] Pecans and Other Nuts in Texas." Bull. No. 2, Texas Dept. Agr.

CHAPTER III

PECAN SEEDLINGS AND CARE OF THE NATIVE GROVE

A CONSERVATIVE estimate of the total number of seedling pecan trees, both native and planted by man, in the United States, is from seventy-five to one hundred million.

In Texas, Oklahoma, Arkansas, and Louisiana the native pecan has become of considerable commercial value as a nut-producing tree. It is estimated that in Texas alone there are between fifty and seventy-five million native seedling trees, which produced, according to the 1920 census, 16,803,543 pounds of nuts in 1919 in spite of almost total neglect.

When the states containing native pecan timber were first settled by the pioneers, little care was taken to protect these trees. The nuts were of almost no commercial value at that time and for many years afterward. The pecan timber was often destroyed with other native growth in clearing the land along the creeks and rivers, which was generally the first to be cleared on account of its natural richness. Thus millions of native trees, probably including many that would have become valuable varieties, were destroyed without regard to the character of the nuts produced. These trees always made a stubborn resistance against the hand of the invader, continuing to send up sprouts annually often for a period as long as fifteen or twenty years. In a few cases, these sprouts

would be allowed to retake the land, though on thousands of acres the pecan timber was totally destroyed or was sometimes left in a close fringe along the streams.

A large percentage of this timber in Texas and Oklahoma is still owned by persons, principally live-stock men, who are not directly interested in the pecan, and who pay little or no attention to its development. Usually they sell the crop on the trees in the summer or early fall at a low price to someone who harvests without regard, as a rule, to the welfare of the trees, and who generally leaves from one-third to one-half of the nuts unharvested.

CARE OF THE NATIVE GROVES

Very little attempt has been made to improve these native groves. They usually stand in pasture land where the trees have to struggle against animals and plants of every description, as well as against the elements. In many places, the native pecan trees, even when all other timber is destroyed, grow two or three times too thick for best results. Often trees that are barren and those that produce nuts too small to be of commercial value are allowed to crowd out those yielding valuable nuts. These groves should be given a better chance. The first step in their improvement should be to remove all underbrush and trees of other species. The pecan trees should then be examined carefully in a good bearing year and all barren specimens and those producing unprofitable crops of nuts removed, in case they are close enough to interfere with some good producing tree. If they are standing by themselves and are of suitable size, they should be worked over to an improved variety.

When it is practical, the land should gradually be put into

cultivation. The first breaking should be shallow so as to destroy as few of the lateral roots as possible. When the groves are uncultivated and the trees crowded, there is usually great damage from lack of moisture. This is shown principally in the shedding of immature nuts and in greatly reducing the size of those that do mature.

The improvement of the grove as suggested above will undoubtedly reduce the ravages from insect pests and diseases and will enable the trees to secure more moisture and plant-food, thereby enabling them to produce much heavier and better crops of nuts. It is, therefore, a very conservative estimate to state that the native crop of seedling pecans could be increased by several million pounds if the groves were given proper care and attention. Plate III shows a native grove of pecans owned by Senator T. H. Ridgeway of San Antonio, Texas, located on the Medina River. Plate III, lower, pictures a group just across the fence that is still in the virgin state. Senator Ridgeway cleared his grove in 1918 and he states that "The production from the fifty acre tract since 1918 has been sufficient to pay the purchase price of the land and the clearing, and the improvements thereon. This grove produced a crop of nuts in 1922 while all surrounding native trees failed."

The pecan tree, in order to function properly, demands a constant and abundant supply of moisture. The oldest and most productive groves stand where nature gives them this supply.

SEEDLINGS PLANTED BY MAN

A large percentage of the older pecan orchards set out by man are seedlings. Even though the choicest nuts may have

been selected for these plantings, the resulting seedlings, in a large measure, were worthless.

Cross-pollination is so prevalent and has been going on for so many generations that trees cannot be expected to come true from seed. Even nuts from a self-fertilized tree do not breed true, since the parent itself is likely to be a cross or a hybrid and its offspring would inherit characteristics from the various types going to make up the ancestry of the tree. The nuts of a seedling vary widely from those of the mother, in size, shape, color, and quality. One hundred pecan nuts may be taken from a tree of any good variety and planted. No two of the resultant seedlings are likely to produce nuts alike; and the chances are that none of them will equal the nuts of the parent tree. Only one out of several thousand seedlings may be expected to produce superior nuts, even though the largest pecans may have been planted.

Seedling trees also come into bearing late, often failing to produce nuts until they are fifteen or twenty years old, and in some instances are barren. Seedling pecan trees should be grown for nursery purposes, for budding and grafting, but they should be fruited only by the novice or the experimenter who is seeking information rather than crops of desirable nuts.

IMPROVED VARIETIES FROM SEEDLINGS

Of all the hickory family, the pecan seems most susceptible to improvement in size and quality of its fruit. Marked advancement by selection has already been made by a number of growers. Improvements in varieties, or rather the increased number of improved varieties, has resulted largely from selections from seedling trees. Some were taken from the wild,

some from seedlings planted by man with little or no knowledge of inherent characters, while others were obtained by cross-breeding existing varieties.

The marked variation in pecan seedlings has played well into the hands of the experimenter who is seeking new varieties. Among every lot planted, he stands a chance of securing an offspring different and superior in some essential points from existing improved varieties. A very large percentage of the improved varieties of pecans catalogued in America today has originated from such seedlings planted by man.

The earliest varieties introduced, however, were individual tree selections, from choice seedlings of the native or wild pecan forests. One of the first was the Centennial. The original tree was a wild seedling on the east bank of the Mississippi River, Louisiana, early in the nineteenth century. It was given the name of Centennial because the nuts took the premium as the best pecan exhibited at the Philadelphia Centennial Exposition in 1876.

The Halbert was a native seedling tree on the plantation of H. B. Freeman in the Colorado River bottom near Milburn, Texas, sometime before 1891.

The San Saba was found as a wild seedling at the junction of the San Saba and Colorado rivers near San Saba, Texas, and was introduced by E. E. Risien about 1893.

The original tree of the Walford was discovered in the Wilson creek bottom, by E. W. Kirkpatrick, near McKinney, Texas, about 1898.

The Claremont, which also originated as a wild seedling, was found on the Pecania plantation, near Ferriday, Louisiana, and was propagated by H. E. Van Deman about 1907.

The Indiana, which is one of the northern varieties of pecans,

was a large native seedling tree in Busseron township,, Knox County, Indiana, and was brought to notice by M. J. Niblack of Vincennes.

Among the long list of varieties originating from nuts planted by man may be mentioned such well known sorts as Alley, Appomattox, Curtis, Delmas, Frotscher, Mantura, Mobile, Moneymaker, Pabst, Russell, Success, Schley, Stuart, Van Deman, and Texas Prolific.

At the present time large numbers of young pecan trees resulting from various crosses of the better known varieties are grown in several sections adapted to their culture. However, only a few have yet been produced from cross-breeding as compared with the numbers from nuts planted where only one, and sometimes neither, of the parent trees are known.

E. E. Risien of San Saba, Texas, crossed the San Saba with the Sloan and secured fifteen nuts from the cross. He planted these nuts and used buds from the resultant seedlings for top-working some rather large pecan trees so as to secure fruit as early as possible. He found very great variations in both fruit and foliage of these crosses and considered only one of them worthy of propagation. From the results he concluded that the male plant in a pecan cross is dominant. Later Risien crossed the San Saba with the Atwater as the male parent and produced a variety which he named Venus. From the Texas Prolific crossed with the Atwater as the male parent he secured the Banquet variety. These experiments were followed by several other crosses from which developed a number of important varieties.

In 1903 C. Forkert of Ocean Springs, Mississippi, crossed the Jewet with both the Pabst and the Success. He obtained better nuts from his crosses between the Success and the

Jewet than between the Pabst and the Jewet. A tree from one of these crosses he named Dependable and considers it a very promising variety.

Numerous other crosses have been made between various varieties of pecans since the experiments of these two pioneers and it is likely that within the next few years a long list of new varieties will be brought out. The principles of plant-breeding now being applied to the breeding of pecans are the most direct means of securing a high percentage of trees bearing good nuts among the progeny which results from definite crosses combining the desirable characters of two varieties.

CHAPTER IV

PROPAGATION OF THE PECAN

THE pecan is more difficult to propagate than most fruit-trees. It is not feasible to root pecans from cuttings, and seedlings fail to come true to the parent type. The propagator has, therefore, to resort to budding or grafting to perpetuate desirable varieties.

The propagation of pecan trees is a highly specialized industry, requiring a skilled operator to get a high percentage of buds or grafts to live. The amateur is likely to meet with discouraging results in attempting to propagate pecan trees, and is advised to buy his stock ready budded or grafted unless he desires to do the work largely for experience.

GROWING SEEDLING STOCK FOR BUDDING AND GRAFTING

The pecan can be budded or grafted on almost any species of hickory, though its own roots are more compatible as stock. No stock superior to the pecan seedling has yet been found for propagating the pecan; and nurserymen employ them almost exclusively. It is hoped, however, that a stock will be discovered that will produce dwarfed, heavy fruiting, and early bearing trees so as to shorten the time between planting and the production of profitable crops. Furthermore with trees of less height, spraying and pruning, as well as the harvesting of the nuts, will be simplified greatly.

There is considerable diversity of opinion among nursery-

men and growers in regard to the best source of nuts for the production of pecan nursery stock. Nurserymen in northern Florida and in southern Georgia, where the greater proportion of all pecan nursery trees are grown, are generally of the opinion that nuts from Louisiana and Texas do not germinate as well as the eastern pecans. The statement is also made that southern seedlings are not satisfactory for northern cions, and vice versa. Neither makes satisfactory progress when the two extremes are used in grafting, owing to the difference of time in starting growth in the spring, and in maturing wood or becoming dormant in the fall. The use of stocks from the northern border of the pecan-growing area, however, offers a field for further investigations to the experimenter who may be in search of stock that will somewhat dwarf and increase the productiveness of southern varieties.

Nurserymen who contemplate propagating pecans to be grown toward the northern limits of their culture should secure nuts for growing stock as far north as the trees are to be planted in order to give them sufficient hardiness to withstand the climatic conditions. However, the nurseryman propagating trees for the great mass of pecan-growers of the lower South, where practically all the large commercial orchards are situated, may expect good results by using plump nuts, medium in size, selected from vigorous growing healthy seedling trees in the same locality or in a latitude and climate approximating that of the nursery. When nurserymen have access to the same seedling pecan trees year after year, they find that nuts from certain individuals produce much better stock than from others, even though there may be no apparent difference between the two lots of nuts.

Occasionally the nurseryman fails to obtain a sufficient quantity of desirable seedling pecan nuts for nursery purposes and has to resort to some of the commercial varieties. If he has a choice of several varieties, he should select those which give promise of producing the most uniform and vigorous seedlings for budding or grafting. The nuts from the various kinds, when planted, may be expected to behave differently in separate regions and vary from year to year even in the same locality. Plantings at the Georgia Experiment Station, however, will give the reader some idea as to the relative results from several varieties grown for nursery stock. The nuts were harvested in the fall of 1919 and held in paper bags in an office building, at ordinary living-room temperature, until February, 1920, when they were planted in uniformly good soil, well fertilized and cultivated. Table IV gives a summary of tree growth as recorded June 15th, 1922.

TABLE IV

VARIETIES GROWN FOR NURSERY STOCK BY GEORGIA EXPERIMENT STATION

Variety	No. nuts planted	No. grew	Highest plant inches	Lowest plant inches	Av. height inches	% above $\frac{7}{8}$ in. diam.
Alley	20	8	54	8	25	62
Appomattox	25	19	37	6	22	62
Atlanta	25	21	38	7	19	48
Beveridge	22	1	8	8	8	0
Bradley	20	16	59	14	29	69
Centennial	15	11	42	8	18	45
Curtis	20	16	56	12	21	56
Frotscher	19	8	31	9	19	50
Jerome	19	13	35	9	17	32
Mantura	20	14	38	11	22	56
Mobile	15	9	32	12	19	55
Moneymaker	25	17	31	9	19	53
Nelson	20	13	35	11	21	55

TABLE IV—*Continued*

Variety	No. nuts planted	No. grew	Highest plant inches	Lowest plant inches	Av. height inches	% above 7/8 in. diam.
Robson	21	13	28	16	22	87
Pabst	20	20	41	8	23	80
Rome	20	13	37	9	20	55
Russell	20	20	27	6	16	40
San Saba	20	15	35	6	17	47
Schley	3	3	28	16	22	66
Stuart	20	17	25	7	13	6
Teche	22	14	36	10	24	63
Van Deman	25	19	31	9	20	61
Seedling	25	17	32	10	19	54

The seedling nuts were from a tree growing in the same locality as the varieties. The plants from the former averaged a little larger than those from the named varieties. The Beveridge nuts were seriously affected by scab and germinated very poorly. The Stuart germinated fairly well but made poor growth, and only 6 per cent of the plants exceeded seven-sixteenths of an inch in diameter by the middle of June, 1922. Too few of the Schley nuts were planted to secure trustworthy averages, but the Alley, Appomattox, Pabst, Robson, Teche, and VanDeman showed relatively high averages in size. The nuts of each variety were from a single tree, yet the very great variation in size of plants seems as pronounced as though mixed seedlings had been employed.

Pecan seedlings in the nursery that do not reach a height above the ground of ten inches the second year should be cut out as weaklings unless abnormal soil or seasonal conditions account for the stunted growth. In determining when a seedling is ready to be budded or grafted, its diameter is a more important factor than its height. However, measurements of rather large numbers have shown that the relation between

height and diameter of pecan seedlings is fairly constant. When caliper measurements are taken about two inches above the soil, the following will approximate the averages, the heights recorded in inches, and the diameters in sixteenths of inches:

Height of seedling, inches.	Diam. of seedling, sixteenths of an inch
10 to 14	5
14 to 18	6
18 to 22	7
22 to 26	8
26 to 30	9
30 to 34	10
34 to 38	11
38 to 42	12

Soils for pecan nurseries are almost as variable as those for growing the trees in an orchard. However, a deep sandy loam with a clay subsoil, highly retentive of moisture, is preferred. Heavy tenacious soils should be avoided as much of the grafting and tree digging is performed during the winter when there is a high degree of moisture. Soils of this kind, if worked while wet, become very hard and are difficult to handle in growing nursery stock. On the other hand, a deep loose sandy soil is not desirable because the young trees are likely to send down a very long tap-root which is practically void of lateral roots. A soil somewhat intermediate between these two extremes is more suitable. A sandy loam well filled with decaying organic matter and having a clay subsoil not more than two feet from the surface can be worked at almost any time of the year and will produce trees with a considerable number of lateral roots. A young tree with a good lateral root system transplants more successfully than one with very few lateral roots. (See Fig. 3.)

At best pecan seedlings make little top growth the first year. Thus it is very important that the most favorable conditions for growth be provided in order that the seedlings may become large enough to be budded or grafted as early as possible.

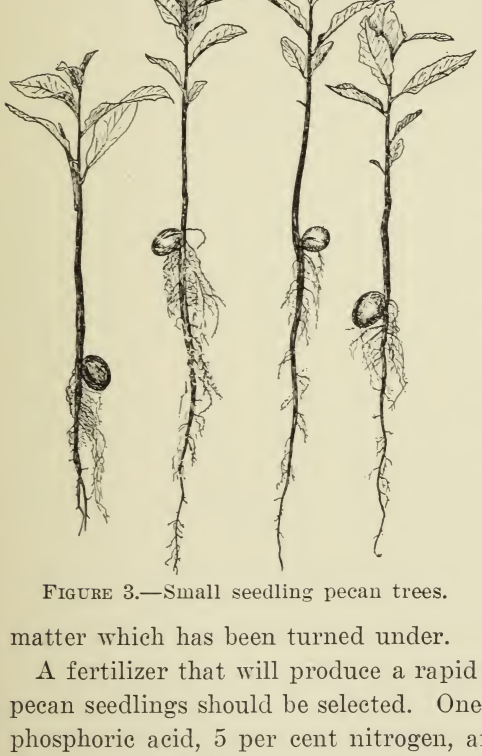


FIGURE 3.—Small seedling pecan trees.

If the soil is lacking in organic matter, a leguminous cover-crop may be turned under or stable manure applied several weeks before planting the nuts. In preparing the soil for a pecan nursery, it should be broken to a depth of ten to twelve inches and subsoiled if a hardpan is present. It should be harrowed thoroughly, so as to cut up and incorporate with the soil any coarse organic matter which has been turned under.

A fertilizer that will produce a rapid woody growth in the pecan seedlings should be selected. One analyzing 8 per cent phosphoric acid, 5 per cent nitrogen, and 3 per cent potash will be suitable for applying to the soil before the nuts are planted. From 400 to 700 pounds to the acre will be sufficient at this time. It should be applied in the drill just before

the nuts are planted and well mixed with the soil by running a plow through the furrows.

If the young seedlings show a lack of thrift in the late spring, one or two applications of a nitrogenous fertilizer may be given. From 75 to 100 pounds to the acre of sulfate of ammonia or nitrate of soda at each time will be sufficient. When two applications are needed, the first should be given about the middle of May, and the other about the middle of June. If only one side application is required, it should be given about the first of June. Early the second spring after the nuts have been planted, that is in the early spring after the young trees have had one season's growth and each spring thereafter as long as they stand in the nursery, from 500 to 1,000 pounds to the acre of the same grade of fertilizer as was used before the nuts were planted should be given the young trees, applied between the rows and stirred into the soil with any convenient cultivator.

The pecan nuts may be planted in the fall soon after they are harvested, or they may be stratified and held until late winter or early spring. In stratifying nuts, they are packed in sand and kept in a dark cool moist place, where they can be protected against rodents and excessive moisture until time to plant. On overflow lands or in the northern part of the pecan belt it may be advisable to stratify the nuts and hold them for spring planting. However, in the lower South it is best to plant in the late fall or early winter so that the nuts may have time to absorb moisture and be in readiness to germinate in the early spring as soon as the soil becomes sufficiently warm to start growth. When plantings are made in spring, weather conditions are likely to be unfavorable for field work and delay plantings to such an extent that some of

the nuts may fail to germinate the first season, and the seedlings from those which do sprout will not reach normal size that year. Late November and all of December and January are suitable for planting pecans. It is very important that the nuts should not become dry before this time.

The rows are laid out from four to six feet apart, the nuts dropped from six to eight inches apart in the row, and covered from one and one-half to two and one-half inches deep. Some nurserymen recommend that the rows be put six feet apart and the nuts dropped every five or six inches in the row. This method of spacing allows the nurseryman to dig out and destroy the weak and stunted seedlings soon after growth begins the second season, leaving only the strong and vigorous ones to be budded or grafted. Just why there is almost invariably a large percentage of small stunted seedlings in a pecan nursery is not fully understood. The practice, however, of discarding the poorly filled and defective nuts will probably eliminate many of those seedlings low in vitality and bring about considerable improvement in the general vigor of the nursery stock.

Well graded nuts may be planted by means of a machine which spaces them properly. Most nurserymen, however, follow the practice of dropping the nuts by hand.

Rows should be laid out as straight as possible. After applying the fertilizer in the drill, a broad flat ridge should be made by listing on the furrow. When the nuts are to be planted, these ridges should be opened, just ahead of the person dropping the nuts, by means of a scooter or bull-tongue plow with a heel-pin slide or some other attachment for leaving the furrow open. A very good practice is to drop

the nuts about five or six inches apart in this furrow and, for the time being, cover them only about one inch deep. Some nurserymen cover the nuts by running a wheelbarrow along the furrow which presses them into the freshly plowed soil, and at the same time a barrel hoop or some similar object attached to the rear of the wheelbarrow drags along the furrow and covers the nuts to the proper depth. Almost any implement that is used for covering corn will serve. This method of planting leaves the nuts in a furrow, yet only slightly lower than the general level of the land, as the furrow is made by opening a ridge previously thrown up. When the rains come, the soil is washed into the furrows, gradually covering the nuts deeper. The nuts are left with a shallow covering at first, so that when warm days occur in the winter, the warmth, with the moisture in the soil, will cause them to germinate earlier in the spring than when covered much deeper at the beginning.

Early in the spring a harrow should be run along the rows to keep down weeds and grass. If the rows are uniformly spaced, the harrow can be driven very close without disturbing the nuts. Some nurserymen run a weeder over the land before the young trees appear. The mule or horse pulling the weeder is allowed to walk between the rows, cultivating two at a time.

As the young seedlings push through the soil in the spring, they should be cultivated in the same way as annual crops, such as cotton or corn. The old adage that tillage is manure is as true with pecan trees as for other plants. Cultivators of the Planet Jr. type, or the common scooter and scrape, may be used for cultivating the nursery. The two-horse riding

PLATE III.—*Above*, native Texas pecan grove with underbrush cleared away. *Below*, adjacent grove in virgin state.

cultivator may be employed with good results in large nurseries while the young trees are small enough to be straddled without injury. Frequent cultivations will reduce the amount of hoeing necessary. However, an occasional clump of grass or a weed will spring up in the row that cannot be reached by the cultivators and should be removed with the hoe.

If the soil is inclined to form a crust over the surface as it becomes dry, or if the moisture is likely to become depleted in the spring about the time the young trees are pushing through, it is a good practice to place a mulch of some organic material, two inches deep and about eighteen inches wide, over the rows after the nuts are planted. The mulching material should be finely broken or shredded so as to allow the young trees to push through without difficulty. Wheat chaff or partially decayed wheat or oat straw is suitable for this purpose. Leaves or pine straw from the woods should not be used, as termites—wood-lice—are almost certain to be introduced and will destroy a considerable percentage of the trees. The practice of mulching pecan nurseries is rather expensive, and when large areas are to be planted, friable sandy loam soil should be selected that will give satisfactory results without mulching.

Pecan nuts planted in the late fall or early winter will germinate the following spring. These should produce plants from eight to twelve inches above the ground, and send down tap-roots from two to two and one-half feet below the surface the first season. The more vigorous should be large enough to bud in the second summer of their growth or to be grafted in the winter following. It will be one year later before the less thrifty plants will be large enough to propagate.

TOP-WORKING PECAN TREES

The importance of top-working as a means of changing seedling pecan trees into more desirable varieties can scarcely be over-estimated. Some of the objects accomplished by this process are: The changing of non-productive and unprofitable seedling trees, both native and planted, of the desired size and age, into desirable varieties; the transforming of unsatisfactory varieties, those not suited to the region or susceptible to diseases or insect pests, into valuable trees of more suitable kinds; the hastening into bearing of new or untried varieties.

It should be remembered that in top-working pecan trees,

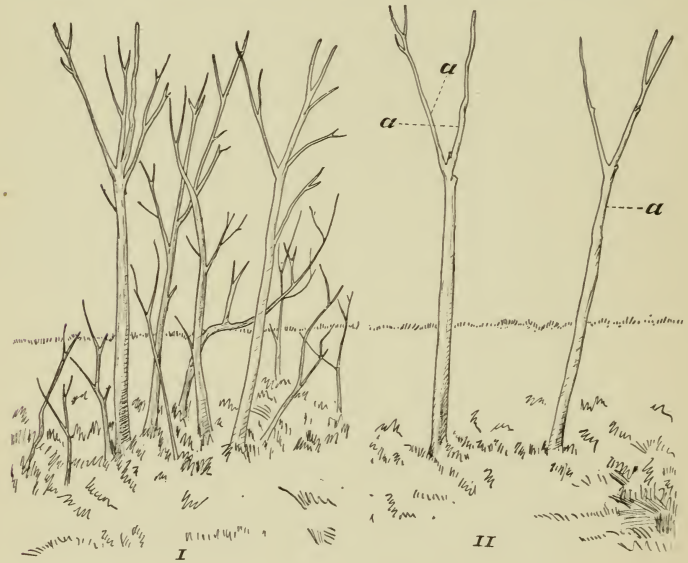


FIGURE 4.—*I*, Showing sprouts before thinning out undesirable ones; *II*, showing sprouts after thinning. *a*, Place where bud should be inserted.

the same fundamental principles of budding and grafting are applied as in the propagation of small nursery seedlings.

Some preparatory work is necessary before top-working pecan seedlings in forests or native groves. All timber or underbrush within a radius of twenty or thirty feet should be removed to give space for cultivation. The weeds and grass should be raked and burned from near the trees that are to be top-worked in old fields. When there are several sprouts in a clump, one or two of the best and strongest should be saved for top-working and the the others cut down (Fig. 4). This preliminary work is, of course, unnecessary in a pecan orchard where the trees are properly spaced and the land already in cultivation.

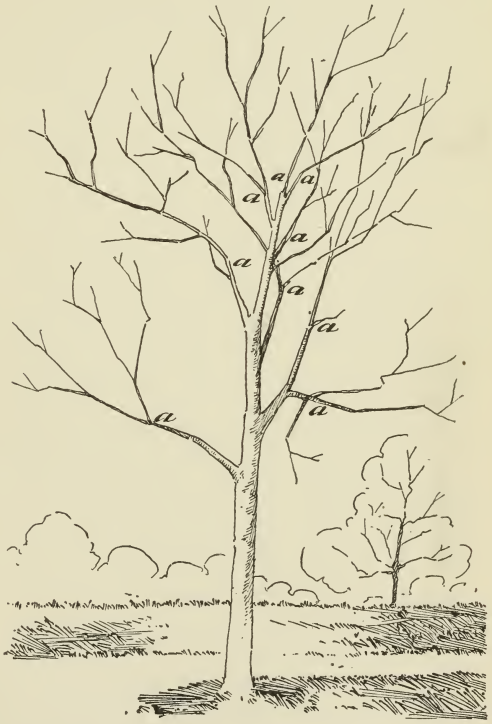


FIGURE 5.—Native seedling tree, showing points where limbs are to be removed for top-working.

There are two radically different methods in the

treatment of trees preparatory to top-working. The old method, and the one still in most common use, is to cut back the top of the trees, often to mere stumps, during the dormant period, in order to force out new and vigorous sprouts in which to insert buds or cions. These new sprouts are thinned out when they are from six to eight inches long and are generally ready for budding by late summer, or for both budding and grafting the following spring. Trees for top-working by this method should be cut back to the point where it is desired to form the new head, leaving a few of the lower branches to carry on the vegetation processes. Trees having a diameter of less than three inches at a foot above the ground should have their entire tops removed from three to four feet above the surface. All the tops should be cut out of trees ranging from three to six inches in diameter

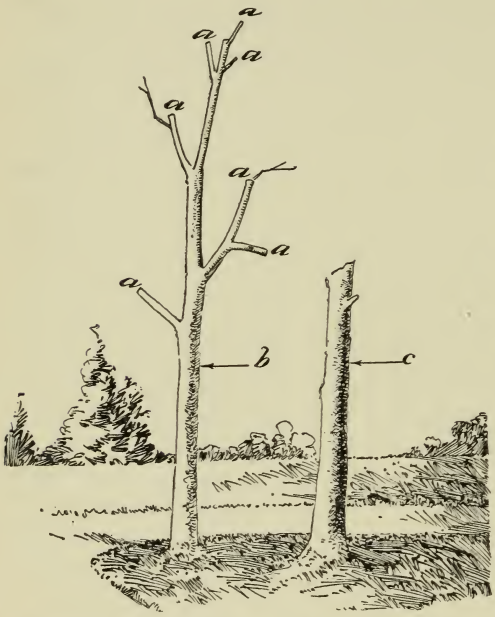


FIGURE 6.—*b*, Same tree as Fig. 5 after heading back for top-working; *a*, stubs from which the new growth is to come; *c*, heading back that is too severe.

except three or four of the lower limbs, while those from six inches in diameter upwards should not have more than three-quarters of their tops removed the first year. The mistake is often made of cutting the tops back too severely (See Figs. 5, 6 and 7).

This method has the advantage of furnishing clean vigorous wood in which to insert buds or scions. It has, however, several disadvantages. (1) It often delays results one season. (2) It is necessary to renew the top twice; first, when the original top is cut back to secure the shoots in which the buds are inserted; afterwards, when these shoots are cut back in order to force the buds or cions. This often results in greatly weakening the tree as it reduces the foliage to such an extent that assimilation is not sufficient to manufacture plant-food. (3) The cutting back of the original top,

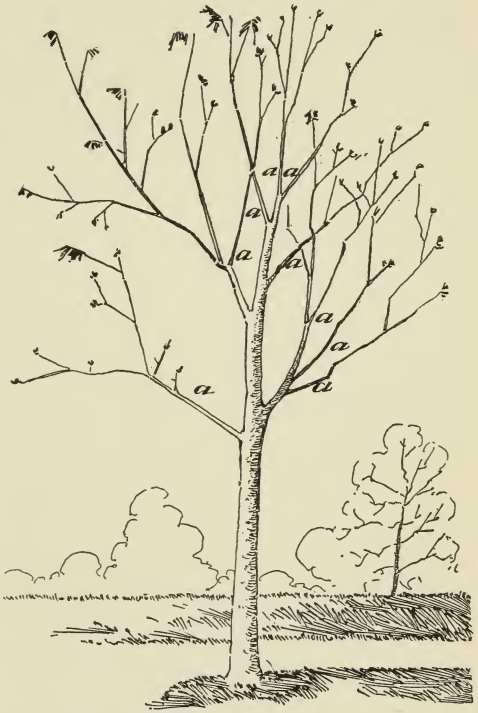


FIGURE 7.—Same as Fig. 5 after top has been renewed at points indicated.

budding on the new shoot and then trimming these to force the buds very often leaves weak, unsightly and poorly shaped limbs to form the new top.

The other method of top-working began with the use of the bark-graft and has been considerably strengthened as a result of the discovery that the patch-bud could be inserted successfully in rough bark on limbs and trunks. In the use of the

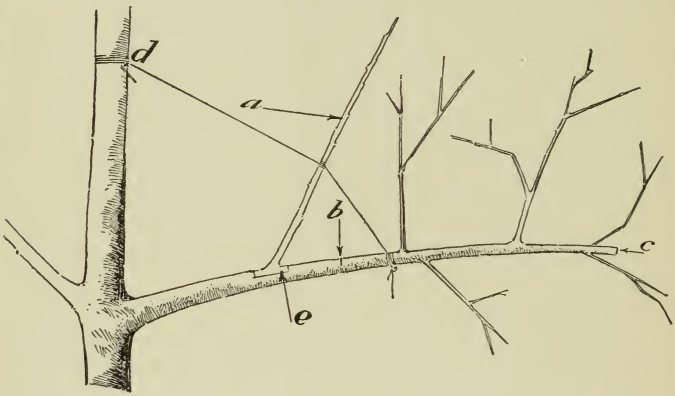


FIGURE 8.—*a*, Young shoot at close of first season's growth; *b*, place sawed in native limb for purpose of forcing out the bud; *c*, end of limb cut off for purpose of forcing out the bud; *d*, coarse twine for staking young shoot; *e*, point where native limb will be cut off at beginning of second season's growth.

bark-graft at least 50 per cent of the limbs are removed and cions inserted in the stubs. With the patch-bud the rough bark on the limb or trunk is pared down and a bud inserted in the fresh and tender bark. The maximum diameter of the limb or trunk at the point of insertion should not exceed three or four inches. No part of the stock is removed until it is seen that the bud is living, and then only enough is cut

back at first to force the bud. The stock is removed just above the new shoot the following season at the time when the new growth is starting (Figs. 8 and 9).

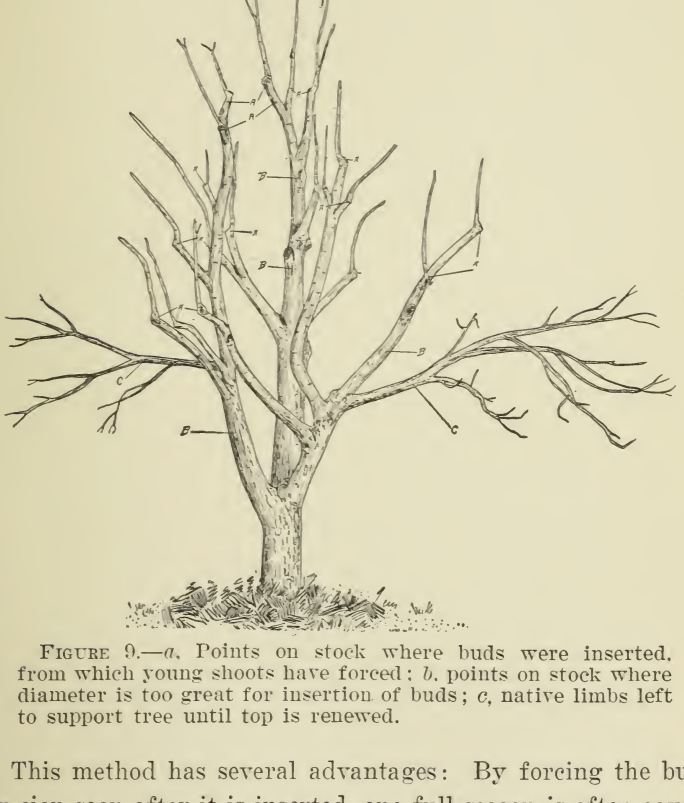


FIGURE 9.—*a*, Points on stock where buds were inserted, from which young shoots have forced; *b*, points on stock where diameter is too great for insertion of buds; *c*, native limbs left to support tree until top is renewed.

This method has several advantages: By forcing the bud or cion soon after it is inserted, one full season is often saved over the old method; in case of the patch-bud the stock is not cut back until it is known that the bud is living; if the cion

fails in bark-grafting the new shoots coming from the stock can be worked later; only one cutting back of the stock is necessary.

When a large number of trees are to be top-worked a platform of convenient height mounted on a wagon will be helpful to the operator. Large limbs should have shallow cuts made on the lower side before being sawed off so as to avoid splitting. Another means of averting splitting is, before sawing the limb, to wrap a stout chain around it just below where it is to be cut off. Limbs or tops of pecan trees having a diameter greater than six inches at the point of sawing heal very slowly. Therefore, such large limbs should not be cut whenever it can be avoided. The cutting back and top-working of very large pecan trees is a doubtful venture, except for the experienced propagator.

In cutting back a pecan tree for top-working, the wounds should be so made and handled as to facilitate healing and prevent exposure to the elements and the attendant dangers of fungus infection. The cut should be made so as to allow drainage; and the cut surface protected with some waterproof or antiseptic covering until the healing process is complete. Among the protective substances employed are white lead paint, grafting-wax, paraffin, coal-tar, and a coal-tar creosote mixture, composed of one-third creosote and two-thirds coal-tar. For large wounds, the creosote coal-tar mixture is probably best, even though excellent results from the use of hot paraffin and some of the other substances mentioned have been reported. In applying the protective covering, the newly-made wound should be allowed time to dry, then a coat of protective substance applied. The wound should be repainted or treated as often as may be necessary for com-

plete protection until it is healed. Otherwise large cavities from decayed wood may develop.

Top-working of pecans is very difficult even with the very best stock and under the most favorable weather conditions. It is practically useless to undertake this unless the work is done by a skilled operator and the topped tree is to be given proper care and attention.

However, when the right stock is used, when the work is properly done, and when good aftercare is given, it is entirely practical as well as profitable to top-work pecans to improved varieties. Furthermore, it can be performed very economically, especially when compared with the increase made in the value of the tree. The pecan has the ability to heal over wounds easily and quickly. When once well established it recovers from severe injuries more quickly than almost any other tree, either native or cultivated. A vigorous healthy pecan that has been successfully top-worked renews its top rapidly and will often begin to produce improved nuts in two to three years. The fact that a tree is barren makes no difference in results secured after top-working.

The trees that can be top-worked most easily and economically are those varying in height from two to three feet, with a diameter of one to two inches, up to thirty-five to forty feet high with a diameter of eight to twelve inches. It is possible to work much larger trees, but it requires great care and good judgment in the placing of buds or cions in order to secure satisfactory results. They also require very careful after treatment.

In the pecan belt there are many old fields where the virgin pecan timber has been removed and sprouts have retaken the land. These sprouts are often thick enough to permit thin-

ning to rows that will allow cultivation. When the sprouts have made a rapid growth, as they usually do on rich soil, and are from two to three inches in diameter and six to eight feet tall, they make ideal stock for top-working. In using stock of this kind, however, care should be taken to select those that have established their own root system and not those coming from the sides of old decayed stumps.

It usually requires considerable experience to be able to place a bud or cion in the proper location on the tree. The tendency is to use too many buds or cions. No exact number can be given that will suit all situations, but under average conditions it is safe to say that the following number of buds or cions should be employed: For young seedlings and sprouts one and one-half to two inches in diameter and from three to eight feet in height, one to two buds; trees two to three inches in diameter, three to five buds; trees four to six inches in diameter, six to eight buds; trees eight to twelve inches in diameter, twelve to twenty buds.

The mistake is often made of placing the buds or cions too far from the ground, and especially too far from the main body of the tree. This reduces the bearing surface of the tree and has a tendency to make it top-heavy, at least for the first few years, often resulting in the twisting and breaking off of the budded part by strong winds.

There has been a great improvement in the methods of working-over trees, especially during the past fifteen or twenty years. The cleft-graft was first employed because it had given good results when used on the apple, European plum and pear in the northern states. Results from the cleft-graft were not entirely satisfactory, so the ring-bud was introduced, being tried first by E. E. Risien of San Saba, Texas. The ring-bud,

when the proper wrapping material was used, gave fairly good results, but at best it was a difficult and severe operation.

The cleft-graft, ring-bud and several other methods have gradually given way to the patch-bud, the chip-bud and the bark-graft or modifications of these. These are given in order of their importance, although the best method to use generally depends on the age and size of the stock and the season when the work is to be done.

Patch-bud.

The patch-bud, or modified ring-bud, has become the most important method of top-working native pecan trees, and is rapidly replacing the whip-graft in the propagation of nursery trees. Since the discovery by J. A. Evans, while acting as pecan specialist for the Agricultural and Mechanical College of Texas, that the patch-bud could be inserted successfully in the rough bark of the trunk and large limbs of trees, there is little need of using any other method in top-working, if it were not that the season for working is lengthened by the use of the chip-bud and bark-graft.

The patch-bud may be inserted as soon as the bark slips freely in the spring and the operator may continue his work until the bark refuses to slip, owing either to drought or the approach of the dormant period in the fall. If there is abundant rainfall during the summer, the budding can often be continued through August; but if a drought begins early in July, it is best to stop in the latter part of that month, even before the bark refuses to slip. Young seedlings given thorough cultivation and vigorous young sprouts usually can be budded with success later than mature trees, especially if the latter stand in sod or pasture land. The best results

are secured early in the spring when the stock is vigorous and still contains part of its reserve food. The healing of wounds is much more satisfactory at that time.

The stock may vary from young nursery seedlings the size of a lead pencil to large trees several feet in diameter, although extremes should be avoided. In order to heal over satisfactorily, the diameter of the stock where the bud is inserted should not exceed four inches.

Prior to the discovery that the patch-bud could be placed in rough bark, it was necessary to cut back the tops of large trees and allow new growth to take place before the buds were inserted. This required that the top be removed before growth started in the spring, and it was generally the first of July before the new growth was mature and large enough for budding, thereby limiting the budding season to only a few weeks. When inserted at this season the buds were generally allowed to remain dormant until the next spring.

Three distinct classes of buds are used in patch-budding: First, the reserve bud; second, the dormant; third, the current-season bud.

On every normal pecan tree a considerable number of buds do not force out with the beginning of growth in the spring. Most of these never force out, usually dropping from the limbs the second or third year, unless actually needed by the tree to replace some injury. These are usually well developed buds and are generally more numerous near the beginning of a year's growth. They are to be found on one-, two- and three-year-old wood. Those on one-year-old wood are to be preferred. These reserve buds have the advantage over all other kinds in that they can be cut fresh from the tree any time during the budding season. It is necessary, however, in

cutting the bud-sticks to destroy all the current season growth on that branch, making it unwise to depend on these when budwood is scarce or when the trees are loaded with nuts.

The standard commercial budwood is cut while the tree is dormant. This should be taken from strong vigorous shoots of the previous season's growth. These shoots generally vary in length from eight to twenty inches, and are from one-fourth to one inch in diameter. The best buds are round and plump and near the base of the shoot. The sharp-pointed flat buds on the ridges near the tip ends of the limbs should not be used when others can be obtained.

This budwood should not be taken too early in the season, but cut while the tree is perfectly dormant, usually from the first to the middle of February. It should be placed carefully in bundles of twelve to fifteen pieces, not over ten to twelve inches in length, and securely tied at both ends. Each bundle should be labeled as to variety and placed in a small clean box with a layer of sand about two inches thick in the bottom. On this are laid the bundles, putting one inch of sand on top and between them, then another layer of budwood, and this process continued until the box has been filled. The box should be labeled and placed in cold storage, where the temperature will not go below thirty-two or above forty-five degrees. Sphagnum moss or clean sawdust may replace the sand. All wrapping material should be moist, but not wet. In case there are no cold storage facilities, the budwood should be buried eighteen or twenty inches deep in a cool, shady, well-drained place, on the north side of a building, or in a deep cool cellar where the temperature is more or less uniform.

It is important to keep budwood perfectly dormant until just before using. Before attempting to utilize stored bud-

wood, it should be placed in a warm moist location until the bark begins to slip, which will generally be from twenty-four to forty-eight hours. Care should be taken to use these buds before they show signs of swelling, as poor success will be attained after they begin to force.

Until a few years ago, especially while the ring-bud was used, the budwood was taken from the current season's growth. This required waiting until the first of July, in order to give the new growth time to mature. Buds of the current season taken before the first of July will seldom live as they are not fully developed. It will often be advantageous to cut the petiole about one-half inch above the bud, from ten days to two weeks before the buds are to be used. The petiole will then rub off when the bud is cut. This operation hastens maturity of the bud and enables the operator to handle it with greater ease. Current season buds will not keep as well as the other two forms. They should, therefore, be used as soon as possible after being cut from the tree. They are important when budding is done late in the season, as it is difficult to keep dormant buds for July work, and reserve buds are very wasteful of new growth, especially when they are cut late in the season.

On small nursery stock the patch-bud should be set from two to four inches above ground, while on trees from one to two inches in diameter it should be from six to eight inches. On young seedlings or sprouts under three inches in diameter the bud or buds should be placed where the diameter of the stock is not over one to two inches. In working over trees, care should be taken to set the buds on well placed branches and as near the main trunk as possible. The nearer in to the main body of the tree the buds are located the more bearing

surface there will be when the new top is formed. However, they should not be inserted where the trunk or limb exceeds four inches in diameter, on account of the difficulty in the healing of the wound after cutting back. The tendency is to use too many buds and to place them too far out on the limbs. The buds should be set in a clean smooth place where no bud has grown before, and always on the upper side of limbs so as to enable the resulting sprouts to start an upright growth.

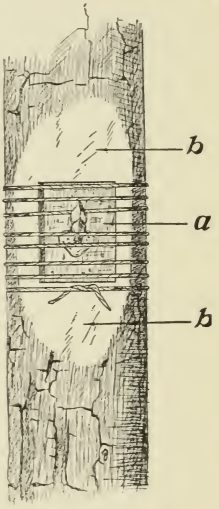


FIGURE 10.
a, Patch-bud inserted in rough bark on limb three inches in diameter; *b*, space where rough bark has been pared down to same thickness as bark containing bud.

Until a few years ago it was not thought practical to insert buds into the rough bark of trunks or branches. The place for the bud should be prepared by first paring down with a strong sharp knife a space in the rough bark about two inches long by one and one-half inches wide. This rough bark on the stock should be trimmed down until it is approximately the same thickness as the bark containing the bud. This will allow the string used in tying to press tightly on the inserted bud, thus insuring the cambium layers of both bud and stock meeting at all points (Fig. 10).

The patch-bud is made by first drawing the budding-knife across the stock, leaving two parallel incisions a little less than one inch apart. A sharp pocket knife is then used to make two vertical cuts on either side about one-half inch apart. Care should be exercised to cut

through the corners so as to prevent hanging when the bud is lifted out. The bud should be prepared in the same way. The bark on the stock should be lifted carefully until entirely free and then pressed back in place. The bark should be removed quickly from the stock and the bud promptly inserted. It is very important to make the transfer rapidly so as to prevent the drying out of the exposed cellular tissues. The bud should fit snugly into its new location, held firmly in place with the thumb, and tied with a cotton string. From five to eight wraps should be made to each bud, and the string drawn tightly enough to hold it firmly against the stock. Raffia, dampened corn shucks, and cloth strings can be used for wrapping material, but cotton twine is just as good and is cheap and easy to handle. It is important to have the string cut and ready to use so as not to cause any delay.

Another method of cutting the patch-bud is giving good results when employed by careful operators. The two parallel cuts are made as described above, but only one vertical cut in the center. The bark is lifted back on either side, the bud inserted, and instead of the bark being removed it fits down snugly over the sides of the bud. In preparing the bud the parallel cuts are made and then the sides cut at an angle of about forty-five degrees, thus enabling the bark of the stock to fit over them more snugly.

As soon as a bud is tied into position all cut places should be waxed carefully. When thick bark is pared down all the cut surface should be covered with wax to prevent cracking. The buds should be closely watched and the string cut so as to prevent binding as the stock increases in diameter. Instead of applying the wax directly to the bud, wax cloth may be

placed over it. All cut surfaces are carefully covered and only the bud is left exposed. The cloth is placed firmly against the sides of the stock with the thumbs and then carefully wrapped with twine (Fig. 11). The strings should be cut on all living buds from two to three weeks after insertion, depending on the condition of the stock. It is easy to tell

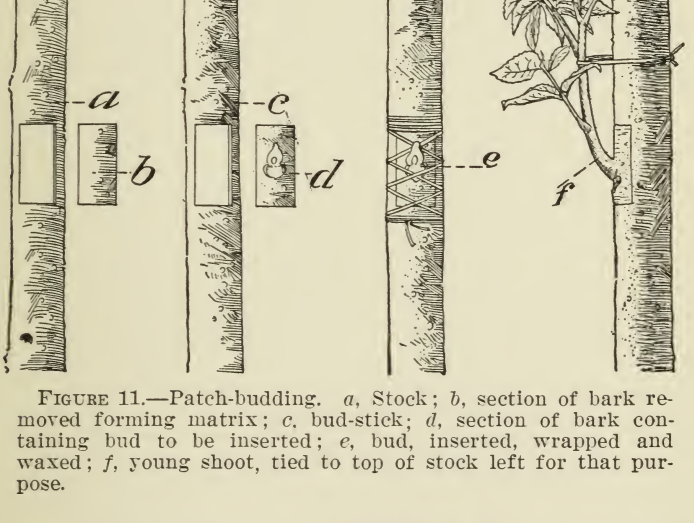


FIGURE 11.—Patch-budding. *a*, Stock; *b*, section of bark removed forming matrix; *c*, bud-stick; *d*, section of bark containing bud to be inserted; *e*, bud, inserted, wrapped and waxed; *f*, young shoot, tied to top of stock left for that purpose.

when a bud is living by pricking the bark supporting it with the point of a knife. If it is plump and green, the string should be cut on the opposite side from the bud.

After the string is cut the bud should be forced. The most satisfactory method with young nursery stock is to cut off the top of the seedling to within eight to twelve inches of the bud. In addition, it is often necessary to remove all native

buds both below and above the point of insertion. It is advisable to force the bud as soon as possible after it has united with the stock. After the middle of July buds force slowly and seldom make much growth before the dormant season, especially if a drought is prevailing. It is, therefore, often

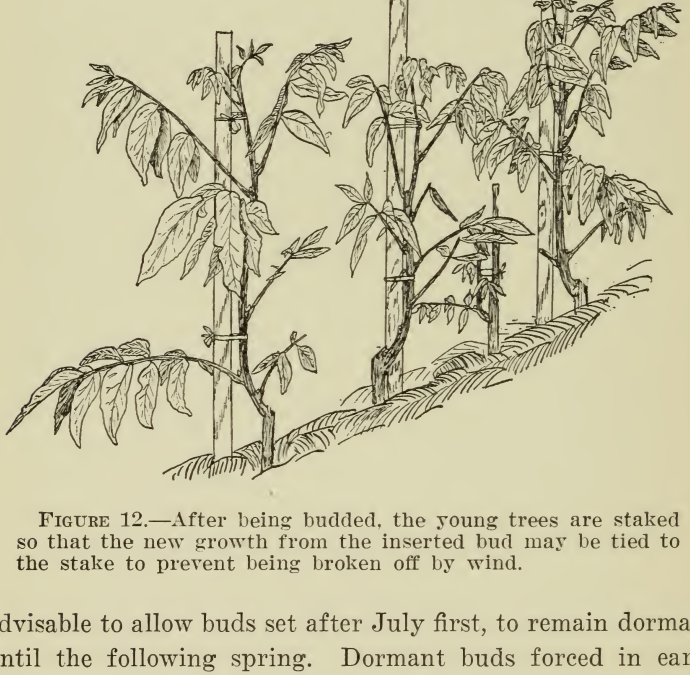


FIGURE 12.—After being budded, the young trees are staked so that the new growth from the inserted bud may be tied to the stake to prevent being broken off by wind.

advisable to allow buds set after July first, to remain dormant until the following spring. Dormant buds forced in early spring generally make a cleaner and more vigorous growth than those started in late summer the previous year. In forcing buds on trunks of seedling trees and on limbs of more than one and one-half inches in diameter, it is often advisable

to cut a notch across the stock one-half inch in depth and one to two inches long, two to three inches above the bud. When this is done, the bud usually forces without such a severe cutting back of the top, until time for complete removal.

When the bud starts into growth, the young shoot generally makes a very rapid growth and soon becomes brittle and top-heavy. To prevent its being broken or blown off, it should be staked, when about four inches long, to the stock above. Heavy twine should be used and care taken not to girdle the young rapidly growing shoot. When the young shoot is about two feet long the stub above it should be cut and a wooden stake driven into the ground to which the shoot should be tied for support.

In working over trees with the patch-bud method the large native limbs forming the top should be cut away gradually, the last cutting not being made until the second or third year after the first buds are inserted. A few limbs should be left unbudded to help support the tree until the new top is developed, when they should be removed entirely.

Some of the advantages of the patch-bud are: A larger percentage can usually be made to grow because the cambium layers touch at all points, on both bud and stock; the work can be done over a longer period of time; stocks can be used from young seedlings to mature trees; if the bud fails to take, the stock is not damaged by cutting back; it is not as expensive of buds as when cions are used; a very slight wound is made when the bud is inserted so that the place can heal rapidly; there is a wider range in securing budwood than with any other method.

Chip-bud.

The chip-bud is used both in the nursery and in top-working large trees. The stock should be approximately the same size as the twig from which the bud is taken. When large trees are top-worked by this method it is necessary to remove part of the top one season and bud on the new growth the next year.

The season for chip-budding in most of the southern states is from February 20 until April 1, the time varying a few days at both ends, depending on whether the season is early or late. The best results are secured when the buds are inserted just before the stock starts into growth, although the work can be continued with fair success until the stock has forced into full growth. Budwood from one-fourth to an inch in diameter should be taken while the tree is still thoroughly dormant. This wood should be packed in moist but not wet sand, moss, or sawdust and put in cold storage, or buried in a cool well-drained place where the temperature is low enough to prevent forcing of the buds.

The buds should be inserted in one-year-old wood, although two- or even three-year-old wood often gives good results, provided it is clean and smooth. A clean smooth place should be selected near the base of the stock. The best place for making the insertion is between the nodes on the stock and not over a bud or joint. A sharp knife should be inserted in the stock and pressed downward and slightly inward for about one inch. It is advisable to go through the bark and into the wood a short distance. The blade should then be withdrawn and a crosswise cut slanting downward made at the base of the tongue of the previous cut, until it is entirely severed. This tongue or chip should, however, be left in position until the bud is ready to be inserted. A plump bud

PLATE IV.—Pecan nursery trees ready to be dug for transplanting to the orchard as soon as frost comes.

should be cut so as to fit snugly into the notch made in the stock. The transfer should be performed quickly so as to prevent drying out of the cut surface. The cambium layers of the bud and cion should come in contact with each other at least on one side and on the top, and it is much better if they can be made to fit on all sides. The bud should be held firmly in place and tied with cotton twine, or wrapped first with waxed cloth. As soon as the bud is tied in place, all cut surfaces should be carefully covered with wax (Fig. 13).

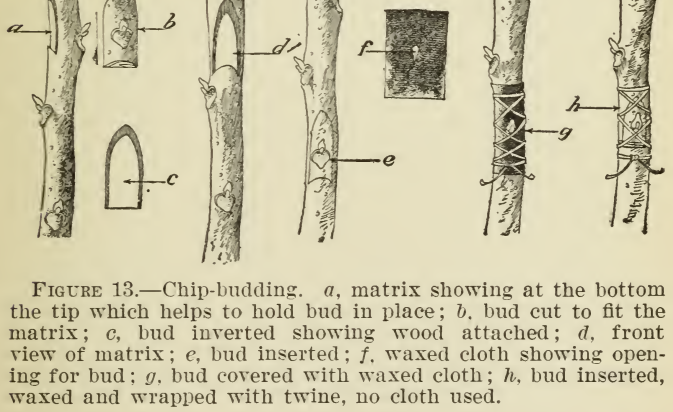


FIGURE 13.—Chip-budding. *a*, matrix showing at the bottom the tip which helps to hold bud in place; *b*, bud cut to fit the matrix; *c*, bud inverted showing wood attached; *d*, front view of matrix; *e*, bud inserted; *f*, waxed cloth showing opening for bud; *g*, bud covered with waxed cloth; *h*, bud inserted, waxed and wrapped with twine, no cloth used.

The chip-bud will seldom grow without being forced. When growth starts in the spring, all native buds and shoots should be removed, both above and below the bud. This should be continued until the inserted bud forces out and the young shoot is strong enough to starve out all native growth. It will sometimes take from ten days to two weeks to force the

bud, during which time the native buds will have to be removed three or four times (Fig. 14). In case the inserted bud dies, one or two native buds should be allowed to grow in order to renew the stock. As soon as the inserted bud forces out so that the young shoot is from four to six inches long, it should be staked to the top, or the top removed just above the bud and a board bound to the stock and allowed to extend from eight to twelve inches above the bud to which the shoot can be tied. This will prevent the young shoot from being blown off by strong winds or knocked off in any other way. Just as soon as the bud forces out, the string should be cut so as to prevent girdling. The cut should be made with a sharp knife on the opposite side of the bud. If waxed cloth has been used, care must be exercised in removing

FIGURE 14.—*a*, Young seedling showing native buds at stage when they should be removed in order to hasten forcing of inserted bud; *b*, with buds removed; *c*, young seedling from which buds have not been removed.

it soon after the bud forces into growth, or else the newly forced bud is likely to be severely injured.

The advantages of chip-budding are: It is easily and quickly done; the bud forces early in the spring and has nearly the full season in which to grow; the work can be performed when the weather is cool and agreeable; buds are easy to keep and ship; a small wound is made which heals over rapidly; if the bud is a failure, new growth can be forced out in time to permit patch-budding by the first of July; the method is economical of buds, as only one is used.

Bark-grafting.

Bark-grafting is employed principally in working over large trees. The stock varies in size from one to four inches in diameter. The cions should be from one-fourth to one-half inch in diameter, and from four to six inches long. They should contain from two to four buds. The cions should be taken when thoroughly dormant and kept in such condition until used. The best time to insert the bark-graft is when the trees have forced into growth sufficiently for the bark to slip freely.

Prominent well placed limbs of the desired size and correct position should be selected and sawed off from ten to eighteen inches from the body of the tree or from the junction of a large limb. The cut surface is then smoothed off with a sharp knife. The bark on one side of the stub is split downward from one to two inches and lifted at the corners. If the bark is very thick and coarse it can be trimmed or pared down, as recommended for the patch-bud. The cion is cut flat on one side at a distance of about one and one-half to two inches, and forced into the slit. It is preferable to cut the cion so

that the lowest bud will stand on the outside just above the stock. The stock containing the cion is wrappeed securely three or four times with stout twine. A small peg a little larger than a toothpick is then pushed under the twine on either side of the cion. All cut surfaces are carefully waxed or the stubs are first wrapped with waxed cloth and then tied. The work should be examined every few days. If cracks occur the wound should be rewaxed (Fig. 15).

Good results are often secured in bark-grafting by slipping a small paper sack over the cion and binding it to the stock. This will prevent the cion from drying out before it has had time to unite, and will protect it in many other ways. The sack should be removed as soon as the cion start into growth.

All native buds should be rubbed off the limb until the cion has started into growth and becomes strong enough to hold its own. In using large trees one or more native limbs should be left either above or below where the cions are to be placed. These limbs will support the tree until it has had time to renew its top, which will be in one to two years, depending on its size. These native limbs should gradually be removed as the top is renewed.

If the stock is over two inches in diameter, two cions should be set opposite each other. If both grow, the weakest should be removed as soon as the wound is healed. A short time after the cions start into growth the string should be cut so as to prevent girdling.

When the shoots on the cion force out they usually make very rapid growth and are likely to be blown or broken off if not given careful protection. When they are from four to six inches long, a board should be bound securely to the side of the stock and allowed to project from twelve to fifteen

inches. The young shoots are securely tied to these supports. They should be removed as soon as the sprouts are strong enough to support themselves.

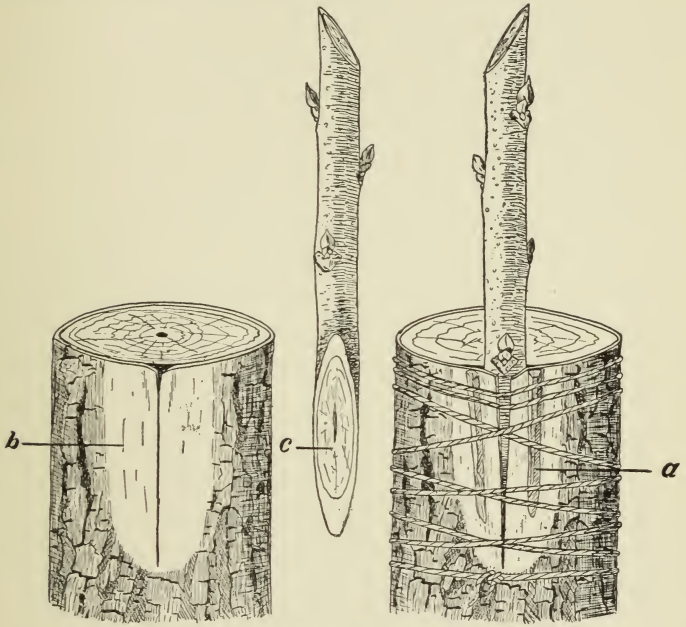


FIGURE 15.—Bark-graft inserted, wrapped and waxed. *a*, Wedge inserted between bark and twine for purpose of closing opening on either side of cion; *b*, bark pared down to make it more pliable and prevent splitting; *c*, cut surface of cion.

All wounds caused by bark-grafting should be kept carefully waxed or painted until completely healed.

In case the cions die, one or two selected sprouts should be allowed to grow from each stub, and they can either be patch-budded the following July or chip-budded the next spring.

The advantage of the bark-graft method is that when successful the growth starts early in the spring, resulting in the development of very strong vigorous shoots the first season. The disadvantages are that it is expensive of budwood and makes a very severe wound that is slow in healing.

Robert P. Morris[1] describes a method of modified bark-grafting which he terms bark-slot grafting. Some of the outstanding features are that the work can be performed during a part of the growing season, that very large limbs or trunks can be grafted, and that the entire cion, buds and all, as well as all cut surfaces, are coated with melted paraffin.

Further modifications of and improvements on bark-grafting methods have been devised by O. J. Wenzel, of Putney, Georgia, who has employed them very successfully in top-working pecan trees. He nailed the cions in place rather than using the "Spanish windlass," a method of tying the cions in place devised by Morris. The three improvements, with directions for application as given by Wenzel, are: nailing, making the top side of the cion shorter, and straight side cuts on the cion just through the bark. Cions of various sizes are nailed with appropriate sized nails. The nails should be placed high so as to give strength and to locate them at the maximum distance from the point where union first takes place and is most active, *i.e.*, near the point of the wedge. Those most suitable are cigar-box nails. Wire brads of the same size may be used, but are not so desirable as there is a tendency for the cions to fall off over the heads of the brads in high winds.

In using this method it is well to observe the following order and precautions: Cut the cion roughly to shape with

[1] Nut Growing, by Robert T. Morris, The Macmillan Co.

a sharp grafting-knife, making the angle of sides of wedge with the long axis acute, and cut slightly through the bark at sides of wedge in planes perpendicular with the faces of the wedge. Hold the cion over the stock against the chosen location, mark carefully around the cion, and cut the bark for the slot, but do not loosen the bark more than enough to part it. Plane the cion lightly on all cut surfaces with a very sharp block plane to freshen and true up all points of contact, loose bark on stock, insert cion, and nail with no loss of time. The cion should make a snug fit on sides and bottom without forcing. Melted paraffin is then applied over the whole cion and end of stub. It should be hot enough to run freely into all cracks and spaces where sap might collect, but not enough to scald the bark. Dormant cions will stand a higher degree of heat in the melted paraffin than will buds inserted in the height of the growing season. The Merribrooke Melter, a type of lantern designed for the purpose, is a satisfactory device for handling the melted paraffin.

The first and most rapid union takes place between the loose strip of bark and top of cion. Therefore, the top space of the wedge should be very short and well below the general surface of the bark of the stock.

As soon as convenient after grafting, it is well to go over the work and remove the dead cions. These left in place afford ideal places for the entrance of rot fungi for as the stock grows and the dead cion dries, cracks open alongside the cion, breaking the paraffin coating and admitting water and spores to the unprotected wood beneath.

On thrifty stock, cions will grow so rapidly that they will demand special care. In general practice, after one is assured that the cions are well started into growth, all seedling shoots

should be allowed to grow. They will nourish the tree and protect the cions from the wind to a great extent, but will reduce their growth considerably.

Whip-grafting.

Whip-grafting is practiced only on young nursery trees. The stock should be from one to three years old and from one-fourth to one inch in diameter. Until the last few years, the whip-graft was employed extensively by nurserymen east of the Mississippi River. It is now giving way to the patch-bud. The whip-graft method seems to give best results in moist sections.

The whip-graft can be made during December, January and February. The best results are generally secured just before growth starts in the spring. The cions may be taken fresh from the tree. They should be of the last year's growth and of straight clean wood, and thoroughly dormant when inserted.

The young seedlings in the nursery row are barred off with a turning plow and the soil pulled back with a hoe so as to expose from two to three inches of the crown of the trees. A cloth is drawn around the stock in order to remove all dirt and trash. The top is removed with a sharp knife at a point from one to three inches below the surface, depending on the smoothness of the stock. The cut should be upwards, and the surface about three times as long as the diameter of the stock. The knife blade should be placed about one-third of the distance from the top point and the slit made downward and inward about one and one-half inches in length. The cions should be about the size of a lead pencil, from four to six inches long, and should contain from two to four buds.

The cion is cut the same as the stock, the slit being made at the butt end. The two should be fitted together and wrapped from four to five times with unwaxed cloth or string. This wrapping material holds the pieces together until they have had time to callus over. Usually the string does not need to be cut, as it will rot before girdling the stock. As soon as the graft is completed the soil should be piled around the cion so that not over one inch at the top will be exposed. When growth starts in the spring, all shoots below the cions should be removed. In case the cion fails to live, one strong shoot from the stock should be allowed to grow. It will often become large enough by the first of July to allow of patch-budding. The cions that live and force into growth should receive careful and thorough cultivation. They will ordinarily be ready for transplanting by fall.

The advantages of whip-grafting are: The work is done during December, January and February, when there is little else to be done; the cion is forced out with the beginning of growth in the spring, thereby allowing the full season for the development of the young top; the graft is below the ground, thereby giving a cleaner and smoother top than can be secured by budding. The disadvantages are: The whip-graft is wasteful of budwood; it requires considerable time.

Shipping budwood.

The shipping of budwood is now becoming an important practice. A considerable quantity is often shipped in such poor condition that it is worthless by the time it reaches the purchaser.

In packing budwood for shipment care should be taken to tie the sticks in small bundles, with moist sphagnum moss or

paper around each package. The bundles should be wrapped carefully with oiled paper and placed in a strong box. As soon as received the oiled paper should be removed and the package dipped in water and put in cold storage, unless the buds are to be used immediately. It is very seldom that budwood can be shipped successfully for a considerable distance when wrapped only in moist paper.

If it is found that the budwood has become slightly shriveled on account of drying out during transit, it is often advisable to soak the bud sticks in warm water for a few hours, when they should be packed in moist sand, moss or sawdust before being placed in cold storage.

BUDDING TOOLS

The Texas Aggie budding-knife was invented by D. V. Shuhart, while a senior horticultural student at the Agricultural and Mechanical College of Texas. The materials needed in the construction of this knife are two one and one-half inch

FIGURE 16.—Above, a good type of budding-knife; below, Texas Aggie budding tool.

stove bolts, two second-hand safety-razor blades and a piece of timber, preferably seasoned oak, ash, hickory or pecan, about eight inches long, one and one-fourth inches wide and one inch thick. Two longitudinal cuts, parallel and about

seven-eighths of an inch apart, should be made with a fine-toothed saw perpendicular to the one and one-half inch surface of the timber and should extend down five inches from one end. Two holes should be drilled one inch and three inches respectively from the same end, through which the three-sixteenth-inch stove bolts should be inserted. These holes are drilled in a line drawn through the center of the one-inch surface of the timber and are perpendicular to it. The surface between the bolts on the one-and-one-fourth-inch side of the piece of timber should be cut down to a depth of about one-fourth inch. The length of the piece removed should not be as great as that of the safety-razor blades, which should be inserted in the two longitudinal cuts between the two bolts, and should be clamped in securely by tightening the bolts (Fig. 16).

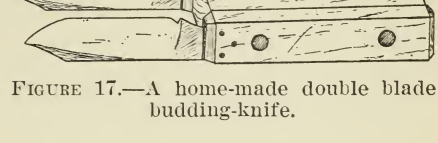


FIGURE 17.—A home-made double blade budding-knife.

A budding-knife very popular with the nurserymen is represented in Fig. 17. These knives are made by riveting two one-bladed rigid knives,—two ordinary budding-knives will serve,—to a wooden handle, so as to make the blades parallel and about one inch apart.

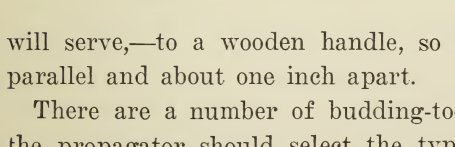


FIGURE 18.—A budding tool.

There are a number of budding-tools on the market and the propagator should select the type which best suits his purpose. (See Figs. 18, 19 and 20.)

GRAFTING-WAXES

The principal ingredients of grafting-waxes in common use in this country are resin, beeswax, linseed oil, alcohol and turpentine. The most popular of these are resin, beeswax and tallow. The proportions in all the mixtures are varied according to the purpose for which they are to be used and also for the convenience of the propagator.

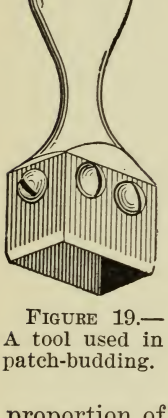


FIGURE 19.—A tool used in patch-budding.

The function of resin in the mixture is to raise the melting point or to produce hardness in the grafting-wax. The beeswax gives toughness and elasticity, and tallow or linseed oil softness to the mixture. Alcohol produces both softness and adhesiveness.

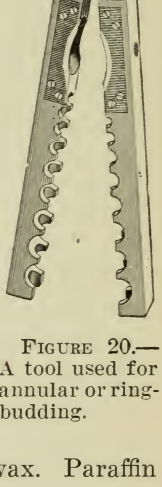


FIGURE 20.—A tool used for annular or ring-budding.

Grafting-wax to be used in winter should contain a larger proportion of tallow or linseed oil to make it sufficiently soft to be applied easily. When the wax is to be employed in summer, the resin is increased to prevent its being melted by the hot sunshine. The ratio of tallow or linseed oil to the other ingredients in grafting-wax, which is to be kept warm over a stove or lantern and applied in a melted condition, should be rather low. Paraffin, however, is often used for this purpose instead of grafting wax. Paraffin does not adhere to the buds or cions as well as some of the grafting-wax mixtures; though it is less expensive and in many instances serves the purpose equally as well.

ALCOHOLIC WAX

Resin	2 pounds
Beeswax	1 pound
Alcohol	180 cubic centimeters or 2/5 of a pint.

The resin and beeswax should be melted over a slow fire, but not allowed to boil, as this may cause the ingredients to volatilize and thus vary the proportion of each. It should be heated for about five minutes after it has apparently melted. When it is completely melted it should be removed from the fire. The mixture must be stirred constantly while cooling to prevent adhering to the sides of the container and becoming hard. When it has cooled to the degree that it feels warm, not hot, to the palm of the hand, one should begin to add the alcohol, pouring it in very slowly and stirring vigorously and constantly. This should be continued until the mixture is somewhat granular in texture and golden-yellow in color. Pure grain alcohol is the best; wood alcohol may be used, and denatured will give good results if it is known not to be denatured with some substance injurious to the bud.

LINSEED OIL WAX

Resin	2 pounds
Beeswax	1 pound
Linseed oil	1 pint or enough to soften

Only high-grade linseed oil, which may be purchased from any drug store or paint shop, should be used. The resin and beeswax are melted together and allowed to cool partially, as in the making of alcoholic wax. The linseed oil is added in the same way as the alcohol.

TALLOW WAX

Resin	4 parts by weight
Beeswax	2 parts by weight
Tallow	1 part by weight

The ingredients are broken into small pieces and may be placed into the pot together, but preferably the resin is melted first over a gentle fire and the beeswax and tallow added. Boiling must be avoided. After the ingredients melt the mixture should be stirred thoroughly and poured into cold water. As soon as it cools enough to be handled it is worked and pulled until it turns a yellowish-white, resembling molasses candy which has been pulled. It is then divided into convenient sized balls or sticks, wrapped in oil paper, and stored away until needed.

LIQUID WAX

Resin	1 pound
Beeswax	1 ounce
Turpentine	1 tablespoonful
Alcohol	5 ounces

The resin should be melted, tallow added, and removed from the fire and the liquids stirred in gradually. This mixture remains fluid. It is stored in cans or bottles and is applied with a brush.

Some pecan propagators have secured excellent results from the use of paraffin as a substitute for grafting-wax when it is applied in a melted condition by means of a brush. It has been especially successful in the top-working of pecan trees with both the patch-bud and the slot-bark-graft methods. The cheapest form of paraffin is the ordinary commercial product sold under the trade name of parawax. This grade is ordinarily satisfactory, but if the propagator finds it neces-

sary he can purchase paraffin with either low, intermediate, or high melting points (Fig. 21).

Waxed string is made by placing balls of cotton twine or of No. 18 or 20 knitting cotton in a hot mixture of two parts of resin and one part of beeswax for a few minutes, then removed and allowed to drain and cool before being used.

FIGURE 21. — A paraffin melter.

Waxed cloth is best made of old cotton sheets or similar material torn in strips about two inches wide. The strips are then dipped in a melted mixture of two parts resin and one part beeswax and drawn over a board or the side of the container to cause the excess wax to drain off. When the strips have cooled they are folded in such a way as to form two-inch squares or "patches." A hole is made in the center by driving a nail through them or with a leather punch. These "patches" are used extensively in patch-budding.

CHAPTER V

SOILS AND FERTILIZERS FOR PECANS

The pecan adapts itself to a very wide range of soil conditions, few other trees surpassing it in this respect. In the early stages of the industry, however, very diverse opinions existed. Some considered it impossible to grow pecans with any degree of success except on soils similar to those on which the indigenous forests were found. A few growers contended that a pecan tree would not bear until its tap-root reached permanent water. Others took the contrary view that the pecan came into bearing earlier and was more prolific upon the uplands removed from the alluvial soils of the river valleys. Subsequent experiences have shown that the better classes of both these general soil types, the great areas of uplands usually planted to corn and cotton and the flood plains of the river basins, are well adapted to pecan-culture.

The pecan requires a well-drained soil for the production of maximum crops. It is acid-tolerant, making better growth on soils slightly acid than on those neutral or alkaline. Pecan trees cannot be grown successfully on wet "craw-fishy" ill-drained land where stagnant water stands on or just beneath the surface a greater part of the time. Because the pecan grows so luxuriantly along banks where the river frequently overflows for weeks at a time does not indicate the adaptability of this nut to wet and sour soils. Careful observations show that these lands are considerably above water level, except

during flood stages of the stream, and are capable of supporting a great variety of plants not at all aquatic in nature. The occasional flood waters are really beneficial rather than detrimental to pecan trees, since they bring down rich deposits of soil which furnish great abundance of readily available plant-food after the flood waters subside. The pecan is fitted by nature, with its strong sturdy trunk and limbs of great elasticity, to resist the flood waters of swollen streams, but cannot endure the still stagnant seep of a marshy soil. Where the willow and gum-tree are at their best, the pecan tree is out of place. Land too wet and sour for the production of general farm crops should not be planted to pecan trees.

Cut-over lands from which the merchantable timber has been removed should be cleared of the younger trees and of as many stumps as possible and cultivated to some annual farm crop for at least two years before being planted to pecan trees. It is very expensive to remove all the stumps when the land is first cleared. It is more economical to grow some cleanly cultivated crop and to allow the smaller stumps to decay. As long as decaying roots and stumps remain in the soil, wood-lice will be harbored in them and attack the young pecan trees.[1] Furthermore, newly cleared land is likely to contain too much acidity or sourness for satisfactory growth of young pecan trees. The growing of corn and cowpeas or velvet beans and fairly clean cultivation for about two years, provided the land is well drained, will reduce the acidity sufficiently to start a pecan orchard. A quicker reduction of the acidity would, of course, be effected by liming the soil. The yields of farm crops on land the first year after reclaiming from the forest are usually small; but by the second year

[1] See Chapter XI.

they should pay more than the expenses of cultivation. If a prospective grower has his nursery stock on hand and is willing to cope with unfavorable soil conditions, he may plant his trees the first year after clearing. Strips of land where the trees are to be set should be well broken as long in advance as possible. Strict precautions should be taken to leave no pieces of decaying roots and limbs in the holes where the young tree is to be set or close around it to attract termites. The strips of land between the rows can be plowed later. The sprouts coming up from the forest tree stumps should be cut off as they appear. This is a rather crude method of starting a pecan orchard and the grower should be in a position to give the trees very close attention for the first two or three years.

SOIL TYPES SUITABLE FOR PECANS

In its native range the pecan flourishes on the alluvial soils of the Mississippi Valley and other western streams. It grows well also on the upland sandy loam soils of the more eastern states adapted to the growth of corn, oats, and cotton. The pecan is influenced more by the fertility, humus, and moisture-content of the soil than by any particular type.

The Norfolk, Orangeburg, Tifton, and Greenville are among the important soil series in the southern United States and eastern Texas and these have been utilized extensively for pecan-growing.

The Norfolk soils are characterized by the light grayish-yellow color of the surface, and by the yellow color and friable structure of the subsoils. They occupy nearly level or rolling uplands throughout the Atlantic and Gulf Coastal Plains and have been derived mainly from Piedmont-Appalachian mate-

PLATE V.—Truck crops in young pecan orchard, with clean-cultivated strip next the trees.

rial. The soils of this series include sands, loamy sands, gravel, gravelly sands, coarse sands, fine sands, very fine sands, sandy loam, fine sandy loams, silt loams, and clay loams.

The Orangeburg series are marked by their gray to reddish-brown color and open structure. The subsoil consists of a red friable sandy clay. They are confined to the uplands of the Atlantic and Gulf Coastal plains. The soils include sands, coarse sands, fine sands, sandy loams, gravelly sandy loams, and fine sandy loams.

The Tifton soils are gray to grayish-brown in color and are underlain by bright yellow friable sandy clay subsoils. Small iron concretions occur on the surface and throughout the soil section. They are always well-drained. The soil occurs as sands, sandy loams, and coarse sandy loams.

The Greenville soil series are reddish-brown to dark red, having a subsoil of deep red sandy clay. They are closely associated with members of the Orangeburg series. These soils are more retentive of moisture than the corresponding members of the Orangeburg series. These series occur as coarse sands, loamy sands, fine sands, sandy loams, gravelly sandy loams, coarse sandy loams, fine sandy loams, loamy gravelly loams, clay loams, and clay.

The loams, sandy loams, and clay loams of the soil types described above are well suited to pecans. Most of the best orchards are on the Orangeburg loams and sandy loams.

The ideal soils of these types are the loams and sandy loams having a mellow surface soil underlain at a depth of eight to ten inches by a friable loamy or sandy clay, sufficiently heavy to retain the nutrient constituents and not too stiff to resist or retard the development of young roots. The surface soil

should contain a considerable amount of organic matter, which will enable it to retain sufficient moisture to keep the trees supplied even in times of drought.

Coarse and deep sands, especially where the water table is low, and clay soils where the subsoil is near the surface, are not suited for pecans and should not be utilized for this industry.

The alluvial soils of the flood plains of the Mississippi Valley, where pecans are native and which have been utilized to some extent for planting the improved varieties, are entirely different in character from those of the uplands just described. The principal soil types are the Yazoo and Sharkey series.

The surface soil of the Yazoo series ranges from gray, slightly darkened with organic matter, to light brown, while the subsoils are mottled grayish, rusty-brown, and sometimes bluish. These soils constitute the best drained types of the flood plains. The sandy loams and fine sandy loams are underlain at a depth of about twelve inches by a brown fine sandy loam and at about twenty-four inches by a bluish colored clay loam. It is a productive rich soil.

The soils of the Sharkey series are of a yellowish-brown to drab color with mottled, rusty-brown, bluish, drab, and yellowish subsoils of plastic structure. These soils contain a high percentage of clay. They occur as bottom lands subject to overflow. They are poorly drained, and on drying, the soil cracks readily and forms small aggregates, which has given rise to the name "buckshot" land.

There is a rather broad strip of country lying between the coastal plains and Appalachian Mountains extending from southern Virginia through the Carolinas, Georgia, and a part of Alabama, which has not been generally recommended for

pecan plantings, but which is beginning to receive some attention for this purpose. Heretofore, it has been generally agreed that as the mountains were approached congenial conditions for growing the pecan were left behind. For this reason, practically all commercial plantings of pecans in the southeastern states were confined almost entirely to the coastal plains soils. The soils of the piedmont range from gray to red with a red clay subsoil and are grouped generally as Cecil soils. They are well drained and retentive of moisture when properly managed. The limited number of plantings made thus far have given surprisingly good results. The trees begin bearing early, are usually prolific, and the nuts, in some instances, fill better than those of the same variety grown near the coast. With the constant improvement of varieties and the rapid development of the pecan industry it is expected that more commercial plantings will be made on the piedmont soils.

In west Texas the well-drained alluvial soils along the inland streams seem best adapted to pecans. These are derived from the various formations through which these streams pass and are composed chiefly of silt loams, very fine sandy loams, silty clay loams, loams, fine sandy loams, and clays. These soils are rich in plant-food and require very little if any fertilizing.

Soils poor in fertility, lacking in humus and moisture-holding capacity should not be planted to pecans unless they can be improved and maintained economically. Deep porous sandy soils which leach and oxidise their humus and plant-food very rapidly can sometimes be built up to support satisfactory growth; but the expense of the soil building exceeds the value of the orchard. Pecan trees planted on this type

of soil rosette severely and sooner or later abandonment becomes necessary. Occasionally a soil type is found which apparently is suitable for growing pecans, but the subsoil shows some form of impervious hardpan or soft leachy sand entirely unsuited to the development of the trees. Pecans should not be planted on wet sour lands, or badly eroded or washed hillsides until they are put into condition to support healthy vigorous trees.

Lands which support only small scrubby forests should not be expected to grow good pecans, but where good specimens of hickory trees thrive without any special attention or fertilizers, it is fairly certain that the same soil will be suitable for pecan trees. Field or truck crops are also good indicators of the ability of the soil to grow pecans. In some instances, however, soils which produce rather poor annual crops may raise good pecans. This is thought to be due to a subsoil containing an unusual amount of plant-food and moisture. The pecan, being a deep-rooted perennial, can penetrate to greater depth than the average annual which feeds chiefly on the surface soil. Generally speaking, however, pecans should not be planted on land unless it is known to be able to produce from one-half to a bale of cotton and from thirty to forty bushels of corn an acre in normal seasons.

FERTILIZERS FOR PECANS

In setting land to pecans, some definite and consistent soil-building policy should be adopted, or better still, soil improvement should be practiced for a year or two before setting the trees. The deep rich alluvial soils of river valleys do not present the same fertilizing problems as do the light sandy upland soils.

Stable manure supplemented with acid phosphate makes a very satisfactory fertilizer for pecans. The beneficial effects in increasing the water-holding capacity and the bacterial flora of the soil, as well as improving its general mechanical condition, extend far beyond the plant-food content of the stable manure as shown by analysis. In actual plant-food, 100 pounds of cottonseed meal contains more nitrogen than does a half ton of stable manure. However, when they are both applied to the soil, the stable manure would probably produce the better tree growth. Unfortunately stable manure is seldom available in sufficiently large quantities to be depended on as a source of fertilizer for large plantings of pecans. From one-quarter to one-half a ton to a tree, depending on its size, applied in late winter or early spring, is satisfactory. It should be spread in a circle around the tree extending out about twice the spread of the limbs and plowed under or harrowed into the soil. From five to fifteen pounds of acid phosphate may be applied to each tree, and worked into the soil with the stable manure.

The use of cover-crops.

The importance of cover-crops for improving soils for pecans is well recognized. The most economical method is probably less understood than the use of commercial or chemical fertilizers. For a long time it was thought that turning under cover-crops while green would cause an acid reaction in the soil which would be detrimental to plant growth. Numerous experiments have proved this to be a fallacy, however.

Fertilizing materials are valued for their content of phosphoric acid, nitrogen, and potash. Lime, magnesia, and iron

are usually present in the soil in much greater abundance than the crops demand or can use, while most soils are deficient in phosphoric acid, nitrogen and potash, in an available form. A cover-crop contains only the amount of phosphoric acid and potash that it has taken from the soil itself, and at most it returns only that which was borrowed. Nitrogen is obtained directly from the air in the soil.

As found naturally in the soil, both phosphoric acid and potash are almost insoluble in water. However, in the remains of plants the potash is in soluble form and the phosphoric acid is combined with lime and other bases which, although somewhat insoluble in water, are in a form that can be acted on much more readily by the roots of growing plants than can the natural phosphates of iron and aluminum. Therefore, while the cover-crop merely returns something which it has taken from the soil, it gives it back in a more available form. The effect, so far as the phosphoric acid in the cover-crop is concerned, is much the same as that obtained by treating rock phosphate with sulfuric acid to bring it into a form to be readily utilized by growing plants.

Cover-crops, especially the deep-rooted species, render another important service in bringing a portion of the phosphoric acid and potash up from greater depths of the soil and leaving it in the decayed plants in the surface layer, where it will be better aerated and more available. As the pecan is so deep-rooted it would seem that this would be of little advantage; however, the pecan obtains a very large percentage of its plant-food from the surface layer of the soil, very little deeper than that used for the support of the ordinary annual farm crops. In special instances in which the tree draws much

of its nourishment from great depths, the subsoil affords unusual conditions for root spread and nourishment.

Careful analyses have shown that most agricultural soils contain, within the first two feet of the surface, enough phosphoric acid and potash to meet the fullest demands of a pecan orchard for more than two generations of men. The importance of making available more of these vast stores should certainly not be overlooked.

Aside from bringing certain mineral elements up from the greater depths of the soil and rendering them more readily available to the growing plant, cover-crops, when turned under and incorporated with the soil, greatly increase its moisture-holding capacity, which in many respects is more important and more beneficial to pecan trees than are large quantities of mineral fertilizers added without this organic material. Moreover, the solubility of calcium, magnesium, iron, and phosphoric acid is measurably increased by the addition of liberal cover-crop materials to the soil. This is caused in part by the action of the inorganic salts on the organic substances or their extracts, and in part by the solvent action of the soluble organic compounds formed during organic decomposition. Such action of organic material incorporated with the soil has a decidedly beneficial effect towards overcoming rosette in pecan trees as well as in promoting a more vigorous growth.

While the phosphoric acid and potash in the soil are fixed quantities, except when foreign materials such as commercial fertilizers are added, the quantities of nitrogen available vary with the ability of the leguminous cover-crop to extract it from the air in the soil. The gain in nitrogen is brought about by nitrogen-gathering bacteria (micro-organisms) which

form nodules and live on the roots of leguminous plants, such as clovers, peas, beans, beggarweed, vetches, and the like, and have the power of feeding directly on the free nitrogen of the atmosphere and thus fixing it in solid form. Each group or class of legumes requires a specific strain or type of nitrogen-gathering bacteria for most satisfactory growth, and unless the soil is already inoculated the bacteria should be introduced from commercial cultures or by adding soil from fields producing good growths of such legumes.

The amounts of plant-food in cover-crops vary with the kind of plant and the amount of growth produced. The relative quantities of the three most commonly deficient elements in plants used for cover-crops have been determined by a large number of investigators.

It is decidedly difficult to give an accurate valuation of cover-crops, since their influence on the texture and the water-holding capacity of the soil may exceed the actual value of the mineral elements of the plant-food which they contain. However, for the sake of comparison they are valued on the basis of their content of phosphoric acid, nitrogen, and potash.

Since nitrogen has more than double the value of potash and four times that of phosphoric acid, it is the chief element of plant-food to be considered in growing a cover-crop to be turned under. This is especially true as the average analysis shows a much higher percentage of nitrogen than of either phosphoric acid or potash. The grower, by knowing the composition of his cover-crop, can easily determine the fertilizing value by calculation on the basis of his yields.

Just what cover-crop the grower should use will depend very largely on local conditions. Whether he shall select a legume or a non-legume as a winter or a summer cover-

crop or both is a problem of soil management or farm practice for the individual grower. Among the more promising winter cover-crops for the pecan orchard are rye, vetch, crimson clover, burr clover, alfalfa, oats, turnips, and rape, while some for summer are beggarweed, bush velvet beans, soybeans, Japan clover, and alfalfa. Kudzu, a perennial legume which makes a very rank or strong vine growth, is receiving some attention.

Cowpeas have long been popular as a summer cover-crop for pecan groves, but since they harbor a species of Hemiptera (squash-bug) which attacks the young nuts during the summer and causes kernel-spot, it is advisable not to plant them in regions in which kernel-spot is prevalent.

Soil type and climatic conditions are important factors in the adaptation of cover-crops to any region. The combination and time of planting and turning under or harvesting the crops should be so arranged as not to interfere with the harvesting of the nuts. When feasible, those cover-crops which reseed themselves naturally should be selected so as to avoid the expense of purchasing seed each year.

It is usually difficult for even the experienced pecan-grower to establish a stand of the southern burr clover over any considerable area, but when this can be done it affords a very desirable winter cover-crop. It matures its seed in April and early May, at which time it may be turned under and the land sown to a summer cover-crop, as soybeans, bush velvet beans, or cowpeas. Unless the land is decidedly deficient in organic matter, the summer cover-crop may be cut off for hay in late August or September. The seeds of the burr clover which were turned in May will germinate in early fall and will produce a good winter cover-crop.

Similar combinations with other cover-crops may be arranged when two are grown on the soil each year. The organic content usually can be kept up if one of them is turned under, while the other may be cut and removed for hay. However, unless the grower is reasonably sure that the humus and plant-food content of the soil are being maintained, both cover-crops should be turned under each year.

Commercial fertilizers.

The chief function of each of the three essential fertilizer elements, phosphoric acid, nitrogen and potash, in the nourishment of plants should be understood in order that they may be applied to the soil more intelligently and economically. Other elements, as sulfur, iron, calcium, and magnesium, are essential to growth, but since they are usually present in the soil in sufficient quantities to supply readily the needs of the growing plants, they need not receive serious attention in compounding a suitable fertilizer mixture for pecans.

The function of phosphorus is to hasten maturity and increase the percentage of seed or fruit in proportion to the size of the plant. It also stimulates root growth. Phosphorus is taken into the plant in solution, as calcium phosphate. It is assisted in circulating through the plant by magnesium, and combines in the cells with nitrogen, sulfur, carbon, hydrogen, and other elements to form protoplasm. Phosphorus applied to soils containing large amounts of nitrogen has a decidedly balancing effect in preventing the plant from going too much to leafy and woody growth.

Nitrogen promotes a vigorous growth of leaf, stem, and wood. It sometimes hastens blooming but delays maturity. It is taken into the plant, in solution, as nitrates, and pro-

TABLE V

Analyses of Common Fertilizer Materials

Material	Per Cent Phosphoric Acid Available	Per Cent Phosphoric Acid Insoluble	Total	Per Cent Nitrogen	Per Cent Equivalent Ammonia	Per Cent Potash
Nitrate of soda	.....	.....	.....	13 to 16	18 to 19½	.....
Sulfate of ammonia	.....	.....	.....	19 to 22	23 to 26	.....
Dried blood (high grade)	.....	.....	.....	12 to 14½	14½ to 17½	.....
Dried blood (low grade)	.....	.....	3 to 5	10 to 11	12 to 14½	.....
Tankage (high grade)	.....	.....	1 to 2	11 to 12½	13½ to 15	.....
Tankage (low grade)	.....	.....	11 to 14	5 to 6	6 to 7½	.....
Dried fish scrap	.....	.....	.....	9½ to 11	11½ to 13½	.....
Cottonseed meal	.....	.....	2	6½ to 7½	8 to 9	1½
Tobacco stems	.....	.....	1	2 to 3	2½ to 4	5 to 8
Calcium nitrate	.....	.....	.....	13 to 14	16 to 17	.....
Acid phosphate	13 to 16	1 to 3	14 to 19	.....	.....	.....
Tenn. rock phosphate	.....	34 to 39	34 to 39	.....	.....	.....
Fla. pebble phosphate	.....	26 to 32	26 to 32	2½ to 4½	3 to 5½	.....
Bonemeal	5 to 8	15 to 17	20 to 25	2½ to 4½	3 to 5½	.....
Muriate of potash	.....	.....	.....	.....	.....	50
Sulfate of potash	.....	.....	.....	.....	.....	50 to 55
Kainit	.....	.....	.....	.....	.....	12½
Wood-ashes, unleached	.....	.....	.....	.....	.....	2 to 8
Wood-ashes, leached	.....	.....	.....	.....	.....	1 to 2
Cow manure (fresh)	.....	.....	0.16	0.34	0.41	0.40
Horse manure (fresh)	.....	.....	0.28	0.58	0.70	0.53
Sheep manure	.....	.....	0.23	0.83	1.00	0.67
Hog manure	.....	.....	0.19	0.45	0.54	0.60
Hen manure	.....	.....	1.54	1.63	1.98	0.85
Mixed manure	.....	.....	0.26	0.50	0.60	0.63

duces a dark green color in the foliage. Nitrogen is assisted in its circulation from the leaves to the fruit by phosphorus. It is a valuable element of plant-food when it is desired to rush the growth of young plants.

The chief function of potassium is the formation of starch and cellulose. It thickens the cell-walls and makes the plant more rigid. It goes into the plant in solution as do other foods and assists in the assimilation or utilization of phosphorus and nitrogen. It increases root development and in some instances enables plants to resist disease. Like nitrogen, it delays maturity.

The source of the various elements of plant-food that make up a fertilizer is important in order to get the slowly available and quickly available elements in the correct proportion. There is frequently a great discrepancy between the costs of plant-food from different sources, and it behooves the grower to select such materials as will give him the desired fertilizer mixture at the least cost.

Fertilizer experiments.

Various fertilizer mixtures have been proposed for both young and bearing pecan trees by practical growers and investigators. While there is a wide range in the mixtures recommended, enough experimental data have been accumulated under actual orchard conditions to be indicative of the plant-food requirements of the pecan on a number of soil types used for commercial plantings. Even though the pecan-grower has the results of carefully conducted fertilizer experiments on the same soil type as his own, he should give serious thought to fertilizing his trees. Especially should he observe the effect of each fertilizer ma-

terial if his soil is of a different type or geological formation from those on which tests have been conducted.

The influence of cover-crops on the effect of fertilizer mixtures deserves close observation. Orchards in which leguminous cover-crops have been grown and turned under will require a fertilizer with less nitrogen than one with no cover-crop.

Fertilizer experiments with pecans conducted by J. J. Skinner of the United States Department of Agriculture show the influence of phosphates, ammonia, and potash when used singly and in combination of two and three. He employed the triangular system of experimentation which included twenty-one fertilizers or combinations, covering the field of ratios or formulas. Four years' work on various soil types and with different ages and varieties of pecan trees shows increased yields of nuts and improvement in vigor of the trees by certain of the fertilizers. Summaries of the results on two soil types for 1921 are representative of the effect of the fertilizer on the yield and the quality of the nuts as reported by Skinner.[1]

The Greenville sandy loam is one of the strongest pecan soils. It has a brown to red surface soil which is underlain by a deep red subsoil. Four-year-old Stuart, Pabst, and Schley pecan trees were given five pounds of fertilizer each in 1918 and in 1919; in 1920 and 1921, ten pounds; and in 1922, twenty pounds. In addition to the use of phosphoric acid, nitrogen, and potash singly and of three complete fertilizers, namely a 9-3-3, a 3-9-3, and a 3-3-9 mixture, there were in the experiment six fertilizers with a high proportion of phosphate and a low proportion of ammonia and potash; six mixtures

[1] Proceedings Ga.-Fla. Pecan Growers' Assoc., 1922.

with high proportions of potash and low proportions of phosphate and ammonia; and six mixtures with high proportions of ammonia and low proportions of the other two constituents. Table VI gives the yield of nuts from the Stuart trees secured in 1921 from each of these fertilizers and from the groups. A large number of trees was used for each fertilizer treatment. The figures in the table represent the average yield to a tree.

TABLE VI

INFLUENCE OF FERTILIZERS ON THE YIELD, AND SIZE AND QUALITY OF PECANS ON THE GREENVILLE SANDY LOAM. (STUART VARIETY.) ANALYSES BY P. D. BOONE.

Fertilizer treatment	Yield of nuts per tree Lbs.	Nuts per pound No.	Length of Nut 64 in.	Diam. of Nut 64 in.	Meat in Nut %	Protein in Meat %	Oil in Meat %
Phosphate	3	52	94	60	46.8	9.1	72.5
Ammonia	8	49	94	60	46.7	11.4	72.0
Potash	3	59	93	60	46.1	10.5	73.9
P_2O_5-NH_3-K_2O							
9 - 3 - 3	24	63	108	56	61.5	8.2	76.6
3 - 9 - 3	13	50	96	62	48.2	10.2	73.3
3 - 3 - 9	8	52	97	60	44.8	8.9	74.0
Aver. 6 high phosphate fert...	7	51	98	61	45.2	9.6	73.2
" 6 " ammonia " ..	9	49	100	62	47.1	10.2	72.4
" 6 " potash " ..	6	53	94	59	47.0	9.7	74.1
No fertilizers	4	53	95	61	46.0	8.3	73.0

The Orangeburg sandy loam is one of the principal soil types occuring in the pecan belt. It has a gray to brownish surface soil which is underlain by a red subsoil. Nine-year-old Schley, Stuart, and Alley trees were given twenty pounds of fertilizer each in 1918, 1919, 1920, and 1921. In 1922, thirty pounds to a tree were applied. The results for the Schley variety in 1921 are given in Table VII.

TABLE VII

INFLUENCE OF FERTILIZERS ON THE YIELD, AND SIZE AND QUALITY OF PECANS ON THE ORANGEBURG SANDY LOAM. (SCHLEY VARIETY.) ANALYSES BY P. D. BOONE.

Fertilizer treatment	Yield of nuts Per tree Lbs.	Nuts per pound No.	Length of Nut 64 in.	Diam. of Nut 64 in.	Meat in Nut %	Protein in Meat %	Oil in Meat %
Phosphate	23	61	108	55	61.9	8.4	77.6
Ammonia	28	59	104	58	63.4	9.0	76.6
Potash	24	66	108	57	62.6	8.8	78.4
P_2O_5-NH_3-K_2O							
9 - 3 - 3	10	51	96	61	46.4	9.8	72.4
3 - 9 - 3	31	62	109	56	63.2	9.8	76.7
3 - 3 - 9	29	66	109	54	62.9	9.0	78.6
Aver. of 6 high phosphate fert.	25	64	108	56	61.9	8.9	76.8
" " " ammonia "	27	61	108	57	63.1	9.3	76.5
" " " potash "	23	63	108	55	62.9	8.8	78.0
No fertilizer	22	66	107	54	62.0	8.7	76.5

Ammonia produced a higher yield on both soil types than did phosphate or potash when these materials were used singly. In a like manner, those fertilizer mixtures high in ammonia yielded more nuts than did those high in either phosphate or potash. In turn, each of these produced more nuts than the unfertilized trees. The use of fertilizers increased the size of the nuts slightly. Those high in ammonia produced larger and better filled nuts than did those mixtures high in phosphate or potash but low in ammonia. The kind of fertilizer has a very marked influence on the protein-content of the nut. When the constituents were used separately ammonia gave a much higher content of protein in the nut than did either the phosphate or potash. Nuts from the unfertilized trees contained the least protein. Fertilizers high in potash develop oil in pecans. In some instances, fertilizers high in potash produced nuts with an increase of as much as

2 per cent of oil. Potash also resulted in nuts with clearer meats having a lighter color than did either phosphate or ammonia.

In 1921, Skinner extended the experiment to include some commercial orchards planted on Greenville, Orangeburg, and Norfolk sandy loam soils. He used a fertilizer containing 9 per cent phosphoric acid, 5 per cent ammonia, and 3 per cent potash, covering an area of about 100 acres. Twenty pounds to a tree were applied, while a number of adjacent trees were left unfertilized as checks. A cover-crop of cowpeas was grown over the entire area. The yields from the Orangeburg soil were representative of the results. Here the fertilized area produced 330 pounds of pecans to the acre, while the unfertilized area yielded only 260 pounds. Skinner says, "This is an average increase of 3.5 pounds of nuts per tree or 70 pounds per acre. With the cost of the fertilizer at $32.75 per ton, the amount applied, 400 pounds per acre, cost $6.75. The 70 pounds of additional nuts secured from the fertilized acre, cost slightly under ten cents per pound."

Fertilizer mixtures for pecans.

Pecan trees in Orangeburg, Greenville, Norfolk and Tifton sandy loams or similar soils, up to seven or eight years after being set to the orchard, should receive from five to fifteen pounds to a tree each year of a fertilizer analyzing 8 to 9 per cent phosphoric acid, 5 to 6 per cent ammonia, and 3 per cent potash. After this age, the ammonia may be reduced, using a mixture that will analyze from 8 to 9 per cent phosphoric acid, 4 to 5 per cent ammonia, and 3 to 4 per cent potash. The amount of fertilizer should be increased two to three pounds each year, that is, a nine to

PLATE VI.—Cotton cultivated between the rows of pecan trees.

ten-year-old specimen should be given twenty pounds, an eleven to twelve-year-old twenty-five pounds and so on, until thirty to forty pounds to a tree each year is reached. As the trees grow larger, the amounts may be increased further according to their needs. The fertilizers should be used in conjunction with liberal amounts of organic matter supplied as cover-crops turned under or as stable manure. Fertilizers will not give maximum returns with a soil deficient in organic matter and incapable of retaining moisture.

The fertilizer should be applied to the soil just before growth begins in the spring. It should be spread uniformly in a concentric circle around the tree, allowing the radius of the outer circle to equal the height of the tree. The inner circle, marking the distance the fertilizer should be kept away from the trunk of the tree, may be only ten or twenty inches from very small individuals one and two years old, gradually increasing in size until the fertilizer is kept eight or ten feet away from the trunks of large trees. It may be worked into the soil by hand or by harrow.

Available materials most commonly employed in making up a fertilizer mixture for pecans are acid phosphate, and sometimes bonemeal, as a source of phosphorus, and muriate of potash, sulfate of potash or kainit as a source of potash. The ammonia is generally derived from two general types of constituents, the quickly available, as nitrate of soda and sulfate of ammonia, and the slowly available as cottonseed meal, blood, tankage, and fish scrap.

Skinner shows the correct proportions for mixing some of these constituents to make a fertilizer containing 9 per cent phosphoric acid, 5 per cent ammonia and 3 per cent potash.

Acid phosphate (16% P_2O_5)	1100 Lbs.
Muriate or sulfate of potash (48% K_2O)	120 "
Nitrate of soda (19% NH_3)	150 "
Sulfate of ammonia (25% NH_3)	120 "
Cottonseed meal or fish scrap (8% NH_3)	260 "
Tankage (8% NH_3)	250 "
	2000 "

In such a mixture, 1.5 per cent is derived from nitrate of soda, 1.5 per cent from sulfate of ammonia, 1 per cent from cottonseed meal or fish, and 1 per cent from tankage. Blood (16% NH_3) could be substituted for tankage, in which case 125 pounds should be used in the mixture, with 125 pounds of some inert material.

If it is desired to use bonemeal as a source of phosphorus, a 9-5-3 goods can be prepared as follows:

Bonemeal (22% P_2O_5) 4% NH_3	840 Lbs.
Muriate or sulfate of potash (48% K_2O)	120 "
Nitrate of soda (19% NH_3)	100 "
Cottonseed meal, fish or tankage (8% NH_3)	250 "
Sulfate of ammonia (25% NH_3)	120 "
Filler	570 "
	2000 "

Such a mixture would have its ammonia derived, 1 per cent from nitrate of soda, 1.5 per cent from sulfate of ammonia, 1.5 per cent from bonemeal and 1 per cent from cotton-seed meal or fish. All of the phosphoric acid and half the ammonia in this mixture is only slowly available.

If the phosphoric acid in such a mixture were derived partly from acid phosphate and partly from bonemeal, it would probably be a better fertilizer for pecans. Such a mixture can be prepared as follows:

Bonemeal (22% P_2O_5), 4% NH_3	400	Lbs.
Acid phosphate (16% P_2O_5)	560	"
Muriate or sulfate of potash (48% K_2O)	120	"
Nitrate of soda (19% NH_3)	150	"
Sulfate of ammonia (25% NH_3)	120	"
Cottonseed meal, fish or tankage (8% NH_3)	250	"
Filler	400	"
	2000	"

In this mixture, 4.5 per cent of the phosphoric acid is from bonemeal and 4.5 per cent from acid phosphate. The ammonia is derived 1.5 per cent from nitrate of soda, 1.5 per cent from sulfate of ammonia, 1 per cent from bonemeal, and 1 per cent from cottonseed meal, fish, or tankage.

CHAPTER VI

POLLINATION OF PECANS

Pollination of the pecan is now recognized as one of the most important factors in the production of a full crop of nuts. Inadequate pollination or some form of sterility in plants as the cause of much poor bearing has occupied the attention of horticulturists for over half a century, and during this time few horticultural plants of any consequence have escaped notice. As pecan trees developed into commercial importance, whether or not they were wholly or partially self-sterile became an important question. Large areas were planted, often to one variety alone, and as they came into bearing there were frequent reports of very poor crops of nuts. This was especially common with some of the popular varieties, such as Frotscher and VanDeman.

Investigation at the Georgia Experiment Station revealed that there are two groups of varieties of *Hicoria Pecan,* which bear a close relation to sterility. The first group, comprising such popular varieties as Frotscher, Moneymaker, Stuart, Rome, San Saba, Moore, Success, and Mobile, are able to pollinate themselves, with the exception that in certain seasons some, especially the Alley, have a tendency to shed their pollen almost entirely before a large percentage of the pistillate flowers become receptive. The second group, comprising such popular varieties as Frotscher, Moneymaker, Stuart, Schley, Teche, VanDeman, Delmas, and Curtis are wholly

or partially dependent on other varieties for their necessary amount of pollen.

These two groups are easily distinguished by the floral characters of the catkins of staminate flowers and also by the difference in development of the pollen-grains. In the first group the embryonic catkins of staminate flowers are inclosed in rather short broad bud-scales, one on each side of the leaf-bud. The catkins themselves are rather short when their length is compared with their thickness, and the individual flowers are shielded by short rather small and inconspicuous bracts. The catkins protrude from the bud-scales from one to five days before those of the second group. In most of the varieties the pistillate flowers become receptive at about the same time that the staminate flowers shed their pollen. A few kinds of this group, however, have a considerable percentage of their pistillate flowers receptive after the maximum dehiscence of pollen (see Fig. 22).

FIGURE 22.— Pecan twigs showing the two groups of varieties in bud stage. Twig on left from group *I*; twig on right from group *II*. Note how the catkins of group *I* protrude while the buds are still small.

In the second group the embryonic catkins of staminate flowers are inclosed in long and rather slender bud-scales. These catkins are usually narrower and longer than those of the first group and the individual flowers are shielded by long narrow conspicuous bracts. The pistillate flowers become receptive from two to ten days before the staminate shed their pollen; and in most cases a large per-

centage of the stigmas of the pistillate flowers have dried or calloused before the pollen is shed, thus precluding fertilization with their own pollen (see Fig. 23).

In size, shape, and general characters, the pollen of the two groups of varieties differs little, but the variation lies in the time of rapidity of the pollen development. In general pecan pollen is somewhat flattened or spheroidal in shape. It is rather large in comparison with pollen from other nuts, being of practically the same size as that of hickory, considerably larger than pollen of Japan walnuts, and much larger still than that of the Spanish chestnut. Pecan pollen-grains have from three to five germpores, and usually in germinating send out a tube through one pore. However, sometimes the pollen-grains send out more than one tube. The catkins of staminate flowers mature and begin shedding pollen first at the basal end, proceeding

FIGURE 23.—Pistillate and staminate flowers of a pecan tree representing group *II*. The stigmas had dried and nut growth started before any pollen had shed from any of the catkins on the tree.

towards the apex. The pollen formed at the distal end or apex of the catkins is almost devoid of germ-pores and not infrequently shows signs of degeneration in the nuclei.

In the development of the pollen in the first group, the average difference in time between the tetrad stage and pollen formation was approximately two days, while for the second group the average was approximately two and one-half days. In the first the average time between the pollen formation and the first shedding of pollen was approximately fifteen days, while for the second group the average was approximately eighteen days; but these intervals vary less than do the intervals between the appearance of the catkins and the tetrad stages of the two groups.

The following tables give the differences and some of the characteristics of the two groups:

TABLE VIII

DIFFERENCES BETWEEN TWO GROUPS OF PECANS

GROUP I

Variety	Variety group	Date leaf buds appear	Date catkins appear	Date pistillate flowers appear	Date pistillate flowers receptive	Date first pollen shed	Date stigma surface dried	Per cent pollen germination	Ultimate length of catkins—mm.
Alley	1	4/4	4/4	4/27	5/8	5/1	5/17	80	85
Mantura	1	4/4	4/5	4/27	5/3	5/1	5/12	30	95
Centennial	1	4/4	4/4	4/27	5/3	5/2	5/12	72	85
Mobile	1	4/6	4/6	4/26	5/6	5/3	5/13	75	95
Nelson	1	4/3	4/3	4/25	5/2	4/29	5/10	76	100
Pabst	1	4/7	4/8	4/28	5/6	5/2	5/21	32	110
Randal	1	4/5	4/5	4/28	5/5	5/1	5/13	70	95
Rome	1	4/5	4/5	4/25	5/4	5/1	5/10	24	120
San Saba	1	4/6	4/6	4/26	5/4	5/2	5/17	36	85

GROUP II

Variety	Variety group	Date leaf buds appear	Date catkins appear	Date pistillate flowers appear	Date pistillate flowers receptive	Date first pollen shed	Date stigma surface dried	Per cent pollen germination	Ultimate length of catkins—mm.
Bradley	2	4/4	4/6	4/25	5/2	5/11	5/9	63	110
Curtis	2	4/5	4/14	4/29	5/7	5/14	5/14	60	125
Teche	2	4/12	4/14	4/27	5/3	5/13	5/11	55	150
Frotscher	2	4/4	4/11	4/27	5/3	5/12	5/11	30	150
Money-maker ...	2	4/4	4/5	4/25	5/2	5/9	5/6	82	155
Appomattox	2	4/5	4/7	4/25	5/3	5/8	5/7	25	125
Russell	2	4/5	4/6	4/27	5/5	5/11	5/8	76	135
Stuart	2	4/14	4/17	4/31	5/8	5/14	5/14	60	120
Van Deman	2	4/5	4/5	4/25	5/1	5/10	5/7	35	170

There is no doubt that self-sterility in pecans is due primarily to the interval between the receptive stage of the pistillate flowers and the shedding of the pollen. Those varieties in Group I, in which the pistillate flowers are receptive at the time the pollen sheds, present no difficulties in the problem of self-fertility. However, those in Group II in which the pistillate flowers are past the receptive stage and the stigmas dried before the first pollen sheds are necessarily self-sterile in varying degrees according to the percentage of dried or calloused stigmas on the tree before the pollen begins to shed. In Group I the stigmas of the pistillate flowers remain in a fresh undried condition for a period of several days, considerably longer than those in Group II. However, all do not become receptive at the same time, and there is some danger of the varieties of Group I shedding their pollen too early for pollinating all their own pistillate flowers, *i.e.,* those coming into the receptive stage late. A number of stigmas of the Alley and the Randall varieties are often still fresh and viscid after practically all the catkins or staminate flowers have dried

and fallen. It is possible, at least in some seasons, for the pollen of these two varieties to shed before all the pistillate flowers are fertilized. This is especially true if there should be heavy winds and rains at the time most of the antlers are dehiscing, for during such weather the pollen is either washed or blown away.

In Group II the interval between the receptive stage of the stigmas and the first shedding of the pollen varies from four to nine or even more days, thus making the pollination of the stigmas by pollen from the same tree rather difficult. In fact it is a frequent occurrence to find trees in the second group with dried stigmas and nuts already formed before the first pollen has shed off the trees. As a rule, the stigmas of Group II dry and callus over from one to five days before the first pollen is shed, thus practically precluding the pollinating of the stigmas by pollen from the same tree. However, in the case of the Curtis and Stuart, a considerable number of belated pistillate flowers will show fresh stigmas on the date when the first pollen is shed. In such cases when these varieties are grown alone, one would not expect complete sterility, but a light crop.

No experiments have been conducted as to just how long pecan pollen remains viable, under various conditions. However, a determination was made of the viability of the pollen under natural conditions, i.e., exposed to the weather in the catkins as they hang on the tree, and it was found to be 80 per cent for Alley, 65 per cent for Jerome, and 100 per cent for Nelson when the pollen was taken directly from the dehiscing anthers. None of the pollen from the same varieties germinated when taken from the dried catkins on the same tree ten days later.

When varieties of Group II are planted, those of Group I

should be set in close proximity to insure successful pollination.

Group I.	Group II.
Alley	Appomattox
Centennial	Bradley
Georgia	Capital
Haven	Curtis
Mantura	Delmas
Mobile	Frotscher
Moore	Hadley
Nelson	Indiana
Pabst	Moneymaker
Randal	President
Rome	Russell
San Saba	Russell No. 2
Success	Schley
	Stuart
	Teche
	VanDeman
	Waukenah

Following is an outline suggesting methods of planting the trees of the two groups:

Group 1	X	X	X	X	X	X	X
Group 2	X	X	X	X	X	X	X
Group 2	X	X	X	X	X	X	X
Group 1	X	X	X	X	X	X	X
Group 2	X	X	X	X	X	X	X
Group 2	X	X	X	X	X	X	X
Group 1	X	X	X	X	X	X	X

Two rows to be planted to varieties of Group II are given for each row of Group I, primarily because most commercial

growers allow first and second place to the varieties of Group II.

In grouping varieties including Alley and Moneymaker, it is well that these be planted near each other, for Alley sheds its catkins before all the pistillate flowers pass the receptive stage and Moneymaker is one of the earliest bloomers of Group II and will serve as a pollinator for the Alley.

The limits to which the pecan will hybridize with other species of nuts has not been determined. However, there is little doubt that it will readily cross with almost any other species of hickory. Pecan-hickory hybrids thus far introduced have been of little economic value as nut-producing trees when compared with the pecan itself. When the hickory blooms synchronously with the pecan, that is, when the pollen of the hickory catkins is shed at the same time that the pistillate flowers of nearby pecan trees become receptive, the hickory may prove of economic importance as a pollinator for the pecan. The resultant plants, if the seeds were planted, would probably produce nuts of very inferior quality. However, as long as the nuts are sold for consumption and not for propagation, the male parent in the production of a crop is of little consequence, if successful pollination is effected.

In the Seventh Annual Report of the Missouri Botanical Garden, William Trelease gives an account of a number of pecan-hickory hybrids. He received flowers, twigs and fruit specimens of one of these from S. G. Galloway of Eaton, Ohio. It seems that the tree which came up near a cultivated pecan showed sufficient characters of both the pecan and *H. minima* (bitter-nut hickory) to mark it as a hybrid between the two species. Similar hybrids are also shown as existing between the pecans and the hickory, the Mocker nut and the bottom shellbark hickory.

CHAPTER VII

PLANTING AND CARE OF THE PECAN ORCHARD

In planting a pecan orchard it should be borne in mind that one is not dealing with a crop that is to be removed in one, two, or even a dozen years, but one that in all probability will occupy the same land for a lifetime. Every possible precaution should, therefore, be taken to guard against making mistakes, because they are usually costly and often cannot be overcome except by beginning all over again. The successful development of a pecan orchard requires an unusual amount of patience, care, skill, and expense.

LOCATION OF THE ORCHARD

The pecan orchard should be located on deep rich soil, or soil capable of being made fertile, whether it is on upland or bottom land. A soil should be selected that retains its fertility well and that will not wash, and such as will produce one-half to a bale of cotton to the acre and from thirty to forty bushels of corn. The pecan is a deep-rooted and long-lived tree. In planting the orchard, it should be borne in mind that the tree is to draw its nourishment from the same area over a long period of time, perhaps for eighty to a hundred years. Only a deep rich soil will furnish this nourishment without becoming depleted, unless plant-food is added at regular intervals during the life of the orchard.

The pecan blossoms late in the spring. Contrary to the

general impression, therefore, it is not often affected by frost and freezes like most other orchard trees. It is thus unnecessary to use the same precaution in selecting elevated land in order to give good atmospheric drainage as in the planting of peaches, plums, and the like.

PREPARATION FOR PLANTING

The soil for the pecan orchard should be prepared well in advance of setting out the trees. Some staple crop should have been grown on the land for at least two or three years before being planted to pecans. It is a serious mistake to plant a pecan orchard on land that still contains virgin timber or that is full of stumps or sprouts, as the cultivation is difficult and expensive and most of the work has to be done with a sweep or turning plow. The young trees planted under these conditions are very likely to suffer severely from drought, insect pests and diseases, from damage by workmen, and from decaying and souring roots left in the soil.

If possible, a green-manure crop should be grown on the land the summer previous to planting the orchard and turned under in the early fall. A good dressing of manure broadcasted and turned under at the same time will give excellent results.

The land should be broken thoroughly and deeply from thirty to sixty days, if possible, before setting the trees. On uplands considerable subsoil can be exposed with advantage at this breaking. A harrow should be run over the soil just preceding the planting.

It is very important to purchase pecan trees from some well known and thoroughly reliable nurseryman. In order to save express and freight rates, it is generally advisable to

obtain them from the nearest reliable nurseryman. Pecan trees should not be purchased through agents unless they are known to be trustworthy and competent. It is difficult for an amateur to tell a seedling from a budded tree. He should, therefore, take no chances on planting seedlings, for he will often have to wait from six to eight years before discovering his mistake. Trees should not be selected because they are cheap. They should be healthy vigorous specimens having the characteristics of the desired variety.

Nursery trees range in age from three to four years from the seed, and from one to two years from the budded or grafted portion. They are usually graded by height or length of the budded or grafted part. The standard grades are one to two feet, two to three feet, three to four feet, four to five feet, and five to seven feet. The most desirable height for average planting conditions is from three to five feet. Trees under three feet are slow in developing, while those over five feet are expensive to transport and difficult to transplant.

The best time for planting pecan trees is from December 1st to February 15th, although occasionally they can be set with good results as late as March 1st. Early trees have a decided advantage over those planted late as they are not so severely affected by excessive drought or rainy spells in early spring and they always start into a more healthy and vigorous growth.

LAYING OUT THE ORCHARD

There are three principal methods or forms for laying out the pecan orchard: the square, the hexagonal or triangular, and following the contour of the land where it is rolling and terraced.

The square method is the simplest and is in most common use. To lay out an orchard the first step is to select the side from which to begin. This is usually the longest side, so that a long base line may be obtained. For the base line, the desired distance from the fence, say twenty feet, should be measured, leaving ample room for cultivation and other orchard operations, and a stake set at each end of the line. Then by sighting from one stake to the other and measuring from the first point, the stakes in the base line are lined up and set at the proper distance from each other. This locates the base line a certain distance from the fence, with all stakes in line, and the distance apart that the trees are to be planted (Fig. 24).

The next step is to square the cross rows from the base line. At each end of the latter a square corner should be made by means of a 60, 80, and 100-foot triangle. One should measure 60 feet back along the base line and hold one end of a 100-foot line there; then hold one end of an 80-foot line at the corner, and where the loose ends of the two lines meet will mark a point on the cross line. By sighting from the corner through this point the cross line is prolonged across the field. When both cross lines have been established, then the fourth side, across the field from the base line, is put in by squaring it on one of the cross lines.

With the field thus squared, the next step is to measure off the distances on each line where the trees are to stand. Then with a man back of the base line, and another back of one cross line, all the stakes in the field may be sighted in place, a third person holding them while the two others sight them in place.

If it is desired to line up the trees by means of furrows instead of sighting, this can be done very easily after the field

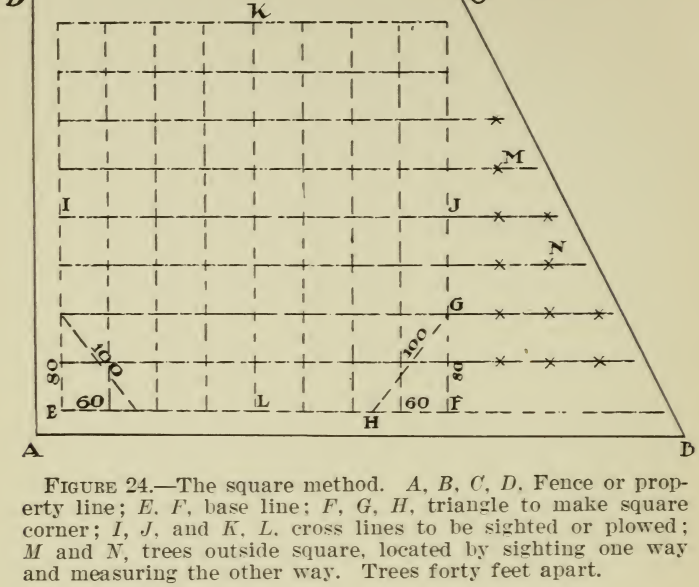


FIGURE 24.—The square method. *A*, *B*, *C*, *D*, Fence or property line; *E*, *F*, base line; *F*, *G*, *H*, triangle to make square corner; *I*, *J*, and *K*, *L*, cross lines to be sighted or plowed; *M* and *N*, trees outside square, located by sighting one way and measuring the other way. Trees forty feet apart.

is squared and the outside stakes located as described above. By plowing furrows parallel to the base line, using the stakes at each end as guides, and then crossing the field in the opposite way, the location for each tree will be marked. With a good plowman, this method is quite accurate.

NUMBER OF TREES TO 10 ACRES

SQUARE

46 ft. 8 in.	200 trees
60 ft.	121 trees
72 ft.	84 trees

The hexagonal method has the advantage of giving the trees more equal distribution and permitting more to the

acre at any given distance. This method also permits greater ease and thoroughness in cultivation.

In laying out the orchard according to the hexagonal method when only a small acreage is to be planted, the simpler plan is to use a line. The base line is first established on one side of the orchard (see previous method) and stakes set at whatever distance from it the trees are to be planted. Two persons, A and B, then take a line or wire marked as to the desired distance. A places one end of the line at the base of the first stake and B steps out opposite the center of the first two stakes and describes an arc. A then places the end of his line at the base of the second stake, and B describes another arc. Where the arcs intersect a stake is set, which determines the location of the first tree. This process is repeated to the end of the row. The first row is then used in the establishment of the second, and so on until stakes are set wherever a tree is to be planted in the orchard.

When a large planting is to be made, a sweep or bull tongue can be used to lay off the rows. The field is laid off in strips of the distance to be allowed between the rows. Furrows are then run in the opposite direction just one-half the distance to be allowed between rows. The person carrying stakes should go down the first row setting a stake at the first intersection and then skipping every other one. When the next row is started, the first stake should be set at the second intersection, and every other one skipped.

NUMBER OF TREES TO 10 ACRES

HEXAGONAL

46 ft. 8 in.	231 trees
60 ft.	139 trees
72 ft.	97 trees

SETTING THE TREES

The distance that should be allowed pecan trees varies greatly, depending on whether the soil is sandy, upland, or rich alluvial bottom land. At least 46 feet 8 inches should be allotted on upland, and from 60 to 72 feet on alluvial soils. When the square method is used, 46 feet 8 inches will allow twenty trees to the acre. In the hexagonal method twenty-three trees to the acre can be planted. According to the square method 72 feet allows 8.4 trees to be planted, while with the hexagonal 9.7 trees can be set at this distance.

The mistake is often made of spacing the trees too closely. Soil that will not develop trees that will crowd when planted under the minimum distance is too poor properly to support a pecan orchard.

Trees can be set close together with a view of taking out every other one when they begin to crowd. This is, however, a very doubtful practice. It is better economy to allow the desired distance and then utilize the unused space with annual crops until the trees need all the room.

The digging of holes for pecan trees is a costly operation, especially when the subsoil is of a hard nature. Satisfactory results are secured by digging with a post auger. The holes should be made from two and one-half to three feet deep, depending on the length of the tap-root, and from eighteen to twenty inches wide. As far as possible the holes should be deep enough to permit the tree to be set without removing any of the tap-root. It is unwise to cut off part of the tap-root in order to make it fit into a shallow hole. The tap-root can be cut back to within twenty or twenty-four inches without seri-

PLATE VII.—Harvesting pecans.

ous damage, but better results are usually secured by leaving the entire root system, except the bruised and broken parts. These should be removed carefully with a sharp knife or pair of shears.

Dynamite can be employed to advantage in digging holes when the subsoil is porous and cracks with the discharge. Positive damage is often done with dynamite when the subsoil is stiff and packs with the discharge. When this occurs, a jug-like hole is made, the sides of which are hardened so that it is difficult for the roots of the young tree to penetrate. Water also collects in the hole during a rainy spell, and, as it is difficult for seepage to take place, the young tree is often drowned out.

The roots of a young pecan tree should not be exposed to dry air or sunlight for any length of time. They should be kept wrapped in wet sacks or carried in a barrel of water. As soon as the tree is set in position in the hole, the top soil should be carefully worked in with the fingers around the roots. All clods should be pulverized before being placed in the hole. Special pains should be taken to place the soil firmly around the tap-root as air spaces will usually cause the soft and spongy root to dry out, resulting in the death of the tree. When the hole is about half full, the soil should be tramped firmly about the roots and a bucket of water added, unless there is sufficient moisture already in the soil. The hole should then be filled level full, tramped, and another bucket of water added if needed, after which loose mellow soil should be banked three or four inches high around the young tree. If fertilizer is to be used, it should be mixed thoroughly with the soil. It is generally safer not to put fertilizer of any kind in the hole, but to work it into the

surface soil a short distance from the base of the young tree where the feeding roots are to develop.

The top of the young tree should be cut back either before or immediately after transplanting, so as to leave from three to six buds above the stock.

PROTECTING YOUNG ORCHARD TREES

Many young pecan trees suffer severely when first set and are often killed outright when the trunks are left unprotected. When the tree has made a rapid growth in the nursery row and the bark is tender, sun-scald is likely to cause considerable harm until the top has developed far enough to shade the trunk.

In many sections rabbits and other rodents do serious damage by gnawing the bark from young trees, often completely girdling them, which results in the death of the specimen.

The young nursery tree when first planted is also subject to the attack of borers and other insect pests until the bark on the trunk has had time to thicken and harden.

The simplest and most economical way of protecting trees from the troubles described above is to wrap the trunk with old newspapers. This can be done best by pulling away one or two inches of soil at the base of the young trees, and then wrapping two or three folds of paper around the trunk, covering it to a height of about two feet or to the first branches. The paper should be tied at the bottom, middle, and top with a light string. The soil should then be pulled back into place at the base. Paper arranged in this way will often last two or three years, when no further protection will be needed.

If the tree is budded low, or if it branches close to the

ground, it may be necessary to use a small-mesh wire for wrapping.

PRUNING

When the young pecan tree first starts into growth, it should be pruned carefully so as to produce a uniform top at the desired distance from the ground. Unless live-stock are to be run in the orchard, which is a doubtful practice, the trees should be headed from two and one-half to three feet from the ground.

The low-headed pecan tree has the advantage over one headed high as it does not suffer as severely from wind storms and is more easily sprayed and pruned. The harvesting of nuts on low-headed trees is a much simpler problem than when the first branches start at a height of fifteen to twenty feet above the ground. The question of spraying pecan trees will become of more and more importance, especially when the great damage done by the case-bearer and the pecan-scab is fully realized. Heading trees high adds greatly to the difficulty and expense of spraying, as well as of harvesting the crop.

After pecan trees have been given the proper form, the only pruning required is when a limb obstructs cultivation or when two limbs interfere with each other.

CULTIVATING THE ORCHARD

There are two general methods of caring for the pecan orchard, until the trees occupy all the land: Giving it clean cultivation; planting crops between the trees.

Pecan trees should be thoroughly cultivated, regardless of their ages, unless they are to be mulched carefully with straw or weeds. The authors do not consider culching practical

except when trees are planted on lawns. It probably requires a longer time for the pecan to reach maturity than any other orchard tree. It will generally be from eight to twelve years before the trees begin to bear in commercial quantities, and fifteen to twenty years before they occupy all the space allowed. It is, therefore, good economy to plant some crop between the rows, especially as it will insure better working of the orchard, and will often more than pay for the cost of cultivating the land until the trees begin to produce paying crops of nuts. There are often abuses arising from cropping the orchard. There should be a thorough understanding between all parties concerned that the young pecan trees are to be given the right-of-way over all other crops grown on the same land.

In cropping the orchard, certain precautions should be observed. Plenty of space should be allowed on either side of the tree row, so as to permit thorough cultivation to be continued after the crop matures or has been harvested. In the western section of the pecan belt the tree row should be cultivated every ten days or two weeks until at least the first of September in order to conserve soil-moisture and provide favorable growing conditions. In the southeastern section where summer rains are more abundant, most pecan-growers cease orchard tillage about the first of August, at which time the cultivated strips of land along the tree rows are sown to a summer leguminous cover-crop, as soybeans, cowpeas or bush velvet beans.

The space allowed on either side of the row should be from five to six feet to start, and should be increased gradually as the trees develop. Corn and sorghum or any other rank growing crop should not be planted. The best results are secured

with cotton, Irish potatoes, sweet potatoes, velvet beans, soybeans, peanuts, and any vegetables.

Two crops can be grown in the orchard in one season by first planting an early maturing sort, such as Irish potatoes, or any of the early vegetables that can be harvested by May 20 to the 10th of June, and then followed with some late maturing kind, such as sweet potatoes, peanuts, tomatoes, egg-plant, peppers, or, in some cases, cotton. (See Plates V, VI.) Irish potatoes grown in a young pecan orchard on the grounds of the Agricultural and Mechanical College of Texas were harvested May 20, and the land immediately set to sweet potatoes, a large crop being grown the same season. As a result of the constant stirring of soil and the unused fertilizer, the young trees make excellent growth under this plan. The orchard was planted in 1909. The land was cropped every year until 1919, the tenth year after planting. Since then clean cultivation has been given the orchard during the growing season or summer months, followed by a cover-crop planted in the early fall and turned under as growth started the next spring.

Orchards can be given clean cultivation from the first; that is, as soon as the young trees are planted. However, this is costly when it has to be kept up eight to twelve years before the trees begin to produce in paying quantities.

Corporations and large individual pecan-growers often do not find it feasible to give intense cultivation to the entire areas of extensive orchards while bringing the trees into bearing. Such growers naturally look for some system by which they can use improved machinery to accomplish the maximum amount of work with a minimum of labor, and at the same time grow some crop that will be remunerative without doing

serious harm to the growing trees. Some have selected oats and cowpeas for this purpose. The oats are seeded in the fall when the land of the entire orchard is broken. A strip about ten feet wide, depending on size of trees, is left along the rows to be cultivated the following spring and summer. When the oats are harvested early the next summer the land is thoroughly harrowed once or twice with a disc harrow, drawn by mules or a tractor, and seeded to cowpeas. The vines are cut for hay in the fall and the land again prepared for planting oats as in the previous autumn. In following this practice, much soil-moisture and plant-food is saved by cutting the oats for hay just before they mature. The growers realize that taking two crops off the land each year is rather hard on the pecan trees and they balance it to some extent by using heavier applications of fertilizers.

Cover-crops, in addition to their many other beneficial effect on the soil,[1] aid materially in preventing washing and the loss of plant-food by leaching. Loose uncovered soil present in the early fall in a pecan orchard which has received clean cultivation during the summer, is subject to washing by heavy winter rains. Such erosion will largely be prevented by the use of a vigorous growing cover-crop which will spread well over the ground when planted in the early fall. Furthermore such a cover-crop will take up the readily available plant-food, thereby preventing its leaching out during the winter and will return it to the soil the following spring when the cover-crop is turned under, just at a time when the trees are in greatest need of nourishment.

Pecan orchard land with a considerable degree of slope

[1] See Chapter V.

should be terraced. This will aid materially in preventing both leaching of plant-food and washing of the soil.

The term "fillers" is applied to any short-lived perennial crop grown to utilize the vacant space until the orchard proper comes into profitable bearing. Fillers are not used as often as annual crops, but in some locations they often give very

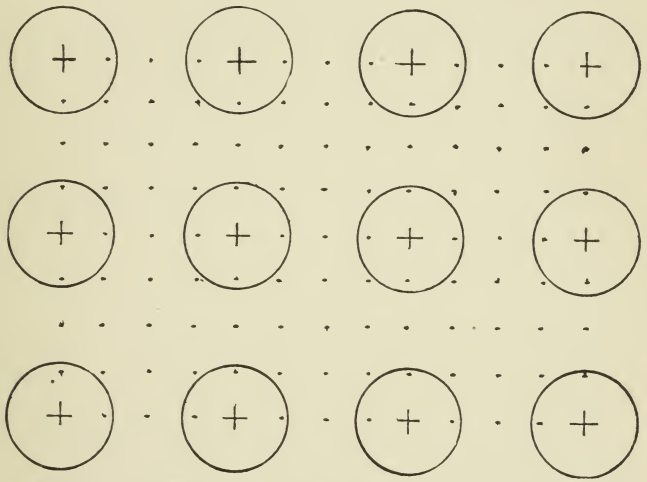


FIGURE 25.—The crosses (x) indicate pecan trees 72 feet apart. The dots indicate fig trees 18 feet apart from the pecan trees and from each other. The fig trees included in the circles are to be removed when they interfere with the pecans. All other fig trees are to be allowed to remain their natural life.

satisfactory results. They should be planted, however, with the definite understanding that they are to be removed just before they begin to interfere with the pecan trees, regardless of their state of maturity. They should be set far enough from the pecans to allow them to reach maturity, in most cases, before they interfere. Some of the fruits that can be

employed most successfully as fillers are peaches, plums, figs, Japanese persimmons, and berries. Fig. 25 shows a plan for planting a pecan orchard on rich alluvial soil near the coast where figs do well. In carrying out this plan it was understood that when the figs began to interfere, the trees on either side of a pecan in the row should be removed. The next step was to remove the fig trees only as they interfered with the pecans. The row of figs that would then be left in the center would undoubtedly reach maturity before it began to interfere with the pecan trees.

The plow should be used in the first breaking of the land each spring. In turning under cover-crops and grass or weeds that have grown during the winter months, nothing will take the place of the plow. In the first few years of the development of the orchard the plowing should be deep and close to the trees. In this way the top roots will be cut and the main root system forced to greater depths, enabling the tree to obtain a firmer roothold and to withstand droughts better. The plowing should become shallower each year until finally it should go just deep enough to turn under the surface growth.

In cultivating growing crops in the orchard, the five-tooth and fourteen-tooth harrows stand preëminent, although one section of a spike-tooth harrow often can be employed to advantage when the space is sufficient between the tree row and the first crop row. After a protracted rainy spell it is often necessary to use a sweep in order to clean the land when the orchard is being cropped. When clean culture is practiced, the spike-tooth, acme or orchard harrow give good results in maintaining a dust mulch.

In cultivating a pecan orchard after the first few years,

it should be borne in mind that a considerable portion of the feeding roots are within a few inches of the surface, and that they should not be destroyed by deep plowing. The lateral or feeding roots take in both the moisture and food for the development of the trees. In good soil these lateral roots usually spread to a much greater distance than the tops of the trees.

When the trees have developed so that cropping is no longer advisable, which will be when they are able to utilize all the available space, the soil should be broken from four to five inches deep each year in the dormant season, and only shallow cultivation practiced during the growing period. The land should be broken to about the same depth each year so as not to disturb the roots unnecessarily. Shallow breaking one year followed by deep plowing the next may result in serious injury to the trees. After the first plowing the disc harrow should be run over the land to break down the rough clods. Some light harrow, such as a spike-tooth or acme, should then be used regularly every ten to fourteen days, in order to keep up a dust mulch, until about the first of September.

It is unwise to turn orchards into sod when they come into bearing, regardless of the character of the soil. The pecan orchard, as it carries its fruit through the dry hot summer months and matures it generally during a protracted drought in late fall, should receive more constant and thorough cultivation than any other orchard crop.

CHAPTER VIII

HARVESTING AND YIELDS OF PECANS

In the process of harvesting, the pecan will withstand rougher handling than almost any other fruit. However, care and intelligence must be practiced if profitable returns from the crop are to be expected.

No very expensive equipment is necessary for harvesting pecans. Some growers advocate step-ladders for picking the nuts from young trees by hand, but the common practice is to knock the nuts off the trees with long bamboo poles. When the trees are too high to be reached from the ground, it is necessary that they be climbed and the nuts knocked off with a bamboo pole by the operator, who moves from limb to limb so as to place himself within reach of the nuts. In flaying the nuts, they should be tapped lightly so as to do the least possible damage to the limbs of the tree. Large trees branching far above the ground may necessitate a ladder to assist the harvester in climbing to the first limbs. Heavy canvas bags or ordinary fertilizer bags that have been washed clean, with straps to go over the shoulders of the pickers, are satisfactory receptacles in which to put the nuts as they are gathered (See Plate VII).

Some growers use two large canvas sheets, spread parallel to each other on each side of the tree to catch the nuts as they fall. Where rank-growing perennial cover-crops such as the

kudzu have been planted, or in native groves, the sheets are a necessity, since otherwise a great many nuts will be lost. These sheets are commonly thirty by sixty feet, although they may be varied according to the spread of the limbs of the trees. In some instances a series of rings are attached to the end of the sheet, through which a rope is passed so that it may be drawn from tree to tree by a mule.

When the nuts are knocked to the sheet, the rear corners from the direction the pickers are traveling are grasped and pulled by hand. This inverts the sheet and dumps the nuts in a windrow at the front or forward edge. Here the nuts are separated from the husks by hand, placed in bushel baskets or some other convenient receptacle, and carried to the pack-house or shed where they are to be dried. Some growers do not separate the nuts from the hulls until they reach the pack-house or shed. If the nuts are spread and allowed to dry for a few days, they are much more easily separated from the husks. This work is termed "shucking pecans." If the nuts cannot be separated from the husks after a few days' drying, they are likely to be faulty and should be thrown in with the culls.

The cost of harvesting depends very largely on the variety, the size of the trees, and the yield. The price usually paid for harvesting is from one to two cents a pound. A good picker will gather from 75 to 200 pounds a day.

In order to prevent waste and thievery, a number of growers have the nuts picked as many as four times during the season. As soon as a large percentage of the husks have split, showing that the nuts are mature, they are knocked off and picked up. This operation is repeated as the nuts mature until the entire crop is harvested. Other growers wait until most of the husks

have split and a small percentage of the nuts have fallen to the ground before harvesting is begun. Only one other picking is made, generally about the time the leaves shed, when the late maturing and scattering nuts on the trees can be found more easily. As a rule, when there are only two harvestings, one cent a pound and sometimes less is paid for the first picking when the nuts are plentiful, and three to five cents a pound at the close of the season when the nuts are scattering.

When the grower is not equipped for drying pecans by artificial heat, they may be dried on frames or trays in any well-ventilated house, or better, in the sunshine during the day and put into the house at night. Frames or trays for this purpose may be of lumber three and one-half inches wide and one inch thick, with heavy galvanized wire netting with one-half-inch mesh. The frames are made seven feet long and thirty inches wide. The side timbers, which are allowed to extend six inches at each end, are pared down and dressed to serve as handles. The wire netting is securely fastened on the bottom of the frame, giving it a depth of three and one-half inches, the width of the board. Each tray holds about 125 pounds and can be handled by two men in sunning in the open air. When carried into the house, these trays can be stacked one upon another and still permit ventilation. The curing of these nuts to fit them for the market will require from a week to ten days, depending on weather conditions, the length of time they are allowed to remain in the sunshine, and the degree of maturity when harvested.

If the nuts are to be sold through an association or exchange equipped with drying rooms, they will be cured by artificial heat before being placed on the market. However, this does

not minimize the importance of sunning and curing the nuts as rapidly as possible after they are harvested, for if kept in piles even for a few days they are likely to mold, which will lessen their market value.

After being properly dried, pecans may be stored for several weeks in any convenient receptacle placed where they will be kept dry and not exposed to excessively high temperatures.

PACKAGES FOR PECAN NUTS

The type of package for marketing will depend very largely on the kind of market the grower wishes to supply. If he desires to sell through an exchange or organized selling agency which supplies its own packages, he may deliver the pecans, ungraded, in bags or some other convenient receptacle. However, if a grower wishes to cater to a private trade, he should strive to obtain a package that meets the approval of the consumer. The package should be light, strong and attractive. A good grade of corrugated paper boxes is satisfactory for mail shipments. Boxes made from six strong thin boards, stained with attractive colors, and wood veneer boxes properly strengthened with wire or narrow steel bands as reinforcements, may be used for both mail and express shipments.

For large freight consignments, the barrel, holding about 175 pounds of pecans, remains in popular use. Shipment in bags, even double bags well sewn, should be discouraged. Such shipments are subject to loss both from being torn in transit and from being pilfered. In fact, the transporting of pecans in bags has become so hazardous that in some instances express companies have refused to handle them.

Under average conditions, a pound of pecans will occupy about sixty cubic inches of space. Based on this, the grower can construct his packages to contain any given number of pounds of pecans. For example, a box twelve inches long, ten inches wide and five inches deep contains 600 cubic inches and so has a capacity of ten pounds of nuts. It should be remembered, however, that the volume of a pound of pecans varies with the varieties and the density of the nuts. For this reason, when boxes are being manufactured for any particular variety or grade, it is best to make a few trial packages first.

GRADING PECANS

Pecan-growers can never hope to standardize the industry until they grade their nuts. When no grading is practiced the grower must necessarily receive a lower price for his product, and in many instances will have to take whatever the purchaser cares to pay.

The grading of pecans by hand is so inaccurate and so long and tedious that few growers attempt it. On the other hand, satisfactory graders cost about $600.00 each, a greater price than most individual growers care to pay. Therefore, the most feasible method seems to be to sell pecans to a central organization which maintains graders.

The graders now in use are manufactured by a number of firms and represent two distinct types. Each, however, grades the nuts according to their smallest diameter. The most common type of grader is a revolving drum, mounted with one end a little higher than the other. This drum is composed of several bands of metal containing oblong perforations. The perforations at the lower end are fifteen-sixteenths of an inch across the narrow way, and those of

each band are reduced by one-sixteenth of an inch as the upper end is approached, where the perforations are only ten-sixteenths of an inch across. The nuts are fed in at the upper end of the cylinder and passed through by gravity. They fall through the perforations into grades differing one-sixteenth of an inch in the smallest diameter and are held separately in bins below. Those nuts measuring one inch or more in diameter pass through the drum and are collected into a bin to themselves (see Plate VIII).

The other type, more recently introduced, grades the nuts by oppositely rotating rods not quite parallel. To each of these is fastened spirally a half-round or hemispherical rod which causes the nuts, as they come from the hopper above, to travel along between the rods until the latter are far enough apart for the nuts to fall through into the proper bins according to the least diameter of the nuts, just as is accomplished by the revolving drum grader.

Wild seedling pecans, as they come from the forest, are so very variable in color and markings, as well as in size and shape, that some dealers have followed the practice of polishing or burnishing so as to give them a more uniform appearance. This is especially true of the seedling pecans imported from Mexico, which are often labeled Texas seedlings, and as they are inferior they tend to discredit the real Texas pecan. The nuts are put into churn-like receptacles which are revolved, rolling the nuts over and over and rubbing them together, until their natural markings are largely obliterated and their surfaces smooth and polished. This work was begun on a commercial scale by R. C. Koerber at Austin, Texas, a few years prior to 1896, the business afterwards being moved to New York City. In some instances the practice has

been carried a step further by putting coloring matter in the revolving churns which paints the entire surfaces of the nuts a uniform reddish-brown color.

The polishing or burnishing of pecans so as to destroy their natural color and markings should be discouraged, as these furnish a part of the distinguishing characteristics and beauty of each variety of seedling nut. The use of coloring matter on pecans is so objectionable, on account of the coloring rubbing off on any object coming in contact with the nuts, that the practice has met with disfavor by the general public and cannot be of long duration.

Pecans passing through either type of grader will have a uniform minimum diameter, but all nuts of the same bin will not necessarily have the same length nor be of the same weight. Suction machines have been devised for separating the light weight or chaffy nuts from heavy ones, but no machine has been constructed that will separate the nuts with diseased or defective kernels, such as those affected by kernel-spot, that are normal in weight. To meet this condition, a cracking test should be applied, similar to that adopted by the 1919 convention of the National Nut Growers' Association, as follows: "In a first-class grade of any of the 'Prime' varieties, the kernels of not more than four shall be wholly defective or not more than six one-half defective or eight one-quarter defective, or a total of eight nuts shall not be more than one-quarter defective per hundred by count. All less well known varieties should be given a guarantee by the grower or seller as to percentage of defective kernels as determined by count."

Attractive pecans, even with defective kernels, will sell,

but if this grade is allowed to enter the channels of trade as first-class nuts, they will certainly react on the industry with disastrous results, and therefore should be eliminated. However, with low-grade varieties, such as the Rome, Mobile and Nelson, it will not be feasible to hold them up to the cracking test outlined above. These should be sold as low-grade nuts or better sent to the crackery.

It has not been thought feasible to fix a standard degree for dryness for pecans. They give off and reabsorb moisture with the changes of the atmosphere. For this reason, an exact degree of dryness will be difficult to maintain. As long as they are sufficiently dry to pass through the channels of the market without deterioration and satisfactory to the consumer, they may be regarded as in a legitimate condition.

Most varieties of pecans are separated into three sizes—number one, two and three—and given arbitrary trade names. The National Nut Growers' Association proposed the following names for grades, in order of size, beginning with the smallest: "(1) Standard, (2) Fancy, (3) Extra Fancy."[1] Following this system, the following groups and sizes of varieties were proposed:

"Group 1.—Nuts which will pass through a bore of 13/16 of an inch in diameter, but not through a bore 12/16 of an inch in diameter, and all larger nuts of the same variety, except when a third grade is to be used, shall be known as 'Fancy,' when of the following varieties: Alley, Aurora, Bolton, Claremont, Colorado, Delmas, Eggshell, Frotscher, Georgia, Hall, Haven, Kincaid, Moneymaker, Pabst, President, Randal, Russell, Sovereign, Stuart and Young.

[1] Proceedings Nat. Nut Growers' Assoc., 1919, 82.

With the same varieties the term 'Standard' shall apply to such nuts as will pass through either an 11/16 or 12/16-inch bore, but not through a bore 10/16 of an inch in diameter. Smaller nuts of these varieties shall not be given a grade standard.

"Group 2.—These terms shall apply to the following varieties when 1/16 of an inch in diameter smaller than with the preceding sorts: Centennial, Halbert, James, Kennedy, Mobile, San Saba, Schley, Van Deman and Waukeenah.

"Group 3.—The diameters for these (group 2) respective grades shall still further be decreased by 1/16 of an inch for the following varieties: Curtis, Moore and Robson.

"With any variety with which it is deemed best to establish a third grade, the term 'Extra Fancy' shall apply to such nuts as will not pass through a bore 13/16 of an inch in diameter for group 1, or through one 12/16 of an inch for group 2, or 11/16 of an inch for group 3.

"With the following varieties, these diameter measurements shall be increased by 1/16 of an inch over those of group 1 for the same respective grades: Lewis, Nelson and Success."

PECAN YIELDS

The records of numerous pecan orchards show that the trees frequently bear a few scattering nuts the third or fourth year. It is, however, not until the eighth or tenth year after planting that a profitable crop may be expected. These records are from trees planted on good soil and receiving reasonable care and cultivation. Just what yields commercial orchards will give on reaching full maturity, about fifty or seventy-five years after planting, is somewhat a matter of speculation. The performance of a large number of old

PLATE VIII.—A modern pecan-grader.

seedlings and some of the older grafted varieties give evidences of very heavy yields even in old age if the trees have been properly treated.

The time of coming into bearing and the yield of pecan trees for the first eight or ten years depend very largely on the variety and soil. Such varieties as the Moneymaker, Moore, Mobile, Success, Burkett, Waukeenah, Halbert and Texas Prolific come into bearing early and fruit heavily while comparatively young. The other extreme is represented by the Pabst, Delmas and Stuart, which make a strong vigorous wood growth during the first few years after being set, but usually become heavy and satisfactory bearers by the time they are ten years old.

Pecans, as a rule, are very variable in their habits of bearing. Very heavy crops are likely to be followed by very light yields. Some varieties, however, are more regular bearers than others. A phenomenally heavy yield of nuts by a tree for one year is frequently quoted by nursery and realty men as an index of the value of the variety while, in fact, the figures may mean little or nothing, as the variety may be an alternate year bearer and so produce fewer nuts over a period of several years than one which bears smaller crops annually. Fair crops practically every year are to be preferred.

The influences of soil and climate on varieties vary so greatly from one locality to another that records from any one place will not apply to yields of pecans in general. The yield records of several varieties of pecans grown at the Georgia Experiment Station, which is located in the lower piedmont section of the state, illustrate the point under consideration:

TABLE IX

Average Yields in Pounds of Nuts to a Tree

Variety	1914	1915	1916	1917	1918	1919	1920	1921	Date Tree Set	
Alley	.03	15.05	11.95	6.40	4.00	38.50	.....	47.50	1908	Jan.
Atlanta	2.77	6.75	5.15	.75	4.40	7.50	.....	28.00	1908	Jan.
Appomattox	1.35	3.80	10.00	1.10	9.90	12.00	.....	52.00	1908	Jan.
Beverage	4.42	9.15	.87	8.07	6.75	.....	.....	3.50	1908	Jan.
Bradley	6.30	9.70	15.20	13.40	33.70	29.00	.....	87.00	1908	Jan.
Curtis	.87	8.50	14.77	.40	1.40	17.00	.....	15.50	1908	Jan.
Centennial	.96	1.05	2.12	3.05	.85	2.12	.....	9.62	1908	Jan.
Frotscher	1.40	1.11	5,90	5.15	1.56	34.50	.....	63.25	1908	Jan.
Mantura	.47	.22	1.52	.50	1.60	9.00	.....	26.00	1910	Jan.
Mobile	.07	1.72	11.42	.....	9.90	2.00	6.00	12.75	1912	Jan.
Moneymaker	7.92	11.32	27.02	5.85	33.92	15.45	19.25	52.00	1908	Jan.
Nelson	3.57	9.02	7.57	6.65	10.55	19.25	1.00	57.00	1908	Jan.
Pabst	2.52	11.87	17.57	8.42	25.37	13.00	8.25	39.00	1908	Jan.
Pan American.	.10	.05	.55	.25	.40	.50	.....	1.00	1908	Jan.
President	1.70	1.10	1.10	.....	.70	1.00	.....	6.00	1908	Jan.
Randal	6.55	17.70	14.50	6.15	30.45	9.00	8.00	19.00	1908	Jan.
Rockville	....	.....	.....	.....	.....	.....	.....	4 Nuts	1908	Jan.
Rome	4.24	8.86	26.70	15.77	8.25	20.00	.38	56.00	1908	Jan.
Russell	2.05	2.40	5.10	1.15	3.75	4.00	.50	12.50	1908	Jan.
Robson	16.57	14.70	24.60	17.67	28.03	12.25	8.25	63.50	1908	Jan.
San Saba	5.52	11.07	7.47	5.95	17.95	14.00	.....	47.00	1908	Jan.
Stuart	.40	4.70	7.95	6.85	3.40	5.50	.....	10.50	1908	Jan.
Teche	.03	10.17	17.26	8.01	18.13	21.58	.91	48.41	1908	Jan.
Van Deman	....	1.47	8.35	2.57	.37	5.75	.25	5.75	1908	Jan.
Washington	....	.....	.....	.....	.....	.25	.....	.25	1908	Jan.
Moore	....	.....	.....	.....	.....	2.00	.....	2.50	1915	Dec.
Schley	....	.....	.....	.....	.....	1.00	1.00	6.00	1915	Dec.
Success	....	.....	.....	.....	.....	.....	.....	3.00	1915	Dec.

The accompanying average yield records were obtained from two to four trees of each variety and illustrate the great variation in yields likely to occur in any locality in which a large collection of varieties are grown. Some of the low yielding sorts, however, in this particular instance, may be high yielding when grown in some other locality and *vice versa*. Thus, in selecting varieties for any locality, the grower should secure as much information as possible regarding their behavior.

High yielding individual pecan trees are desired; however, the grower should not lose sight of the fact that the average pecan in any commercial planting falls as far short of the record yields of a few individual trees as does the average beef steer of the prize winner at the International Live-Stock Show. This may be illustrated by giving the yield records of a few outstanding individuals with which the records of ordinary pecan trees may be compared. Among these individual trees will be found native forest seedlings; and budded or grafted trees planted in orchard form on cultivated land.

The original Halbert tree, about 110 years old, near Coleman, Texas, produced as much as 400 pounds of nuts in one year and averaged 200 a year for ten years. The original San Saba tree, about 100 years old, near San Saba, Texas, yielded as many as 480 pounds of nuts in one year and averaged 215 pounds for twenty-eight years. The original Oliver tree, about seventy-five years old, near Junction, Texas, has produced 800 pounds in one year and averaged more than 500 pounds for thirty years. The original Hollis tree, more than 100 years old, near Bend, Texas, has borne 1,060 pounds in one year, and averaged 300 pounds for seventeen years. The original Sloan tree, 150 years old, near Stacy, Texas,

yielded 1,000 pounds in one year and averaged 700 pounds for twenty-five years.[1]

Eight seedling trees, not over forty years old, on the place of W. J. Millican, Bend, Texas, gave a yield, in 1919, of 450 pounds of nuts for the lightest bearer of the eight trees, and 670 pounds of nuts for the heaviest bearer. Three native seedling trees, standing not more than 100 yards apart, near Bend, Texas, on the Colorado river, have records of producing 870 pounds, 995 pounds and 1,060 pounds of nuts each respectively for the year 1919. The heaviest yielding of these three is the Mother Hollis tree. About a mile up the river from Bend, Texas, stands another seedling which produced 1,400 pounds of pecans one year and 1,140 pounds another season. The year that 1,400 pounds were harvested from this tree, a large number of the pecans dropping early were eaten by hogs, leading the owner to believe that had the entire yield been saved, fully a ton of nuts would have been harvested from the one tree that year.

A. G. Delmas and Sons gathered 235 pounds of pecan nuts from a thirteen-year-old Delmas tree. Theo Bechtel of Ocean Springs, Mississippi, harvested from a Van Deman tree, a record of which was not begun until the tenth year, 100 pounds the tenth year, 70 pounds the eleventh year, 60 pounds the twelfth year, and 185 pounds the thirteenth year. A. G. Lowrey of Preston, Georgia, picked 700 pounds of nuts from a seedling tree sixty years old. John West of Monticello, Florida, harvested 900 pounds of nuts from one seedling tree.[2]

Reports of other yield records have been made through letters. H. W. Smithwick, Americus, Georgia, has eighty-

[1] A. C. Easly—Texas as a Pecan Possibility; Proceedings Nat. Nut Growers Assoc., 1917.

[2] J. B. Wight, some Aristocrats in the Pecan World.

five acres in pecans, embracing more than a dozen varieties, ranging from ten to fifteen years after planting, that produced 14,126 pounds of pecans in 1921. The 1922 crop was very much shorter than this. J. S. Scarboro, Tifton, Georgia, harvested 3,400 pounds of pecans from 100 ten-year-old trees in 1921, which was followed by a very light crop in 1922. G. C. Pabst, Ocean Springs, Mississippi, gathered a total of 9,000 pounds of nuts from 100 thirteen-year-old pecan trees in one year. From seventeen other trees, eight years old, of the Stuart variety, he harvested in one year 1,700 pounds. J. A. Kernodle, Camp Hill, Alabama, obtained a little more than 1,000 pounds of nuts from seventeen fourteen-year-old pecan trees in 1921. These seventeen trees are growing on one acre of land where the soil has been kept in a high state of fertility by growing an annual winter cover-crop of bur clover, followed by corn and soybeans planted between the rows of trees in the spring after the clover seeds matured. Growers in many sections of the pecan belt may be able to give some authentic records of yields that will surpass these, but the general average or even the trees of the best commercial plantings will fall far below them.

From the fourth to the eighth year inclusive, each average tree of a well cared for orchard of varieties adapted to the section in which they grow should produce a total of fifteen to twenty-five pounds of nuts. During the next five years, each tree should yield a total of 85 to 125 pounds. For the next period of seven years, which will bring the tree up to twenty years after planting, the total yields should range from 500 to 700 pounds of nuts. From this it would be expected that an orchard of pecans on good soil and properly treated should produce a total of 600 to 850 pounds to a tree for the

period of twenty years after it is planted. Growers, however, are more likely to measure up to these yields for the first thirteen years because most trees are planted too close together and will begin to crowd long before they are twenty years old. In addition, the average grower who gives his trees good care during the first five or six years of their bearing life does not fully realize their growing demands for plant-food, moisture, and space for development and for the production of increased yields. Many growers apply very little more fertilizers to a twenty-year tree than to one only twelve or fourteen years old.

Another important factor is that young trees are more easily protected against insects and fungous diseases as they can be sprayed more readily than the older and larger specimens. Also, some varieties grow and produce well for several years and then develop a degree of susceptibility to certain diseases that greatly reduces their productiveness.

In large commercial plantings of pecans there are almost invariably a sufficiently large number of low-yielding trees each year to keep the average production very much lower than those previously stated. Records from a number of large commercial orchards, where the trees range from twelve to fifteen years of age, show that the average yield to a tree each season rarely exceeds six pounds through the fifteenth year after planting. The highest yielding trees of these orchards, however, are in strong contrast with the average yielders.

The question of varieties, as previously mentioned, has a very important bearing on the yield of pecan nuts. The Stuart and the Schley are planted possibly more extensively than any other two varieties of pecans. In some regions in

which both of these sorts are apparently well adapted, the Stuart surpasses the Schley in yields by about 50 per cent. The Schley nuts, of course, bring a better price in the market than the Stuarts; but it is not expected that the premium paid for the Schleys will be great enough to offset a 50 per cent less yield.

CHAPTER IX

COMMERCIAL CRACKERIES AND STORAGE OF PECANS

The cracking of pecans on a commercial scale has developed rapidly in recent years. According to Robert E. Woodson, St. Louis, Missouri, the commercial shelling of pecans was begun by the Barnhart Mercantile Company in 1884.[1] At this time a hammer with a block of lead as a base was used for cracking the nuts. There was small demand for pecan kernels until 1889, the year Woodson invented a cracking machine which was operated with one hand and fed with the other. It was fifteen years later that he invented a power-driven, automatic, self-feeding machine for cracking large quantities of pecans. Following this, other cracking machines were invented and are working successfully today.

In operating one of the most common types of automatic power-driven machines, the nuts are poured into a hopper through which rotates an endless-chain belt with cups or projections just large enough to pick up and carry one nut each over into a slot of the machine. A piston-like rod working automatically in the slot brings pressure on the ends of the nut, which cracks it. The nut is then released into a receptacle below with a minimum of broken kernels.

[1] Proceedings Nat. Nut Growers' Assoc., 1913.

SOAKING PECANS FOR CRACKING

The shells of pecans that have been allowed to dry out after harvesting will generally break with only one or two long cracks, and the kernels will shatter badly when run through the commercial crackers. Soaking makes the shell brittle so that it cracks in numerous places and the meat tough so that it will not crumble. One method is to dip the nuts in water just below the boiling point for fifteen or twenty minutes. The nuts are then taken out and their surfaces allowed to dry before being cracked. This gives good results so far as cracking of the shells and picking out the kernels are concerned, but the hot water has a decided tendency to darken the meats.

Another method of soaking is to place the pecans in a large tank of water, turn on enough cold water to cover them, and allow them to soak five or six hours. The water is then drained off, the top of the tank closed, and the pecans allowed to remain in this damp atmosphere for one to five days before cracking. The best results are usually secured from the third to the fifth day, because by this time the moisture has penetrated the shell and livened and toughened the kernel.

Still another method is to place the dry pecans in a room lined with tin or some other waterproof material. The nuts are sprinkled with water as they are brought in and allowed to remain in this room where the atmosphere is heavily charged with moisture for several days before cracking.

When the pecans have been thoroughly soaked, it is necessary to dry out the excess moisture from the meats before they are packed. This can be done best by placing them in trays 24 inches wide, 36 inches long, 4 inches deep, and made of 1-by-4 material. The bottom of the tray is covered with ordinary

screen wire. These trays are made so as to fit into frames and are stacked twelve high in five rows. Each tray holds from thirty to forty pounds of pecans. At night an electric fan with twelve-inch blades is set so as to send a current of air through these pecans. When the weather is clear, the meats will be dried out thoroughly by morning. If the atmosphere is moist, an electric heater is set back of the fan to help take up the excess moisture. The meats are thus ready for packing the second day after the nuts are cracked.

HAND NUT-CRACKERS (Figs. 26 and 30)

There are hand-propelled nut-cracking machines, but since these are operated on the same principle as the power-driven machines, they need no further consideration in this connection.

There is a very great variety of small hand nut-crackers on the market. The more efficient types are those that are

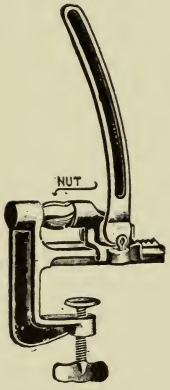


FIGURE 26.

FIGURE 27.

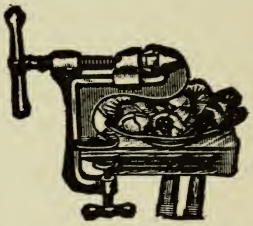


FIGURE 28.

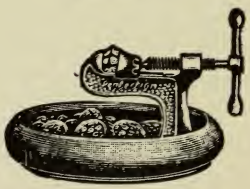


FIGURE 29.

Hand nut-crackers.

clamped to the table and worked by means of a compound lever or by a spiral central pinion which exerts pressure on the ends of the nut, cracking it without crushing the kernel very seriously. The other general type has two small metal rods or handles fastened together at one end by a hinge-like connection and notched or grooved on the inner side at the hinged end for holding the nut. This operates on the principle of the lever. Both types sell at very reasonable prices and give satisfactory results for family use.

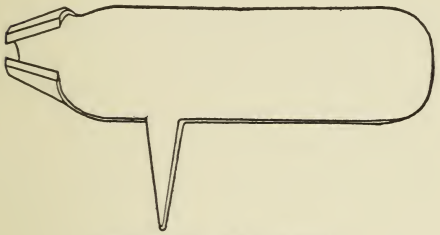


FIGURE 30.—A nut pick.

COST OF SHELLING PECANS

The cost of shelling pecans depends very largely on the kind of machinery used and the volume of business. When good machines and other equipment are installed and when there is sufficient volume of nuts to operate for nine or ten months in the year, the labor becomes more skilled, and the shelling can be done at a lower average cost than when the supply is sufficient to run only two or three months out of the year. Modern cracking machines sell for about $850 each, and the power for operating them is also an item of expense.

Machines crack the nuts very successfully, but as yet no machine has been devised that will successfully separate the shells from the kernels; consequently this work must be done by hand. The kernels are picked out by ordinary labor,

the cost varying in different sections. Some crackeries pay a higher rate for the unbroken halves of kernels than for the pieces so as to induce the workers to take more care in getting out the unbroken halves. The price paid a pound for picking out the kernels ranges in most of the crackeries from four to eight cents. The higher sums are paid for picking a pound from the ordinary seedling nuts, while the lower are for the standard varieties.

STORING PECANS

The pecan, unlike a great many fruits, does not deteriorate rapidly after harvesting. However, if held indefinitely under ordinary conditions, it will eventually become inedible on account of the rancidity of its fat or oil-content. When large quantities of pecans are to be held for the greater part of the year, as at some of the shelling plants, adequate provision should be made for storing before the nuts are cracked and also for storing the kernels as long as they are held exposed to the air before being marketed.

Little information is available to show just the best temperature for keeping pecan nuts and kernels. The nut is, however, tolerant of rather wide variations in temperature and may be expected to remain in good condition for several weeks or even months when the storage-room is kept reasonably cool. Both the nuts and the separated kernels would probably remain in good condition for the greatest length of time if maintained at a temperature just above the freezing point. However, experienced pecan men say that this is neither practical nor necessary. They claim that pecan nuts and especially the separated kernels when taken from extremely low temperatures and placed on the market where

they will be exposed to high temperatures deteriorate much more quickly than those held at a storage temperature ranging from 40 to 50 degrees F. Pecan nuts are more easily stored without marked deterioration than the kernels after they are removed from the shells. However, it seems certain that as long as the storage-room is held down to 40 degrees F. the pecan nuts may be expected to keep well, provided other favorable conditions are supplied.

Since the kernels of pecans are high in oil, often running above 70 per cent, conditions favorable to preserving the oil may be expected to be good for keeping the nuts. Rancidity of the oil is one of the first signs of deterioration. Aside from low temperature, it is important that the moisture or humidity of the air in the storage-room be held as low as possible. This should be borne in mind in deciding on the type of refrigeration or cold storage. Rancidity of pecan kernels may be ascribed to the action of moisture on the free fatty acids formed in the presence of air and some soluble ferment as enzymes. The action of dry air, so far as rancidity is concerned, is very slow in the deterioration of pecans as compared with moist air, and moist air and high temperature combined are very deleterious. A desirable storage-room for pecans may be described as one with a temperature ranging around 40 degrees F., dry air, and very little light.

Light, especially direct sunlight, produces a blanching effect on oils or fats, thus making it necessary to guard as much as possible against exposing pecan meats. Pecan kernels, even before they are shelled, if left in the sunshine very long, will deteriorate by blanching. For this reason, nuts in storage should be protected against strong sunlight as well as moist warm air.

It has been the practice of some walnut-growers of the Pacific slope to put up kernels by the vacuum process, but this was not applied to pecans on a commercial scale until the early part of 1922. There are two types of machines for this work. One of them seals glass jars, while the other seals tin cans. When the kernels are graded, the unbroken and well-formed halves are placed in the glass jars, while the chipped halves and broken pieces are put in tin cans. The machine exhausts the air and seals the top, leaving the kernels in a vacuum. When put up in this manner, the kernels will usually keep indefinitely and can be placed on the pantry shelf of the housewife to be used as needed.

CHAPTER X

MARKETING PECANS

The pecan is now going through a process of standardization and introduction into the world markets. General demand for the better grade nuts dates back to the exposition at New Orleans in 1886, when an extensive collection of choice thin-shelled pecans from the Mississippi bayous was exhibited. It was not until 1900, however, when a very complete exhibit of America's choicest varieties was shown at the Paris Exposition that any noticeable world-wide demand for pecan nuts was created.

The price of pecans, before the advent of improved varieties in any quantity, was based on the demands for wild seedlings. The producers considered these seedling nuts merely a by-product, costing nothing but the harvesting. This, together with the very limited demand, caused exceedingly low prices to prevail, and even as recently as 1900 pecans sold as low as two to four cents a pound. Before 1910 the price advanced, with considerable fluctuations, to sixteen cents a pound. This rise was due largely to the invention and installation of cracking machinery which enabled the dealers to put unbroken half kernels on the market in large quantities ready for use, and also enabled them to use all grades of nuts. With this widening market for the seedling pecans came a very much greater demand for the standard named varieties.

The limited production of standard varieties of pecans

heretofore and their general popularity had enabled growers to dispose of their crops with little difficulty through the express and mail-order service. However, as the large commercial orchards approach full bearing, producers are turning from the limited mail-order business at high prices and are seeking other methods of marketing with a vastly greater capacity for promptly handling large quantities.

Individuals and corporations having strong financial backing and growing large quantities of pecans are often able to keep in close touch with the more important channels of trade and can market their nuts independently to good advantage. Even the small grower who has patience and business ability can build up a trade that will dispose of his pecan nuts at good prices. Such a trade is developed slowly, but can be increased considerably by prompt service and by supplying nuts of the highest quality. The average small grower, however, can market his nuts to much better advantage through some marketing association, provided it is properly organized and managed. Intelligent marketing is impossible without information concerning crop and market conditions and the average producer lacks both the facilities and the time to obtain it. A marketing association controlling the products of a number of growers can employ experienced men to secure the necessary information and to sell the products to the best advantage. In addition, organizations with a large volume of business have marketing connections and outlets not open to the individual producer generally.

COÖPERATIVE MARKETING ORGANIZATIONS

Coöperative marketing associations are divided into two classes, one including those formed with capital stock, the

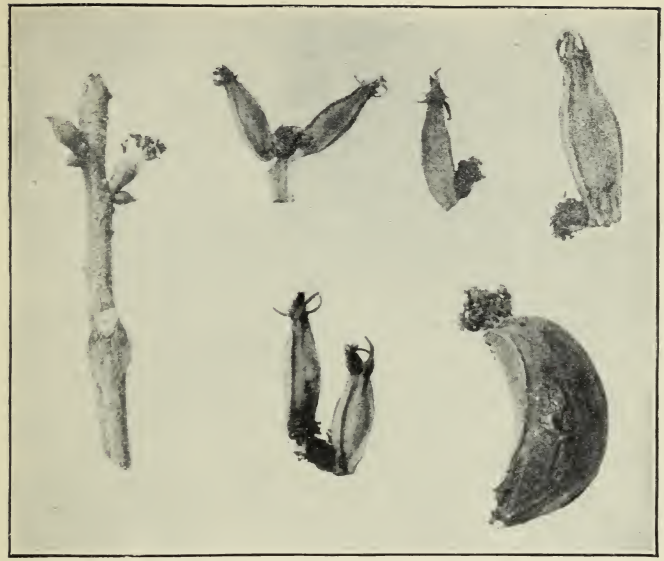


PLATE IX.—*Above*, young pecan nuts attacked by the larvæ of the nut case-bearer. *Below, left*, leaf case-bearer, spring cases on main leaf-stalks. *Below, right*, adult beetle of flat-head tree-borer.

other non-stock non-profit organizations. In either case, membership should be restricted to bona fide growers. Membership in the capital stock class is represented by the ownership of one or more shares of stock, while in the non-stock non-profit form the member pays an entrance fee and receives a membership certificate, which entitles him to all the privileges of the association.

A farmers' coöperative association, formed on capital stock, is operated on the one-member one-vote basis, regardless of the variation in the shares owned. This in a measure discourages the buying up of the capital stock by a few members who might desire to gain control of the organization for selfish purposes. It also makes the ownership of the capital stock unattractive to outsiders. Associations of growers, organizing on this plan, usually limit the ownership of the capital stock to actual producers. From a legal standpoint, it might be difficult to prevent a member from selling his stock to an outsider, but the one-member one-vote provision tends to render the stock unattractive to outside investors. A disadvantage of this plan is that there is no method of preventing an unequal distribution of stock ownership among the members.

The non-stock non-profit form of organization is the one most used now by growers. Under this plan the one-member one-vote provision obtains and membership is also limited to actual growers. Operating capital is secured from banks and from the War Finance Corporation by offering the commodity controlled by the organization as collateral. Under this plan there is no capital stock to be sold, and, therefore, it is impossible for outsiders to gain a foothold. Under both the capital stock and the non-stock non-profit forms of organ-

ization, complete control of all activities is in the hands of the membership.

A coöperative marketing association is an organization of the growers or producers for the purpose of collective selling, in an orderly manner and on a supply and demand basis, individually produced farm commodities. Any producer who pays the membership fee can have one vote, no more, in the governing of the organization; the profits above operating expenses are distributed among the members in proportion to patronage or the amount of business transacted. A better, shorter and more economical method of distribution is obtained by coöperation than any single grower could possibly hope to procure alone. This type of marketing association is a step forward in rendering service and effecting savings for the producers. It has reached its highest development in California, where the California Fruit Growers' Exchange was organized in 1893. More recently organizations have been formed in that state for the handling of walnuts, raisins, almonds, prunes, poultry and other commodities. The Eastern Shore of Virginia Produce Exchange has operated successfully for more than twenty years. The Florida Citrus Exchange has made remarkable progress in recent years.

Organization by commodity.

One of the fundemental principles of coöperative marketing is that organization be on a commodity rather than on a community basis. Heretofore, a small number of growers living in the same community would organize to sell their produce collectively in order to ship in carload lots and reduce the expenses of marketing. Sooner or later the buyers pitted the local associations against one another

and so the latter failed to secure results, for they were put in open competition with producers of the same commodity. This was the experience of the citrus fruit exchanges of California that finally forced them into organizing the big California Fruit Growers' Exchange. Organization on the principle of commodity is a broader conception than on a community basis. Under this system all commodity organizations handling the same commodity unite to form one large association which recognizes the various community associations as component parts. The field service of the general association keeps all the local sections in touch with each other and with headquarters. Wherever the volume of business warrants, the field service organizes new local associations.

The advantages of the organization of marketing by commodity are obvious. In the first place it eliminates destructive competition; secondly, it tends to stabilize the market. When the general association controls a large percentage of the commodity, there is little danger of glutting one market and starving another; consequently the price will run more evenly and the demand will be steadier. When an association handles a large percentage of the commodity, it attracts the most influential type of buyers and can command the respect of the business world and use to advantage the ordinary channels of trade that are not accessible to small business. In addition, the larger the volume of business, the less in proportion are the overhead expenses and the more able is the association to hire experts in all necessary lines.

Standardization of commodity.

Another fundamental principle of successful coöperative

marketing is standardization of the commodity. This is merely good business. The farmer is frequently criticized for lack of attention to the uniformity and quality of his products. As an individual he is powerless to remedy this weakness both from lack of time and because his production is too limited to warrant dividing into grades. However, if he is a member of a coöperative association, the marketing experts set a standard that will appeal to the buying public. When the farmer's produce is brought to the warehouse of the association, it is graded to the standard by experts generally, in the case of pecans, into first grade, second grade and culls. These sorts are then expertly packed and attractively labelled. The first grades are pooled or mingled with those of the other members and put on the market. When the association is large, especially when it controls a large percentage of the commodity on the market, the first grade pool will be of sufficient quantity to attract attention and command a higher price. The second grades go through the same process of pooling and marketing. The culls are also pooled and in the case of pecans are sent to the crackeries, shelled, and sold for their meats. The prices paid in the various markets during the season for the first grade produce are pooled and the grower receives the average. The same method of pooling prices takes place in the other grades. The farmer's share of each pool is determined by the proportion of his product to the total amount.

The greatest advantage in standardizing a commodity is the ease with which it can be advertised. Advertising any except carefully graded products of uniform quality would not show much results. Special trade names and trade-marked brands soon become widely known and facilitate the

sale of the products handled. The California Fruit Growers' Exchange, whose standardization has reached a high stage, is able to advertise citrus fruits on a national scale at a comparatively small cost for each box of fruit handled. This is due partly to its volume of business and partly to the grouping of its produce under various brand names whose standards are rigidly enforced.

Membership contracts.

Only the producers of the commodity should be admitted to membership in a coöperative marketing association. This is to insure unity of interests among the members and to prevent any personal schemes.

There must be a legal and enforceable contract between the association and the member, by which the latter is bound to sell and deliver his commodity to the association over a period of years; and the association is bound to receive, grade, store, ship and sell the product to the best possible advantage, wherever a market can be found, and to pay to the member for his commodity the average price received, less the actual cost of operation.

Enforceable contracts are essential to insure delivery of the product to the association. Interests with which a coöperating marketing organization is competing sometimes offer temptations to the members in the form of higher prices, for the purpose of breaking up the association and thereby eliminating this competition. Without some method of holding the members to their contracts, the association could never be assured of sufficient volume of business. It would be unable to make stable market arrangements, secure capable help, or reach any final agreements for financing, storage

and other essential features. Suitable liquidated damages for violation of contract should be provided.

Government of a coöperative association.

A board of directors, nominated and elected annually by the membership, should have charge of the business affairs of the association. As a rule, the most successful business men are chosen, but an annual election enables the members to maintain on the directorate the really strong men who have rendered efficient service. The directors are not paid, except a small per diem while actually at work.

A general business manager should be appointed by the directors. He should be paid a salary commensurate with his qualifications and the type of work he is expected to do. He should understand grading and packing, but it is more important that he should be a trained market man fully conversant with the sales end of the business. He should be allowed to name whatever assistants are necessary for the efficient conduct of the business.

Finances.

Funds for general running expenses and to make advances to the growers are borrowed on warehouse receipts representing the commodity in storage, bills of lading or other commercial collateral. Financing a coöperative association of the Sapiro type is a very safe form of banking, as the association has absolute and legal title to the product handled and even to that which will be grown in future years. It borrows at low percentage for short periods of time and the collateral is absolutely first class. As rapidly as the commodity of a certain grade in a given pool is

sold out, the loans on that pool are repaid and the interest stopped.

It is customary for the coöperating marketing association to make an advance of part of the value of the commodity at the time of delivery. Further payments are made to the grower on each pool from time to time, and final settlement after the pool has been disposed of entirely. Final payment consists of pro-rating to the member all the money remaining to the credit of the pool in which his product has been placed, less the proportionate amount necessary to pay his share of the operating expense, and deductions for reserves for credit, to retire indebtedness for subsidiaries, such as warehouse companies and other essential expenses. In the case of pecans, the operating expenses are proportioned on a basis of the tonnage of nuts handled for each grower.

The National Pecan Growers' Exchange.

A coöperative association to market pecan nuts is operated under the name of the National Pecan Growers' Exchange. The possibilities of this organization having been discussed for three or four years, a committee composed of C. A. Vanduzee, chairman, and J. B. Wight, Cairo, Georgia; H. C. White and J. M. Patterson of Putney, William P. Bullard of Albany, B. W. Stone of Thomasville, T. H. Parker, Moultrie, Georgia, and others, was appointed at the annual meeting of the National Nut Growers' Association held at Thomasville, Georgia, in May, 1914, to study the subject and devise plans. This committee made a report to a called meeting of the Georgia-Florida Pecan Growers' Association during the annual meeting of the National Nut Growers' Association at Thomasville, in October of the same year. Its action was approved

by both associations, and the committee made a standing committee of both organizations. In due time, the National Pecan Growers' Exchange was organized as nearly as possible approximating the California Walnut Growers' Association, and chartered under the laws of the state of Georgia, with headquarters, for the time being, at Albany.

It is the policy of the National Pecan Growers' Exchange to organize and establish local or sub-exchanges in various localities in which the crops are large enough to warrant the erection of plants for curing, grading, and packing the nuts for shipment. The shipments are inspected and come into possession of the National Exchange, which has a contract buyer ready to receive them. Localities which organize sub-exchanges have the privilege of electing representatives who can participate in all deliberations of the board of directors of the National Exchange. All members of the National Pecan Growers' Exchange have one vote each in all matters pertaining to its management.

Each year, about the first of October when crop conditions are known, the growers supplying the Exchange with nuts are invited to attend or send a representative to a meeting for the purpose of agreeing on prices for pecan nuts for that season. Efforts are made to fix these prices with fairness and justice both to the buyer and the grower. During the summer preceding the harvesting of the nuts, orders are solicited from brokers through their jobbers, subject to the approval of the price to be named by the Exchange. The contracts of sale contain a guarantee against the Exchange reducing its opening price.

When a delivery of nuts from the orchards is made, they are first cured by being placed in warm, dry, air-heated com-

partments of the warehouse. They are next put through grading machines, and packed for shipment. Fifty-pound wooden boxes are the standard package of the Exchange. The nuts are attractively labelled with their brand names. Some varieties, such as Schley, which demand a premium on the market, and certain inferior sorts are, however, sold separately. Such varieties as the Stuart, VanDeman, Pabst, Frotscher and Delmas, are assorted and blended together. The first grade of these are sold under the Apex brand, and the second as the Junior brand.

The cost of operating the Exchange varies from year to year. However, when the expenses of its services are prorated among its members, it is from four to five cents on the pound.

NATIONAL PECAN GROWERS' EXCHANGE

ALBANY, GEORGIA

Marketing Agreement

THIS AGREEMENT Made and entered in this ..... day of .....1923, by and between the National Pecan Growers' Exchange, a corporation organized and existing under the laws of the State of Georgia with its principal office and place of business in the city of Albany, Georgia, hereinafter called the "Exchange," party of the first part; and ..... of ..... hereinafter called "Member," party of the second part

Whereas, the Exchange is a non-profit making co-operative corporation organized for the purpose of handling and selling pecan nuts and pecan products and whose principal purpose is to facilitate the marketing, to standardize the grades and to create and maintain a stable and profitable market for pecan nuts and pecan nut products and to eliminate waste and the duplication of expense in marketing same; and it is essential to the accomplishment of said purpose that it be assured of a definite source of supply both as to volume of

nuts to be handled and as to the revenue necessary to meet its operating, fixed and necessary expense; and this agreement on the part of the member to sell all nuts owned or controlled by him through the medium of the Exchange will materially conduce to the accomplishment of those purposes; now,

Therefore, for and in consideration of like agreements on the part of the other like members of the Exchange; and the mutual covenants and agreements of the said parties hereto they have and now do hereby mutually covenant and agree as follows, to-wit:

1. All pecan nuts owned or controlled by the Member during the years 1923, 1924, 1925, 1926 and 1927 shall be sold through the Exchange, except only such nuts as the Member may desire to reserve for personal use but not for sale. And during the term the Member shall not buy, sell or trade in pecan nuts excepting they be sold by the Member through the Exchange under this contract.

2. The Member hereby appoints the Exchange the sole and exclusive agent of the Member for the purposes of this Agreement with full power, right, title and authority in its own name to transact such business and take such action as may be necessary, incident, or convenient for the accomplishment thereof; and to borrow money and mortgage or otherwise pledge the said pecans or any of them, for the purpose of obtaining advances for Members and for the corporate purposes of the Exchange.

3. The nuts shall be delivered by the Member at his expense upon the order of the Exchange to some local or sub-Exchange plant for curing, grading, classifying or otherwise processing and packing and thereafter to be sold by the Exchange; charges for the services of the said local or sub-Exchange shall always be reasonable and only sufficient to cover the operating, reserve, fixed and necessary charges, the said local or sub-Exchange operating in a coöperative way in behalf of the Exchange and for the good of the Members of the Exchange.

4. The nuts shall be delivered to the Exchange or its order at the earliest reasonable time after maturity; and the varieties shall be unmixed; and until delivery to the Exchange the nuts shall be handled carefully and shall be spread and kept from heating in bulk; and if to be shipped to the Exchange by common carrier the nuts must be air dried enough to insure against loss by heating in transit.

5. In order to facilitate the economic and satisfactory marketing of the pecans and in order that no preference shall be in favor of any Member, it is understood and agreed that all pecans delivered by the Member to the Exchange may, after grading and before packing, be pooled or intermingled with pecans of like grade, type and quality delivered to the Exchange by other Members; and the Exchange shall be the sole judge of the grade to which all pecans delivered belong.

6. The Exchange may in its discretion establish one or more pools regulated by or conditioned upon the date of delivery to the Exchange by the Member; and nuts delivered in time to come within the first pool may take priority in settlement over late pools delivered; and the determination by the Exchange of grades, pools, standards and classifications and prices for which nuts shall be sold, and differential as to grades and prices, shall be final and conclusive.

7. As soon as the nuts have sufficiently formed upon the trees in each year, and whenever thereto requested by the Exchange, the Member shall mail to the Exchange at its head office an estimate of the yield of pecans covered by this Marketing Agreement, and also each year immediately upon the harvesting of such nuts mail to the Exchange a statement of the amount of such yield.

8. As soon as the first pool good nuts in each year delivered by the Member can be properly classified as to grade and quality the Exchange will make as substantial an advance payment thereon as, in its judgment, the market and financial conditions will permit of; and in the same manner an advance on good nuts delivered in subsequent pools of that year; the balance due the Member in any year will be distributed at the close of the season's business when all pools have been sold out, the Exchange first deducting from such final settlement all its own charges for inspection, propagation, marketing, incidental and necessary operations, and the charges of the local or sub-Exchange as in Section 3 provided; all remittances may be made by the Exchange to the Member direct or through the aforesaid local or sub-Exchange.

9. Any losses occurring from the selling of any nuts by the Exchange due to failure of collection or loss in transportation or handling; and storage, reserves, interest and insurance charges may also in the discretion and judgment of the Exchange be pro-

portioned ratably by the Exchange and same deducted on a pro-rata basis in final settlement as provided in Clause 8.

10. (a) The parties hereto fully understanding and admitting that it will be impracticable or extremely difficult to fix the actual damage to the Exchange which will result from the breach of this contract by the Member, hereby expressly agree and stipulate that in the event of the Member's neglect, failure or refusal to deliver within a reasonable time to the Exchange as herein required the pecan nuts, or any part thereof, which are to be delivered under this Agreement the Member will pay to the Exchange the sum of seven cents per pound for Schley nuts covered hereby and not less than two cents per pound for seedling nuts and five cents for all other kinds of varieties covered hereby but not so delivered, as liquidated damages for such breach; and the Member shall upon request render the Exchange a statement of all nuts sold outside the Exchange with check to cover the damages herein provided for; and this statement may in the discretion of the Exchange be made a condition precedent to final settlement with the Member.

(b) The Member agrees that in the event of a breach or threatened breach by him of any provision regarding delivery of pecans the Exchange shall be entitled to an injunction to prevent breach or further breach hereof and to a decree for specific performance hereof; and the parties agree that this is a contract of sole and exclusive agency under special circumstances and conditions and that the Exchange cannot go to the open market and buy pecans to replace any which the Member may fail to deliver.

(c) If the Exchange bring any action whatsoever, by reason of a breach or threatened breach hereof, the Member agrees to pay to the Exchange all costs of court, costs of bonds and otherwise, expenses of travel and all expenses arising out of or caused by the litigation and all reasonable attorney's fees expended or incurred by it in such proceedings; and all such costs and expenses shall be included in the judgment and shall be entitled to the benefit of any lien securing any payment thereunder.

11. The Member agrees that by this Marketing Agreement he is helping to carry out the express aims of the Exchange for co-operative marketing, for minimizing speculation and waste and for stabilizing the pecan nut markets in the interest of the grower, the buyer and the public through this and similar obligations signed

by other Members. The Exchange agrees that during the term of this Agreement it will not accept for sale or deal in any pecans except for the account of the Members of the Exchange and under Agreements similar in form to this one and such other form as may be adopted by the Board of Directors not inconsistent with this Agreement, for general use in dealing with its Members.

12. If this Marketing Agreement be signed by a firm, co-partnership, corporation or association and the firm, co-partnership, corporation or association be terminated by voluntary dissolution or otherwise during the existence of this Agreement then it shall apply to each and all the individuals thereof after such termination.

13. It is agreed that this Marketing Agreement contains the whole agreement between the Exchange and the Member and no statements or representations are of any force or effect unless set forth herein. And the Member acknowledges receipt of a copy of the By-laws of the Exchange.

14. In consideration of the undertakings of the Member the Exchange accepts the trust created and will use its best efforts not only to dispose of all nuts delivered to it during the seasons of 1923 to 1927 inclusive to the satisfaction of the Member but to endeavor by all legitimate means to extend and broaden the market for pecan nuts by stimulating old and opening up new markets at stable and profitable prices to the end that pecan marketing may be established on a permanent and profitable foundation.

15. The Exchange further engages that it is a grower's co-operative, non-profit marketing association without capital stock and that its operations will be carried on as economically as consistently may be; and that it is operated with equal rights to all and special privileges to none.

16. Each Member shall be entitled to one and only one vote irrespective of tonnage, at any Membership meeting of the Exchange for the election of Directors or the transaction of any other business coming before any regular or special meeting.

17. This Agreement binds the heirs, executors, administrators or successors of the respective parties hereto; and no Member shall be permitted to make a fictitious sale of property in order to evade the obligations of this Agreement.

In witness whereof the said Exchange has caused these presents to be executed in its name and signed on its behalf by its President;

and the Member has hereto signed his name the day and year first above written.

NATIONAL PECAN GROWERS' EXCHANGE
by .....
President.

Member .....
Address .....

It will be helpful to the Exchange for the Member to fill out the following as nearly as can be done:
Acreage ..... Location .....
Variety, ages and number,
of trees each variety .....
.....
.....
Production for the
past three years .....

CHAPTER XI

INSECTS ATTACKING THE PECAN

During the early days of the industry it was the impression that the pecan was free from serious maladies and that a regular spraying schedule would become necessary only in the very remote future. Lenient nursery inspection laws and the almost phenomenally rapid development of the industry produced most favorable conditions for a dissemination of both insects and diseases, since nursery stock and budding and grafting wood were bought, sold, and exchanged with little thought of scattering pests which would, in later years, demand serious attention. Several million pounds of pecans have been imported from Mexico each year without inspection and many pests have been introduced.

The pecan is probably attacked by fewer serious insect pests than almost any of the common orchard fruits; nevertheless, some of the most serious must be combatted or the crops of nuts will be greatly reduced, and in many cases the trees severely injured. In order to combat these insects successfully it is necessary to know their characteristics, complete life history, and feeding habits. By recognizing and destroying a pest in its incipient stage a great saving in a year's crop of pecans may be accomplished, and a general spread of the insect prevented.

PECAN LEAF CASE-BEARER (Plate IX)

(*Acrobasis nebulella,* Riley)

The leaf case-bearer is perhaps the most destructive of the insects that attack pecans east of the Mississippi River. It passes the winter in the larval stage and may be found in small bags or cases singly attached to the buds of the small branches. Soon after the buds swell or start growth in the spring, these small larvæ crawl out of their cases and begin feeding on the nearest unfolding buds or tender leaves. They are ravenous feeders and, when the numbers are large, are capable of defoliating the tree almost completely. In eating out the buds and tender twigs, this insect greatly decreases the crop of nuts. Furthermore, defoliation just at this time, when the tree is making its maximum annual growth, weakens it to such an extent that many of the limbs die back a considerable distance from the terminals.

The larva or "worm" of the pecan leaf case-bearer feeds voraciously and grows rapidly after the opening of spring and pupates in the case from the latter part of May until the first or second week in June, according to climatic conditions. The pupal state lasts from sixteen to twenty-three days, at which time the adult moth emerges and soon begins to lay eggs.

The egg-laying period of the moth extends from the latter half of May until about the first of August. From one to twenty eggs may be laid on a single leaf. These eggs are small, soft, and semi-transparent objects, usually attached along the midrib on the under side of the leaflets. The eggs hatch from six to nine days later and the larvæ, when first emerging, are reddish-brown in color. They begin feeding

on the lower surface of the leaves at once. They feed sparingly during the summer and grow slowly, barely reaching a length of six one-hundredths of an inch by autumn. As excrement and frass accumulate, the particles are formed into a small case, bound together, and lined with silken webs, spun by the larva. This case, which gives protection to the larva, has one end attached to the leaf; the other end is open, through which the larva feeds. As the larva eats the under side of the leaf, the upper surface turns brown. The larva begins eating at the spot where the egg is laid, working its way to the right and left as it extends its feeding surface in a fan-shape design. It thus constructs a winding or tortuous tube or case, which is, for a time, much longer than the larva's body. As the larva matures, the case becomes almost straight, being larger at the feeding end. Feeding of the larvæ in the summer is not so harmful to the tree as in the spring while the buds are unfolding.

As cool weather approaches, a short time before the leaves shed, the larvæ desert their cases, crawl down the leaf-stems, and take up winter quarters in small oval hibernating cases, called hibernacula, which they construct and attach loosely around the bud. Here they remain in a semi-dormant stage until early the following spring, when the leaf and staminate flower-buds begin to swell, at which time they resume feeding.

All varieties of pecans that have been exposed to heavy infestations of the leaf case-bearer have been attacked. However, a wide difference in susceptibility of commercial sorts has been observed.[1] Among those comparatively resistant are Moneymaker, Haven, Georgia, Curtis, Russell, Mantura,

[1] W. F. Turner. Bull. 49, Ga. State Board of Entomology, p. 13.

Teche, and Young. Among those showing a high degree of susceptibility are Capitol, VanDeman, Schley, Stuart, Nelson, Frotscher, Taylor, Alley, Appomattox, and Delmas.

Control.

Natural enemies of the leaf case-bearer are helpful toward its control. In addition to a few species of minute parasitic wasps, flies, and predacious bugs attacking this pecan enemy, certain birds, including the mocking-bird, blue jay, and orchard oriole, have been known to peck open the cases and eat out the larvæ.

The best method of control is to spray the trees thoroughly with arsenate of lead between the middle of August and the last of September. All efforts to destroy this species by spraying with arsenical mixtures during the spring and with concentrated lime-sulfur and miscible oils in winter have thus far failed. The cases or hibernacula seem to be so durable and tightly woven that winter sprays fail to penetrate them to an effective degree. Spraying with arsenate of lead in the spring seems to fail largely because a sufficient percentage of the larvæ is not exposed to the poison at any one time to make an application worth while.

The spray mixture recommended for the August or September application is as follows:

Arsenate of lead powder	1 pound
Lime (unslaked), ...	3 pounds
Water	50 gallons

The lime is slaked with water, the mixture diluted to ten or twelve gallons, and strained through a fine-meshed strainer so that no particle large enough to clog the spray nozzle will escape into the solution. The arsenate of lead is

PLATE X.—*Above*, pecan nuts infected by scab. *Below*, the pecan weevil, adult male on right, adult female on left.

made into a thin soupy paste with water and stirred into the lime solution. This mixture is then made up to fifty gallons with water, at which time it is ready to be applied. The lime is added to the mixture to neutralize any free arsenical acid which may be present in the arsenate of lead and prevent burning or injury to the foliage of the trees. If two pounds of fish-oil soap are added to each fifty gallons of the arsenate of lead spray mixture, the spreading and adhesive qualities will be improved. The effectiveness of arsenate of lead spray in the control of the pecan leaf case-bearer depends very largely on the thoroughness of the application.

PECAN NUT CASE-BEARER (Plate IX)

(*Acrobasis hebescella*, Hulst.)

The nut case-bearer is the most important insect attacking pecans west of the Mississippi River, where it is native and most prevalent. It has, however, invaded a large percentage of the orchards in the southeastern part of the United States, and in many sections is a strong rival of the pecan leaf case-bearer in the heavy damages wrought. The loss due to this insect is somewhat difficult to determine and varies from one year to the next. Some years there is almost a total destruction of the crop, and at other times the loss is very slight. A greater part of the loss attributed to frost in the past has been due to this insect.

The adult is a small gray moth with a wing expanse of five-eighths inch. It flies only at night and is not attracted to lights. The moth is about the same color as the bark of the tree and is also very secretive. On that account it is seldom or never seen and is extremely difficult for even an ento-

mologist to locate. The moth deposits its eggs at the calyx end of the nut, as a rule, and seldom lays more than one egg to the nut. The eggs are at first white with a greenish cast, but about the second day after laying small reddish spots appear on the surface and before hatching the egg turns almost red. The larva, when it emerges from the egg, is a pinkish-white. It usually bores into the nut at the base and spends the remainder of its existence there. After entering the nut it becomes gray in color. Just before pupating it turns greenish. The pupal stage is passed within the nuts, and before pupating the larva weaves a loose cocoon from whence comes the name nut case-bearer. From this pupa there emerges a moth which starts the next generation.

The number of generations is largely determined by the supply of pecans. In the years in which there is an abundant crop of nuts there are four generations, but if the nut supply is cut short for any reason there may be only one generation and a partial second or only two generations.

The larvæ pass the winter on the limbs of the tree at the base of buds, and as soon as the first warm days of spring come and growth starts they begin feeding at the ends of the limbs on the tender leaflets and growing buds. These larvæ complete their growth in this condition and pupate. The moths which issue from these pupæ appear from the last of April to the end of May, and the maximum number are issuing from the 8th to the 15th of May. The larvæ which come from this first generation of moths attack the nuts when they are about the size of a garden pea, and this is the time when the major damage is done to the crop. The first generation is passed within the nuts, and one larva usually destroys, wholly or partially, several clusters of nuts. The

larva usually pupates in dried nuts, and before pupating it ties several nuts together so they will not fall to the ground.

The second generation appears in June or July, by which time the number of larvæ is considerably decimated by parasites. On that account the damage by this generation is not very great. The moths of the second generation lay their eggs on the calices of the nuts much as those of the first, except that a larger number are laid at the base of the nut. The larvæ tunnel out the nuts when they are about half grown and pupate in them after spinning a cocoon similar to those of the first generation.

The larvæ of the third generation do not enter the nut proper but work around between the hull and the nut and pass their life there, and moths which emerge from the pupæ lay their eggs on buds. The larvæ which issue from this generation are those which pass the winter.

Control.

To control this insect is difficult, but with a proper knowledge of the life history and with adequate equipment it can be done effectively. Control measures must be adopted at the critical time. It is necessary to have a spray outfit which will maintain at least 250 pounds pressure, and greater than that is desirable. It is advised that only gasoline spraying outfits be employed. A gun should be used so that the spray may reach the highest part of the tree at a good pressure.

There is a wide range in the strength of spray. Most entomologists in the Southeast recommend only one pound of arsenate of lead powder to fifty gallons of water, and consider any more than this largely a waste of material; but entomologists west of the Mississippi favor the use of as high as

three pounds of the dry arsenate of lead to fifty gallons of water. All agree, however, that the spraying should be thorough, covering the tree as completely as possible.

The time of the first spraying will vary in different latitudes, and with the difference in earliness and lateness of the season, but will be some time between the 8th and the 22d of May. A second and a third spraying should be made at intervals of ten days after the first.

Spraying for the second generation of larvæ is usually not necessary, but when it is needed it should be done the latter part of June.

PECAN BUD-MOTH

(*Proteopteryx boliana,* Sling.)

The pecan bud-moth is most troublesome on nursery trees. It occasionally appears in large numbers and does considerable damage to trees in orchards before they reach any considerable size. This insect is generally distributed over the pecan belts and its attacks are confined very largely to the pecan.

The adult moth has a wing expanse of about five-eighths of an inch, and is generally gray mottled with black and brown. The blackish-brown zigzag pattern of the fore wings extends from the base across the middle to the tips. The hind wings are a solid dusky gray. The moths are very abundant in autumn and are found on the trunks of the trees or other nearby objects. When they are disturbed they fly away in a jerky, zigzag motion for only a few yards, and then return, alighting on the trunk with the head down.

The small, whitish, oval eggs are laid on the twigs of the pecans, where oviposition occurs before the leaves come out,

and on the upper surface of the leaves after the foliage becomes expanded. The larva is yellowish-green, covered with fine hairs, has a black head which becomes dark brown with age, and when fully grown is a little more than half an inch long. The brownish contents of the alimentary canal show plainly through the semi-transparent skin. Pupation may take place in the folds of the leaves, in the buds of the trees, or under the bark scales of the trunk.

In the lower South there are five or six generations of this species each year. Hibernation being in the adult stage, egg-laying begins in the very early spring. Gill points out that the average life cycle of this species is forty days—five days being spent in the egg stage, twenty-five in the larval, and ten days in the pupal stage.[1]

Control.

The pecan bud-moth very seldom, if ever, does enough damage in a bearing orchard to necessitate spraying, but its attacks on nursery stock sometimes become serious. Its habit of feeding on the bud causes branching of a young tree and stunts its growth, which is very objectionable to the nurseryman since his scale of prices usually runs with the height or length of his trees. When the trees are kept in a vigorous rapidly growing condition, the buds unfold so rapidly that the insects are able to inflict very little damage. For this reason liberal applications of fertilizers, good nursery soil, and efficient cultural methods are the chief essentials in preventing serious damage of the bud-moth in a pecan nursery. When the infestation is heavy, however, it is advisable to spray the trees with arsenate of lead in the spring just as

[1] Farmers' Bull., 843, U. S. Dept. of Agric., p. 26.

the buds are unfolding. The same spray as that employed for the pecan leaf case-bearer will be satisfactory. (See Fig. 31).

PECAN SHUCK-WORM

(*Laspeyresia caryana,* Fitch.)

The pecan shuck-worm spends the winter in the larval stage in the husk of the pecan, either hanging on the tree or on the ground. Pupation takes place in the husk in very early spring. Many of the adult moths emerge before the leaf and nut development of the pecan, and they are thought

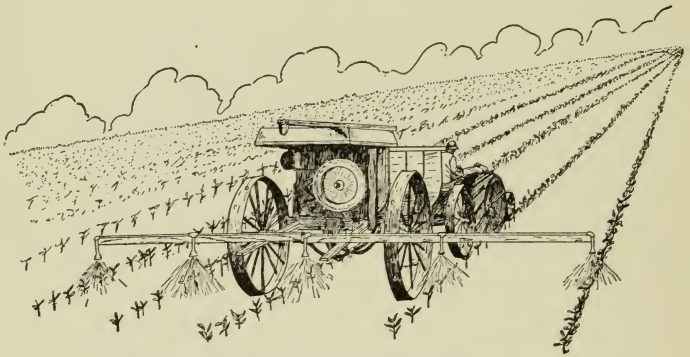


FIGURE 31.—Spraying the pecan nursery.

to lay most of their eggs on the pignut hickory, which is earlier than the pecan. The eggs are laid on the nuts and leaves of the pecan during the summer. The incubation period of the eggs is about five days. As soon as they hatch, the larvæ bore into the husk of the nearly matured pecans and begin feeding. They sometimes enter the nut, but usually confine their feeding to the husk. If the nuts are attacked in their early stage of growth, they fail to develop

and fall to the ground. Those attacked just before maturity have more or less shriveled kernels, and the nuts are difficult to separate from the husks at harvest time. Nuts which are practically mature before the shuck-worm enters the husk ripen in fairly good condition, except that the shells are more or less discolored which detracts from their market value. This species is thought to feed on the tender twigs of the pecan and on the hickory during the interim between the emergence of the moth and the formation of the pecan nut.

The wing expanse of the moth rarely exceeds three-fifths of an inch. It is smoky-black, tinged with purple, and has short yellowish streaks across the front margin of its fore wings. The larva has a creamy-white body and a light brown head and is about three-eighths of an inch in length when fully grown.

There are probably three broods of this species in the extreme lower South, but possibly only one near the northern limits of pecan culture.

There is a difference in susceptibility of varieties of pecans to the shuck-worm. In the infested sections of the piedmont or more elevated parts of the pecan belt, the Stuart variety is heavily attacked.

Control.

Since the shuck-worm hibernates in the shucks or husks of the pecan and the hickory, they should be gathered and destroyed in the fall soon after the nuts are harvested. Inasmuch as the larva enters the husks almost immediately after hatching and is beyond the reach of spray solutions, spraying is not generally recommended. Plowing under the husks has

not been effective in the destruction of the larvæ, since they will emerge through several inches of ordinary soil.

PECAN WEEVIL

(*Balaninus caryæ,* Horn.)

The pecan weevil, also called the hickory-nut weevil, attacks both hickories and pecans. It is distributed practically all over the pecan belt, but has caused greatest damage to the seedling trees of Texas.

The adult is a small dark brown beetle tinged with gray, with a long snout, very similar to the chestnut beetle. The female has a very much longer snout than the male and by this means punctures the nut before it reaches full maturity, in the late summer, and places the egg in the kernel of the nut with her ovipositor. The larva is a short thick grub with a light brown head. It feeds on the kernel until about the time the nut ripens, when it cuts a circular hole through the shell and enters the ground to the depth of six or eight inches, where it spends the winter in the larval or grub stage. Pupation takes place in the ground, and the adult beetle emerges in August and September. Egg-laying begins very soon after the beetles emerge. The work of the pecan weevil is very easily recognized by the circular holes made by the larvæ as they leave the nuts.

Control.

If local conditions permit, hogs should be turned into the orchard after harvest to clean up the weevil-infested nuts which remain on the ground.

Larvæ in the nuts in storage may be destroyed by fumigation. The nuts are placed in a nearly air-tight receptacle and

a shallow pan set on top of them. One fluid ounce of carbon disulfide to each bushel of nuts is poured into the pan and the receptacle tightly closed for twenty-four hours. The larvæ will then be dead and the nuts may be aired out and consumed as desired. Carbon disulfide is highly inflammable and should be kept away from fire.

PECAN CIGAR CASE-BEARER

(*Cleophora caryæfoliella, Clem.*)

The cigar case-bearer sometimes becomes a serious pest to the pecan. However, it is not generally rated as one of the most troublesome insects attacking this crop. It is distributed practically all over the pecan belt and attacks the hickory and black walnut as well.

This insect spends the winter in the larval stage in cases attached to the limbs of the tree. As growth begins in the spring, larvæ come out of their cases and feed on the unfolding buds and tender leaves. They pupate in the larval cases which appear in the lower South about the middle of May. The moths emerge and begin egg-laying in June. The eggs hatch within a few days and the larvæ enter and feed between the two epidermal layers of the leaves. Later they come out and construct dark brown cases resembling miniature cigars. The larvæ move these cases around as they feed.

Control.

When the insect becomes numerous, it is advisable to spray the trees with arsenate of lead in the early spring. The spray recommended for the pecan leaf case-bearer will be suitable.

FALL WEBWORM

The fall webworm becomes very conspicuous by its webs in pecan trees in the late summer and early fall. The colony of larvæ constructs a web covering a cluster of leaves on which they feed. This web is extended to other leaves as those within are eaten. The caterpillars leave the web in late autumn and pupate in loosely constructed hairy cocoons beneath scales of bark on the trunk or under rubbish on the ground. The adult moths emerge in April or May and lay their eggs in clusters on the leaves of the pecan tree. These eggs hatch about a week later, and each group of larvæ form a web in which they feed. These larvæ pupate, and the second brood of moths are out by the middle of the summer. From the eggs of these moths hatch out the larvæ which are so conspicuous, by their webs, in pecan trees during the fall.

Control.

Webs of the first generation of larvæ may be destroyed by burning them out with a torch fixed on the end of a long pole, or twisted out of the trees by means of a long slender pole with a nail driven through one end. If this work is done thoroughly, the number of larvæ in the second generation will be small.

When there is a heavy infestation of the fall webworm, the trees may be sprayed with arsenate of lead, using the same mixture as is recommended for the leaf case-bearer.

PECAN OR WALNUT CATERPILLAR

(*Datana integerrima,* G. & R.)

The egg-laying habits of the adult of the pecan or walnut caterpillar are very similar to those of the fall webworm.

The caterpillars of this species, however, feed in mass but form no web. The larvæ molt several times and pupate in the soil, where they spend the winter in the pupal state. The adult moths emerge from the overwintering pupæ in early summer. There are two generations each year, and it is the second generation of larvæ that usually appears in such large numbers.

Control.

As the larvæ appear in large numbers, the trees should be sprayed with arsenate of lead. Plowing the soil after the larvæ have pupated will destroy many of them.

TWIG-GIRDLER

(*Oncideres cingulatus,* Say.)

The twig-girdler has a fondness for the hickory and persimmon as well as for the pecan. It has a very broad distribution, being found practically all over the pecan belt. The female beetle first girdles the twig from one to two feet from the terminal end, then deposits the eggs in small punctures in the bark just below the leaf-scars on the twig. This is done in late August and in September. The girdled twig soon dies and is likely to be blown to the ground by the wind very soon afterward. This girdling seems to be for the purpose of killing the twig and preventing the egg being crushed by the growing tissue and also to provide more suitable food for the larvæ. The eggs hatch about four weeks after being laid, and the young larvæ begin feeding just under the bark of the girdled twig. They continue feeding during the warmer periods of weather in winter and remain in the larval stage until the following August, at which time they pass through

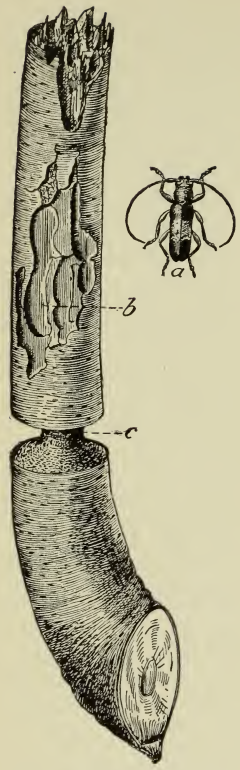


FIGURE 32.—The twig-girdler; *a*, beetle; *b*, larval tunnels; *c*, girdling work of adult.

the pupal stage and soon emerge as adult beetles ready to renew the life cycle. Some few of the pupæ are thought to remain over winter, and the adults emerge the second year. When twig-girdlers appear in large numbers they cause serious damage to pecan nursery stock and small trees in the orchard. They do very limited harm to the large bearing trees (Fig. 32).

Control.

Since the girdled or cut-off twigs contain the eggs and larvæ of this beetle, the most satisfactory method of reducing the numbers for the following season is to collect and destroy the infested twigs. Hickory and persimmon trees growing near should also have the twigs gathered and destroyed.

Spraying with arsenate of lead has been effective in protecting young pecan trees against the twig-girdler. One and one-half pounds of powdered arsenate of lead to three pounds of lime are used with fifty gallons of water for this spray. The first spraying is given about the 20th of August or just before beetles are known to begin girdling the twigs. The second spraying is about the 20th of September, or about three weeks following the first application.

BORERS

The commonest species of borers attacking the trunks and larger limbs of the pecan are the flathead borers (*Chrysobothris femorata,* Fob.) and the Cossid borer (*Cassula magnifica,* Stecker.). The flathead borers are the more destructive. The adult of this species is a flat dark beetle. The larvæ bore into the bark and feed on the cambium, which is the most vital part of the trunk. When a number of the larvæ attack a tree, especially a small one, they are likely to destroy the cambium layer all the way around and kill it outright. The attacks of this borer may be located by cracks and depressions in the outer bark. About the only remedy known at this time is to dig out the borers and paint the wounds with pine tar or white lead paint.

The adult of the Cossid borer is a moth sometimes spoken of as the roundhead pecan borer. The larvæ bore deeply into the body of the tree. Their attacks are easily located by quantities of reddish-brown castings at the base of the infested tree. Pupation takes place in the burrows and the moth comes out in the spring. These borers can be destroyed easily in the burrows by injecting a few drops of carbon disulfide by means of a medicine dropper, and then plugging the hole with a small piece of wax or stiff moistened clay.

"WOOD-LICE" OR TERMITES

(*Leucotermes californica,* Koller.)

Termites—wood-lice or white ants, as they are called—feed largely on dead and decaying wood, and may be found under the bark of felled trees and in the decaying twigs scattered about in the litter where a fair degree of moisture is main-

tained. They often attack wood foundations of buildings and do considerable damage. This species also attacks live plants, especially the tap-roots of young pecan trees when these are set on newly cleared land in close proximity to decayed forest tree roots containing wood-lice, and when litter, leaves, and straw containing dead twigs, as mulch, are hauled in from the woods and spread around the young trees.

Termites live in colonies and, on account of their underground habits of feeding, often attack a small pecan tree and completely hollow out the tap-root and extend their feeding gallery up into the main stem before the damage is discovered. They rarely cause trouble to pecans on land free of decaying parts of forest trees, and do very little harm to trees of considerable size. Their chief damage is to newly set trees for a pecan orchard, and to young seedlings in the nursery when grafting is practiced.

Control.

When colonies of termites can be located, they may be destroyed by fumigating with carbon disulfide. However, the simplest method of control is to keep pecans off the land until most of the remains of the forest trees have been cleared away or decayed completely and to use no litter from the woods as mulch.

JUNE-BUGS

(*Phyllophaga sp.*)

June-bugs sometimes become injurious to pecan trees, and when they do the damage is considerable. The June-bug is the adult of a common grub-worm, which is found in pastures and grass lands and in old rotten stumps. It attacks

corn, cotton, and small grains. These insects have a life history which extends from one to three years, and in localities in which they are abundant outbreaks may be expected at such intervals. The June-bug feeds at night and cuts small pieces from the leaves and at dawn hides under piles of leaves or any kind of rubbish which may be at hand.

The best way to control these insects is in the larval stage by plowing up the ground in winter and exposing the pupæ and larvæ to the elements, attacks of birds, and other similar agencies. This is not always possible, and under such conditions the trees may be sprayed with arsenate of lead at the rate of two pounds to fifty gallons of water.

RED-SHOULDERED SHOT-HOLE BORER

(*Sinoxylon basilaris,* Say.)

Several closely allied beetles often attack pecan trees, boring small holes at the juncture of the two limbs or sometimes entering small trees and entirely girdling them by cutting a circular channel just under the bark entirely around the trunk. No remedy is known for this class of damage, but as these insects more often attack trees in a weakened condition, precautions may be taken to keep them healthy. It is possible that a repellent wash would keep the beetles from working.

SCALE INSECTS

The pecan is not immune to scale insects. They have not become of sufficient importance, however, to necessitate spraying as is the case for apples, peaches, pears, and other orchard fruits.

GREEN STINKBUG

(*Nazera viridula*)

Turner[1] and Demaree,[2] working independently, found southern green stinkbug (*Nazera viridula*) to be the chief cause of pecan kernel-spot. Heretofore the latter has been treated as a disease, but the spot seems merely to be injuries caused by insects.

The spots on the kernels of the pecan, caused by this insect, can be detected only after the nuts are shelled. The spots are circular in outline, slightly sunken, brown to black in color, about one-eighth of an inch across, and about one-sixteenth of an inch deep.

The stinkbug is rather generally distributed in the lower South. It is decidedly affected by low temperatures, and its numbers are very greatly reduced when the temperature falls as low as 15 degrees F. The bugs attack cowpeas in preference to almost any other plant and the vines furnish a favorite breeding place. The eggs are laid in clusters on the under surfaces of the leaves. When cowpeas are grown as a cover-crop in a pecan orchard, the vines frequently begin to dry up in September. When the bugs find their food becoming scarce, they leave the pea vines and go to the pecan trees, where they start feeding by puncturing the young nuts and sucking the juices without leaving any visible sign of the injury. They may inject some toxic substance into the pecan which they pierce, but there seems to be very little evidence that they introduce any specific disease organism.

[1] Turner, W. F., Nazera viridula and Kernel spot of pecans. Science N. S. Vol. 47, p. 491, 1918.

[2] Demaree, J. B., Proceedings Ga.-Fla. Pecan Growers' Assoc., 1922.

The stinkbug feeds readily on soybeans, but attacks velvet beans only when forced to do so by a scarcity of other more desirable food. For this reason, growers have adopted a general policy of planting velvet beans instead of cowpeas as a cover-crop in a pecan orchard after it comes into bearing.

The insect attacks the nuts on the lower limbs very much more severely than those higher up. Thus, in years of heavy infestation, it is good orchard practice to harvest the nuts from the lower limbs and keep them separate.

CHAPTER XII

PECAN DISEASES, AND SPRAYING OUTFITS

The pecan is subject to a considerable number of distinct diseases, only a few of which are known to cause serious damage. Not all of those herein mentioned are sufficiently harmful at present to be of particular economic importance, but it is well for the grower to be able to differentiate them from the more serious diseases, and to know some of their outstanding characteristics in case they develop more destructive tendencies in the future.

PECAN SCAB (Plate X)

(*Fusicladium effusum,* Wint.)

Scab is probably the most serious disease of the pecan, and when the infection is heavy the entire crop of nuts may be destroyed. The disease is caused by a fungus attacking the leaves, twigs, and nuts. It is characterized by a dark velvety superficial growth confined to rounded spots or pustules ranging in size from mere specks to an eighth of an inch or more in diameter. In these pustules the spores of the fungus are developed. The spores may be scattered from tree to tree by wind or insects, so that the disease may spread rapidly when susceptible varieties are present. When these spores fall upon leaves, twigs, or nuts, in the presence of moisture, they germinate and send mycelium or the vegetative part of the fungus into the green and tender tissues, causing new pustules.

Severe infection may kill the tips of the leaves, but the

greatest damage is with the nuts. Early in the season it is not uncommon for the entire crop of nuts to become so badly damaged that they fall to the ground. Infection late in the season is likely to cause the nuts to be undersized and to leave a large percentage of mere empty shells.

Pecan scab is very generally distributed over the southeastern states and to some extent over the entire pecan belt. It is most severe along the Atlantic and Gulf coasts where there is an abundant rainfall and a humid atmosphere throughout most of the growing season. The severity of the disease diminishes as the distance from the coast and the elevation of the land above sea level are increased. Scab does comparatively little damage to pecans 150 to 200 miles from the coast, except on certain varieties known to be decidedly susceptible.[1]

Scab is apparently carried over winter on the small diseased spots on the twigs. The severity of the disease fluctuates from year to year somewhat according to the weather conditions. Frequent rains and a constant humid atmosphere during the spring and early summer produce conditions favorable to severe infections of scab. In west Texas, where the rainfall is light and the atmosphere less humid and where the elevation is above 800 feet, scab is of minor consideration in the commercial orchards and native groves. However, when some of the west Texas varieties of pecans, the San Saba for example, are planted in the coast country of the southeastern states, they are very susceptible to the scab disease.

[1] The entire crop of Beveridge pecans was destroyed by scab for a period of several years at the Georgia Experiment Station which is more than 200 miles from the Atlantic Coast and has an elevation above sea level of 946 feet.

There is a great variation in the susceptibility of vareties of pecans to scab. Some are practically immune, others are so susceptible that practically the entire crop is lost when they are planted in a region with little elevation and near the coast. Susceptible varieties near the coast may be highly resistant when grown further inland; the reverse is true when varieties are transferred from inland to coast regions. Some of the varieties that have been planted on the coastal plains of the southeastern states may be grouped as follows, according to their susceptibility or resistance to scab: Very susceptible, Delmas, Georgia, and San Saba; partially susceptible and sometimes severely attacked, Bolton, Pabst, Schley, and Van Deman; usually free of disease but occasionally attacked, Alley, Mobile, Moore, and Nelson. Those practically immune are Frotscher, Moneymaker, Russell, Stuart, Success, and Teche. During periods of frequent rains and heavy dews the varieties having considerable resistance are likely to be severely attacked, and very susceptible kinds may be destroyed entirely.

Control.

The propagation of varieties of pecans immune or highly resistant to scab is one of the most satisfactory and surest means of control. Susceptible varieties may be top-worked with cions from highly resistant or immune trees.

Spraying the trees with bordeaux mixture will be effective in holding the scab in check, provided the varieties are not unusually susceptible. The following proportions are satisfactory:

PLATE XI.—Spraying pecan trees.

Copper sulfate (blue stone)	4 pounds
Lime (unslaked)	6 pounds
Water	50 gallons[1]

From three to four sprayings should be given during the growing period. The time of the first application will depend largely on the season, latitude, and time of appearance of scab. Under average conditions scab may be expected to appear in small spots on the leaves of pecan trees in the southeastern states, the latter part of May or early June, necessitating the first application of spray. The second spraying is given in the latter half of June or about three weeks following the first. The third is put on about the middle of July, and the fourth from the 15th to the 20th of August.

In some cases bordeaux mixture causes severe foliage injury to pecans. This may be overcome partially by the substitution of a lime-sulfur or a modified lime-sulfur spray (one gallon of concentrated lime-sulfur solution added to a 1-2-50 bordeaux mixture) for the third and fourth bordeaux sprays. The lime-sulfur spray may be made by adding one gallon of concentrated lime-sulfur solution to fifty gallons of water.

PECAN ROSETTE

There is a divergence of opinion as to the cause of pecan

[1] Dissolve the copper sulfate in a small quantity of hot water in a tub or barrel. Slake the lime in another vessel and make it up to 25 gallons with water. Pour the two solutions into a third vessel at the same time and stir well. Bordeaux mixture should be strained as it is put into the spray tank. As copper sulfate solutions attack iron or tin, they should be prepared in stone or wooden vessels. When it is desired to spray for insects, as the case-bearer, bud-worm, fall webworm, and fungous diseases at the same time, one pound of powdered arsenate of lead is added to each 50 gallons of bordeaux mixture.

rosette. Some authorities[1] treat it as a chloratic disease and class it with the infectious mosaics; others[2] place it with the non-infectious diseases arising from malnutrition. In either case, proper soil management will largely overcome the trouble.

Early stages of the rosette may be detected by the small, wrinkled, mottled leaves near the ends of the branches. The disturbance may affect the whole tree, but it is more likely to appear first on one or more branches. The affected branches fail to grow full length, causing the leaves and lateral branches to form in a mass, which gives a rosette effect. In severe cases the twigs die back several inches from the terminals, this usually occurring in late summer. The following spring the buds below the dead portion of the twig start a growth which appears to be healthy and normal, but by midsummer the growth is again shortened and rosettes formed as in the previous year. Unless the tree recovers, as it sometimes does, this putting out of new growth and dying back continues year after year until the tree develops a bushy top badly disfigured with many dead terminals. Pecan trees very seldom die as a direct result of rosette. However, affected trees bear very few nuts, and having been weakened by rosette, may readily succumb to other maladies.

The rapid spread of the pecan industry and the general lack of knowledge of what the trees require have led many growers to plant orchards on soils totally unsuited to the crop. As a result, rosette is found in the pecan orchards of the southeastern states in varying degrees, probably ranging from 10 to 20 per cent of the total planted. Applications of

[1] Rand, Pecan Rosette, U. S. Dept. Agr. Bull., No. 1038.

[2] McMurran, Pecan Rosette in Relation to Soil Deficiency, U. S. Dept. Agr. Farmers' Bull., No. 756.

an abundant supply of humus-forming materials and liberal supplies of plant-food to the soil, coupled with certain improvements in the texture of the soil so as to increase greatly its water-holding capacity, would probably reclaim or produce healthy trees in practically all of the rosetted orchards at the present time. In many instances, however, it would not be a profitable expenditure of effort.

Pecans are not suited to infertile deep sandy soils or to clay soils underlaid with sand or badly washed and depleted hillside soils. The advisability of trying to increase and maintain the fertility of such soils is doubtful, especially since good pecan soil can be secured at reasonable prices. On the other hand, rosetted pecan trees growing on soils capable of permanent improvement may be reclaimed profitably.

The most economical method of soil improvement to overcome pecan rosette is a practical problem for the individual grower. Heavy applications of stable manure supplemented by a complete commercial fertilizer, containing its nitrogen in an organic form, worked into the soil beneath the trees and extending well out beyond the natural spread of the limbs, may be expected to give good results. Whether this method is preferable to or more economical than the growing and turning under of leguminous cover-crops supplemented by commercial fertilizers must be determined by the facilities of the individual grower and local conditions.

The application of lime to the soil has given poor results so far as the control of rosette is concerned.

A common mistake of growers who set out pecan trees on improved soils is that they plant the orchards too heavily with intercultural crops and do not supply sufficient plant-food for the first four or five years. It is much less difficult to prevent

rosette in young pecan trees than it is to reclaim old trees that have rosetted for a number of years. For this reason, growers should begin soil improvement with the planting of the orchard and see that the trees are well fed from the start.

PECAN DIEBACK

(*Botryospœria berengeriana,* De Not.)

Dieback of pecans has been confused by growers with rosette and also with winter-injury. Matz has shown, however, that the disease is caused by a specific fungus and is distinct.[1] He says that "Towards the base of a partly diseased twig, the bark is often of a water-soaked, waxy appearance, and there is usually a definite margin between the infected and healthy tissue. The older diseased portions of the bark or twigs and branches are dry and sunken, the longitudinal ruptures in these being more conspicuous, and bear the fruiting bodies of the fungus which are embedded in a black matrix or stroma. Numerous young shoots often start out further back on the branches which have been partly killed. As the disease spreads these young shoots may become infected and ultimately die. These dead clusters of short branches suggest a similar symptom commonly observed in rosette. However, this, as in rosette, is a physiological reaction. No deformity or crumpling of leaves is found to be due directly to dieback, though it may be associated with it through some other cause."

Control.

Pruning out and burning all dead wood of pecan trees infected with the dieback disease is the means of control

[1] J. Matz, Bull. 147, Fla. Exp. Sta., pp. 142-143.

most generally recommended. The dead and diseased twigs are difficult to locate in winter. More effective work can thus be done if the trees are carefully gone over in the fall just as the leaves begin to shed, and again in the spring after the buds swell. In both operations the diseased twigs are cut off well down below the juncture of the dead and the live wood so as to make certain of removing all infected tissues. The control of dieback depends very largely on keeping out dead and weakened branches. Twigs injured by rosette or by attacks of insects often afford harboring places for the dieback fungus, and so far as possible should be pruned and destroyed.

NURSERY BLIGHT

(*Phylloticta caryæ*, Peck.)

Pecan nursery blight is confined to the leaves and is principally a disease of nursery stock. It is, however, sometimes found on mature trees, especially those weakened by overcrowded planting or with their vitality lowered by rosette. In fact, attacks of the disease are favored by any condition which may lower the vitality of the tree.

The disease has about the same distribution as that of pecan scab and is usually first observed in April soon after the leaves reach full size. Rand found that the first indication of infection of nursery blight appeared as "Minute, roundish spots, which are dark reddish brown on the upper leaf surface and blackish on the lower. These slowly increase in size until a diameter of two to five mm. is often reached in the individual spots. With increase in size the center of the spot on the upper surface assumes an ashen-gray color, which is usually bordered with reddish brown, while the lower surface remains black throughout or with an occasional tiny ashen-

gray spot in the center of this dark colored area."[1] As these spots coalesce, the leaf dries up and falls to the ground.

Control.

Nursery blight can be controlled by spraying with bordeaux mixtures of the same strength as recommended for pecan scab. The first application is given in the spring soon after the trees are fully leaved out. The spraying should be repeated every three or four weeks until late summer, or until the trees have attained a normal amount of annual growth. From four to five applications of the bordeaux mixture will give the trees ample protection against the disease.

PECAN BROWN LEAF-SPOT

(*Cercospora fusca,* Rand. Syn. *Clasterosporium diffusum,* H. & W.)

The brown leaf-spot of pecans is found practically all over the pecan belt. The disease is thought to attack some species of hickories as well. It attacks the leaves of pecans and there seems to be very little difference in resistance of the leading commercial varieties. Brown leaf-spot is not rated with scab as a menace to pecans although it reaches a point of severity when the trees are defoliated.

Leaf infection occurs from early summer until fall. The disease is characterized by very small irregular dark reddish-brown spots which extend through the tissues of the leaves and have about the same form and color on both sides. As the spots increase in size they lose a part of their irregular

[1] Rand, F. V. Some Diseases of Pecans, Journ. Agr. Research. Vol. 1, No. 4, pp. 303-337.

outlines and assume a lighter reddish-brown color with a darker brown border. When the spots reach about a half inch in diameter, the leaves drop. From five to six weeks after the spots form, club-shaped spores of the fungus are produced, usually on the upper surface. The disease is spread by these spores which are carried by the wind to other leaves which become infected in turn so that new spots form.

Control.

The pecan brown leaf-spot rarely reaches such severity as to necessitate spraying. However, the disease may be controlled by carrying out the same spray schedule with bordeaux mixture as is recommended for pecan nursery blight.

POWDERY-MILDEW

(*Microsphœra alni,* Salm.)

Powdery-mildew occurs rather generally throughout the pecan belt. It makes its appearance in the early part of the summer and is very noticable during rainy and humid periods. The fungus frequently covers the leaves and nuts with a white powdery growth, causing only slight damage.

Spraying with bordeaux mixture, as recommended for nursery blight, will control this disease.

ANTHRACNOSE

(*Glomerella cingulata,* S. V. Von S.)

Anthracnose is well distributed throughout most localities in which the pecan is grown commercially. Attacks have been light and the industry has not suffered any serious effects from the disease.

Infections of anthracnose occur on both the leaves and the nuts of the pecans. The fungus forms reddish to grayish-brown blotches on the leaves, varying in size, sometimes covering the entire leaf. On account of the reddish color of the blotches the disease is often spoken of as "rust" by pecan-growers. The blotches on the nuts are black, irregular, and slightly sunken below the surrounding healthy tissue.

In extreme cases infected young nuts and leaves may be attacked so severely that they fall to the ground. Generally, however, the infection is on the outer surface of the husks of the nuts and on mature leaves, where very little damage is done. The losses to growers from anthracnose have been so small that specific control measures have been thought unnecessary.

PECAN CATKIN DISEASE

(*Microstroma juglandis,* (Bering.) Sacc., *var. robustum,* Higgins.)

The distribution of this disease is not well known. It is found on the catkins of practically all the commercial varieties of pecans in the early spring soon after the catkins reach full size. Infected staminate flowers of catkins are somewhat distorted and are of a paler green hue than normally. Higgins found that "The stamens and under-surface of subtending bracts were covered with a white substance which, at first glance, gave the impression of white fly; but, which, on examination, was found to be the white spore-clusters and basidia of a fungus belonging to the genus Microstroma. A little later when the pollen was being shed, the contrast between healthy and diseased catkins was made more conspicu-

ous by the failure of infected anthers to dehisce."[1] The diseased anthers contained degenerate or empty pollen-grains which were often collapsed shells.

The fungus, which was determined as a robust variety of *Microstroma juglandis,* sometimes infects and destroys as much as one-third of the pollen. However, since the pecan normally produces a superabundance of pollen, the disease is not likely to become a menace to the industry unless the infectiousness of the organism becomes very much greater than has thus far been reported. No measures of control have yet been thought necessary, nor have any been offered.

CROWN-GALL

(*Bacterium tumefaciens,* Sm. and Town.)

The well-known crown-gall organism which afflicts so many orchard trees attacks the pecan also. While both the hard and the soft types of crown-gall have been found on the pecan, natural infection of either type is only occasional in the nursery. The common practice of digging out and burning all diseased plants recommended for nurseries in general is equally applicable to the pecan nursery or infected trees. When a piece of soil is known to be badly infected with crown-gall, pecans should not be planted there for several years.

PECAN BLACK-PIT

This disease usually appears about midsummer, and in the early stages no evidence of infection or injury of any kind can be observed on the outside of the nut, but within there is a browning and disorganization of the internal

[1] Higgins, B. B. A Disease of Pecan Catkins, Phytopathology, 7: pp. 42-45, Fig. 1, 1917.

tissues. The dead brown tissues are surrounded by a seemingly normal green husk. However, as the disease progresses, sunken glossy black spots and blotches appear on the outside of the husks and the nuts soon fall to the ground.

Little is known of this disease, and so far it has not caused very serious trouble. Often when there are three or four nuts in one cluster, apparently the weaker ones succumb to the disease, indicating what some have termed a self-pruning process.

WOOD-ROTTING FUNGI

Wounds arising from mechanical injuries of pecan trees, as pruning, hail, windstorms, and the like, make possible points of entrance of wood-rotting fungi. Unless the wounds are given some protective covering during the healing-over process, serious injuries are likely to result. Painting the wounds with coal tar is one of the simplest methods of protection. It may be necessary to paint large wounds twice or three times before they finally heal. Wounds already invaded by the wood-rotting fungi should be cut out down to the sound wood before treating. In this case a coat of creosote followed by a coat of coal tar is advisable. Large cavities, after the decayed wood has been chiseled out and the walls have been disinfected, may be filled with concrete, a method practiced in modern tree-surgery.

TIP-BURN AND WINTER-INJURY

Tip-burn of pecans is indicated by the tips and the margin of the leaflets becoming brown in hot dry periods. If the weather conditions are extreme the leaves may die. Tip-burn is thought to be due to excessive evaporation. It is not considered a very serious trouble.

Winter-injury is much more troublesome than tip-burn, and under certain conditions causes heavy losses in young orchards. The trouble is caused by sudden and great changes or fluctuations in the temperature in late autumn and winter. Vigorous young trees making a late fall growth are most likely to be injured. The tender cambium cells do not seem to be able to adjust themselves to sudden freezing following a warm period of weather. More especially, however, does the injury result when the sun shines out warm suddenly following a freeze. Winter-injury usually occurs on the trunks of the trees just above the ground. On examination, the injured portion shows a dark watery condition just under the bark and has a sour odor. The injury is thus sometimes called "sour sap."

Winter-injury rarely affects pecan trees after they are eight or nine years of age, or after they begin to bear commercial crops of nuts. It can be largely prevented, however, by wrapping the younger trees with fertilizer bags or some similar material in the late fall just before the weather turns cold. The trunk is wrapped with four to six thicknesses of the sacking material for a distance of about three feet above the ground, and is allowed to remain until the following spring.

If the orchard is sown to cover-crops in June or July and no fertilizer applied after that date, the trees will cease growing earlier in the fall and will be more resistant to cold injury.

SPRAY OUTFITS AND METHODS OF SPRAYING PECAN ORCHARDS

For most satisfactory results it is necessary to have an outfit with sufficient capacity and power to spray satisfactorily a

pecan orchard within the period in which spraying has been found to be effective. Only a motor-driven spray pump can be relied on for bearing pecan trees. Orchards of medium-sized trees, and limited in area, may be sprayed efficiently with an outfit ranging from four to six horse power. Large commercial orchards require high power sprayers of eight to ten horse power. The low power machines are practically worthless in a pecan orchard after the trees reach the bearing age.

The high capacity spray outfit has no tower. The operator sprays from the ground or from the top of the tank. The spray rod will not do effective work for more than about twenty feet above the ground and for this reason it has been almost completely supplanted by the spray gun. The latter works best on a high power machine so that effective spraying can be accomplished from fifty to sixty feet above the ground. (See Plate XI).

A ten horse power outfit has the capacity for operating two guns at one time. The output of spray solution will average about eight gallons a minute. The medium-sized outfits can operate only one spray gun, while the small or low power machines having from one to two horse power, are not recommended for the use of a spray gun. A pressure of 250 to 300 pounds should be maintained to use a spray gun satisfactorily. It is, therefore, necessary to employ only the best grade of high pressure spray hose connected with long-stem couplings to prevent blowing apart when subjected to high pressure.

The wheels of the tank truck should be rather high and have broad tires in order to lessen the draft over soft and uneven ground when the tank is full of spray solution. A

tank with a rather large capacity should be used in order to lessen the necessity of refilling so often. Unless there is a convenient water supply in or near the orchard, much time will be lost in driving to the filling station each time the spray tank becomes empty. This loss of time may be overcome partially by hauling the spray material to the machine in barrels or some other convenient receptacle. When feasible, the refilling station should be provided with an elevated tank so that the spray or supply tank can be filled by gravity. When it is necessary to fill the spray tank from nearby streams or ponds, much time can be saved by equipping the spray pump with an attachment that will enable the operator to let a hose down into a stream and pump the water into the tank.

A pecan tree should be sprayed quickly and with the loss of as little spray material as possible. A good method is to begin on the lower limbs and move the spray gun to the right and left with short uniform horizontal movements, gradually working up to the top of the tree. On reaching the top, another section of the tree is sprayed by similar movements directed downward. The number of sections are governed by the size of the specimen. By this method, the tree can be sprayed uniformly and thus avoid overlapping in some places and omitting others.

CHAPTER XIII

UTILIZATION OF THE PECAN

Many important reports on nuts for human food are coming from public and private laboratories, and the literature on the question has become voluminous. Nuts furnish not only the elements required for human food, proteins, oils, and carbohydrates, but also the vitamine B.[1] In fact, nuts contain most of the mineral essentials for the building of sound human tissue. The pecan is in the first rank of nuts as human food, and the public is becoming better informed as to its high food value, so that this nut is destined to have an important place in the regular bill of fare.

Considering the high oil-content of the kernels, it is not improbable that some special use will be found for pecan oil. As yet, however, the expressing of oil is not practiced commercially, and the nuts are valued entirely for their meat or kernel-content.

The pecan kernel is highly nutritious and, when thoroughly masticated, is easily digested. Probably no product of the American soil is more palatable in its raw stage, even to the novice, than the pecan. It is prized most highly for dessert purposes. It is also coming into very extensive use in the making of confectioneries, cakes, breads, and salads.

[1] Cajori (1920) Proc. Soc. Exp. Biol. Chem. 17, 65.

FOOD VALUE OF PECANS

All edible nuts are high in nutritive food value, and far exceed, in this respect, most other food substances. As compared with other nuts, the pecan is outstanding in its content of fat and has more calories to a pound of kernels. The pecan, like several other nuts, contains about 50 per cent of shell, which of course reduces the food value for dessert purposes of the gross product as found on the market.

TABLE X

COMPOSITION OF NUTS[1]

(Edible portions)

Kind of Nut	Per Cent Protein	Per Cent Fats	Per Cent Carbohydrates	Per Cent Ash	Calories to a Pound
Pecan nuts	11.0	71.2	13.3	1.5	3633
Almonds	21.0	54.9	17.3	2.0	3030
Brazil nuts	17.0	66.8	7.0	3.9	3329
Filberts	15.6	65.3	13.0	2.4	3432
Hickory nuts	15.4	67.4	11.4	2.1	3495
Persian walnuts	16.7	64.4	14.8	1.3	3305
Chestnuts	6.2	5.4	42.1	1.3	1125
Butternuts	27.9	61.2	3.4	3.0	3371
Walnuts	27.6	56.3	11.7	1.9	3105
Coconuts	5.7	50.6	27.9	1.7	2986
Peanuts	32.0	47.0	24.4	2.0	2560

The food value of pecan meats in calories to a pound is 3633, whereas the average value of cereals is 1654 and that of meat 810 calories to a pound, which is less than one-fourth that of pecans. This high caloric value of pecans is, of course, due to the high fat—or oil—content of the meats.

The food value of fresh fruits and vegetables in calories to a pound, as compared with pecans, runs very low, averaging not over 300, or less than one-twelfth that of pecans. In other words, one pound of pecan meats has the same

[1] From Kellog, 15th Ann. Report. Nat. Nut Growers' Assoc.

energy and heat-producing value as twelve pounds of fresh fruits or vegetables.

A man at ordinary work requires from 2500 to 3000 calories a day for energy production, and 0.28 pounds of protein for tissue-building. From the caloric value of pecans, it is readily observed that a very small quantity of these nuts supplemented with fresh fruits and vegetables would supply him. Furthermore, the factors of flavor and palatability of the pecan, which are beyond its nutritive value as shown by analyses, enter into the trade prices of this nut, since such qualities go far toward popularizing it with the consumers.

TABLE XI

COMPOSITION OF MEATS, CEREALS, FRUITS AND VEGETABLES
(EDIBLE PORTIONS)

	Water per ct.	Protein per ct.	Fats per ct.	Carbohydrates per ct.	Ash per ct.	Calories to a lb.
Pecan nuts	....	11.0	71.2	13.3	1.5	3633
Porterhouse steak	....	19.1	16.1	....	...	975
Mutton	....	15.1	14.7	....	...	890
Pork chops	....	13.4	24.2	....	...	1245
Ham, smoked	....	14.2	33.4	....	...	1635
Bacon, smoked	....	9.1	62.2	....	...	2715
Sausage, frankfort	....	19.6	18.9	....	...	1155
Beef soup	....	4.4	0.4	....	...	120
Chicken	....	13.7	12.3	....	...	765
Goose	....	13.4	29.8	....	...	1475
Turkey	....	16.1	18.4	....	...	1060
CEREALS						
Whole wheat flour	....	13.8	1.9	71.9	1.0	1650
Macaroni, vermicelli, etc.	....	13.4	.9	74.1	1.3	1645
Wheat breakfast food	....	12.1	1.8	75.2	1.3	1680
Buckwheat flour	....	6.4	1.2	77.9	.9	1605
Rye flour	....	6.8	.9	78.7	.7	1620
Cornmeal	....	9.2	1.9	75.4	1.0	1635
Oat breakfast food	....	16.7	7.3	66.2	2.1	1800
Rice	....	8.0	.3	78.0	.4	1620
VEGETABLES						
Beans, dried	12.6	25.5	1.8	59.6	...	1520

	Water per ct.	Protein per ct.	Fats per ct.	Carbohydrates per ct.	Ash per ct.	Calories to a lb.
Beans, string	83.0	2.1	.3	6.9	...	170
Beets	70.0	1.3	.1	7.7	...	160
Cabbage	77.7	1.4	.2	4.8	...	115
Celery	75.6	.9	.1	2.6	...	65
Corn, green (sweet)	75.4	3.1	1.1	19.7	...	440
Cucumbers	81.1	.7	.2	2.6	..	65
Lettuce	80.5	1.0	.2	2.6	...	65
Onions	78.9	1.4	.3	8.9	...	190
Peas, English	74.6	7.0	.5	16.9	...	440
Potatoes, Irish	62.6	1.8	.1	14.7	...	290
Potatoes, sweet	55.2	1.4	.6	21.9	...	440
Spinach	92.3	2.1	.3	3.2	...	95
Squash	44.2	.7	.2	4.5	...	100
Tomatoes	94.3	.9	.4	3.9	...	100
FRUITS						
Apples	84.6	.4	.5	14.2	.3	290
Bananas	75.3	1.3	.6	22.0	.9	512
Blackberries	86.3	1.3	1.0	10.9	.5	270
Figs	79.1	1.5	....	18.8	.6	380
Grapes	77.4	1.3	1.6	19.2	.5	450
Lemons	89.3	1.0	.7	8.5	.5	205
Olives	67.0	2.5	17.1	9.0	4.4	407
Oranges	86.9	.8	.2	11.6	.5	240
Peaches	89.4	.7	.1	9.4	.4	163
Pears	80.9	1.0	.5	17.2	.4	163
Persimmons (Japanese)	80.2	1.4	.6	17.2	.6	174
Plums	78.4	1.0	....	20.1	.5	395
Prunes	79.6	.9	....	18.9	.6	370
Strawberries	90.4	1.0	.6	7.4	.6	180
Watermelons	92.4	.4	.2	6.7	.3	140

As shown by the foregoing tables, the pecan has from three to four times the caloric value of beef. Experienced stockmen have found that 150 pounds of dressed beef is as much as each acre of grazing land should be expected to produce annually. An acre of pecan trees in full bearing should yield, on the average, about six times this number of pounds of nuts, or about three times this amount of meats. Thus,

one acre of pecan trees in full bearing will equal about nine acres of grazing land for beef production, so far as food nutrients are concerned. After a pecan orchard of suitable varieties reaches the bearing age, few crops will yield an equal amount of food nutrients with so little expense of production.

The fats and carbohydrates of the pecan are the elements of food that produce heat and energy. On the other hand, the protein, containing nitrogen, is the essential element in tissue-building and is necessary for the promotion of health and strength in any balanced ration. In studying the nutritive elements composing foods, dietitians have found that if 10 per cent of the total ration consumed is protein, the body will receive an abundant supply of this material for repairing its nitrogenous tissues, the only function for which protein is essential. By referring to the table, it will be observed that a little more than 10 per cent of the food nutrients of the pecan is protein, although it contains very little carbohydrates. Thus, if the pecan is combined with bread, fresh fruits, and vegetables to supply the carbohydrates, the elements will be almost in a correct ratio for a balanced ration.

Beyond the purely chemical food value of the pecan, its similarity in composition to certain nuts known to contain an abundance of the vitamine B makes it fairly certain that the pecan also contains this element so essential in certain body processes. Coward and Drummond[1] report that the walnut, almond, peanut, Brazil nut, and Barcelona nut are relatively low in food value as sources of vitamine A; however, the pecan nut seems not to have been examined for this accessory food factor.

[1] Biochem. Journ. Vol. XIV, No. 5, Oct. 1920.

Uric acid arises from the nucleo-proteins and purin bodies present in the food and metabolized body tissue. It has long been known that the excretion of uric acid is higher from an animal than from a vegetable diet, the fact being explained by the larger amount of uric acid-forming material contained in the former. An excessive amount of uric acid in the system will lead to a derangement of normal body processes. Pecans, in this respect, have a decided advantage over meats in the diet, since they are practically free from purin bodies, which are the uric acid forms in proteins so common in meats.

Under some conditions, the pecan may be substituted for meats and constitute an integral part of the menu along with bread, vegetables, and fruits. When pecans are eaten at the close of an elaborate dinner, however, they are likely to cause some discomfort or even distress, as would any other highly concentrated food following a superabundant meal. For this reason, the belief has been prevalent that the pecan is difficult to digest. No trouble need be feared, however, when the pecan is consumed as a part of the regular meal.

Since the pecan is so high in fats, thorough mastication is very important. Pecan meats should be masticated sufficiently to form a smooth paste in the mouth so as properly to prepare the mass for the action of the several digestive juices. Particles of kernels not masticated are likely to pass through the alimentary canal as foreign bodies and not digest at all.

TYPE OF PROTEIN IN PECANS

Dowel and Menaul and also Cajori[1] found the nitrogen

[1] Journ. Biol. Chem. Vol. 46, No. 3, 1921.

of pecans distributed in such a way as to give the nut a high nutritive value as a source of protein. Cajori[1] discovered the principal protein of the pecan to be a globulin, and reports the distribution of the nitrogen in the pecan globulin as follows:

	Per cent
Amide nitrogen	9.8
Humin nitrogen	3.6
Argine nitrogen	22.9
Histidine nitrogen	3.7
Cystine nitrogen	0.8
Lysine nitrogen	6.2
Monoamino nitrogen	51.7
Non-amino nitrogen	0.8

Following Friedeman's analyses showing that the integument or outside cuticle of the pecan kernel contains a considerable percentage of tannins, Cajori[2] conducted feeding experiments with rats and secured much more rapid growth when the rats ate pecan kernels from which the cuticle had been removed, thus furnishing evidence that the tanning of the cuticle or integument was a hindrance to the best growth of the rats. The protein of the pecan, however, is of a very choice character. Some of the earlier investigators referred to the protein of nuts as vegetable casein because it closely resembled the protein of milk. The amino acids, lysine, and cystine, which have been found to be essential to growth, are present in relatively large quantities in the pecan. Especially is this true for lysine, as shown by the foregoing tabulation.

PECAN OIL

The fats of pecans, which are their leading food principle,

[1] Journ. Biol. Chem. Vol. 49, No. 2, 1921.
[2] Journ. Amer. Chem. Soc. Vol. 42, No. 11, 1920.

are among the most digestible of all forms. They have a low melting point and are much more readily assimilated by the body than are the common animal fats used for human food, with the exception of butter.

The properties of pecan oil[1] are as follows:

Percentage of kernels of pecan nuts	47.0
Percentage of oil in the kernels	70.4
Specific gravity of pecan oil at 15 degrees C.	0.9184
Saponification value	198.0
Iodine absorption of pecan oil	106.0
Volatile acids (Reichert-Meissl value)	2.2
Acetyl value	1.16
Insoluble fatty acids (Hehner value)	93.4 per cent
Lecthin	.5 " "
Cholesterol	.28 " "

Foods containing oils with low melting points are usually very palatable; and, in case of swine at least, where they compose the bulk of the ration for a considerable time, soft and oily flesh is produced. This fact was observed by the soft and oily condition of the pork of animals raised on mast and shipped to the markets from parts of Arkansas and Texas where large forests of pecan trees were growing even before the cultivation of the pecan became an industry.

CARBOHYDRATES OF THE PECAN

The pecan is well supplied with proteins and fats, but is deficient in its amounts of carbohydrates. For this reason, fruits and fresh vegetables, which are low in fats and protein, are most excellent supplementary foods to be eaten with pecan nuts. The distribution of the carbohydrates in the pecan is as follows:

[1] Deiler; Amer. Chem. Journ. 43, No. 1, 1909.

	Per cent Total Carbohydrates [1]	Per cent Pecan Kernels (Dry Basis)
Sucrose	9.03	1.18
Invert sugars	21.90	2.88
Araban	14.82	1.95
Methylpentosans	1.68	.22
Cellulose (crude fiber)	14.29	1.76
Amyloid	4.54	0.59
Starch	0	0
Tannins	2.57	0.33
Hemmicellulose (dextran, etc.)	31.17	4.09
Total	100.00	13.00

The high content of sucrose and invert sugars and the relatively small amount of cellulose or crude fiber of the pecan give the carbohydrates a high dietetic value. However, this is offset to some extent by the high percentage of tannins in the integuments of the kernels. In preparing foods from pecans for invalids and convalescents, it would thus seem advisable to remove the integuments from the kernels so as to eliminate the tannins from the diet.

Cajori [2] reports that the integuments of pecan meats cannot be removed successfully by blanching with hot water as can be done with some other nuts. The hot water fails to detach the membranous skin from the numerous crevices of the wrinkled surfaces of the meats. He found, however, that this could be accomplished by using a caustic soda solution. The pecan halves are placed in a wire basket and dipped into a boiling 1 per cent solution of sodium hydroxide and agitated for one minute. When removed from the hot sodium hydroxide solution, the pecan meats are washed several times with hot water as quickly as possible. Immediately following they are

[1] Friedman, Journ. Amer. Chem. Soc. Vol. 42, No. 11, 1920.
[2] Journ. Biol. Chem. Vol. 49, No. 2, 1921.

PLATE XII.—*Above*, catkins or flower clusters of pecan. *Below*, meats of pecans, showing kernel-spot.

washed once with a one per cent solution of hydrochloric acid and again with hot water. The hydrochloric acid removes any traces of the sodium hydroxide. When this process is carried to completion as rapidly as possible, the solvent action of the alkali, and consequent loss of protein, is restricted to the outer layer of the nut halves. This process removes the integument or skin of the meats and gives a white non-astringent product.

PECAN RECIPES

The increase of America's annual crop of pecans has afforded sufficient quantities for increased uses for culinary as well as for dessert purposes. The pecan in its natural or raw state is decidedly palatable and appetizing. However, it may be made to appeal even more strongly to the average palate when properly prepared and combined with other food products or cooked in mixtures. The pecan is one of the best nuts for culinary purposes, and in most recipes in which other nuts are called for, pecans may be substituted.

The recipes here given were proposed, thoroughly tested, and found to be good by such authorities as Mrs. Thos. A. Banning, Elizabeth Wilson, Mrs. W. N. Hutt, Mrs. Harriet C. North, and Mrs. J. A. Kernodle. They may be followed with assurance of good results.

BREADS

Pecan Nut Bread, No. 1: 2½ cups of sifted flour (½ graham, ½ white), 3 teaspoons baking-powder (measurements level), ¾ teaspoonful salt, 1¾ cup sugar, 1 cup pecan kernels broken in pieces, 1 egg, ⅔ cup sweet milk, 3 tablespoons of butter. After mixing the ingredients, put in greased pan, grease top of loaves, let stand ten minutes, and then bake in oven, not too hot, for 40 minutes. This amount makes one loaf of bread.

Pecan Nut Bread, No. 2: 2 cups of milk, 2 cups of water, 1 tablespoon of lard, 4 cups of flour, 1 yeast cake, 2 tablespoons sugar, 1 teaspoon salt, 1 cup chopped pecans, ½ cup lukewarm water, five cups whole wheat flour. Scald the water and milk together and pour over flour and lard, let cool until medium hot, then add white flour. Beat for ten minutes and then add yeast dissolved in the half cup of lukewarm water. Cover and let rise until very light. Then add the nuts and whole wheat flour, making a soft sticky dough. Place dough in buttered bowl and let rise until it gains twice original bulk, then form into loaves. Place them in pans, grease top, having each half full, let them rise until pans are full. Bake for one hour. The above will give enough material for three loaves.

Pecan-Date Bread: To 1 cup of hot cooked oats, add 3 tablespoons brown sugar, ½ teaspoonful salt, 1 tablespoon butter, add ¼ cake yeast dissolved in 4 tablespoons lukewarm water and flour to knead. Let rise over night. Next morning add ⅔ cup each of pecans cut in small pieces and of dates cut fine. Shape in loaf, let rise and bake in a moderate oven fifty minutes.

MEAT SUBSTITUTES

Nut Loaf, No. 1: Chop rather coarsely 1½ cups of mixed nuts, pecans, hickory, or walnut and almonds, moisten with cream or meat stock; add 3 cups of soft bread crumbs and mix thoroughly with the nuts; season with salt, paprika, and tablespoon chopped parsley, and add one beaten egg. Mix all the ingredients well and shape into roll, place in baking pan, and baste occasionally with stock or hot milk. Cook about one-half hour.

Nut Loaf, No. 2: One cup of pecan kernels chopped fine, 1½ to 2 cups of bread crumbs, ¾ cup of sweet milk, 1 egg beaten into milk, salt to flavor, and a little pepper. Bake ½ hour or steam ¾ hour.

Sauce for same: 1 tablespoon butter heated, 1 tablespoon flour stirred in juice from one can of tomatoes stirred in while boiling. Salt and pepper to taste. When well cooked pour over loaf and serve.

Nut Croquettes, No. 1: Mix 1 cup of finely chopped pecan kernels with 1 cup of dry bread crumbs, add ½ teaspoonful of salt and ¼ teaspoon of paprika, and drop in 1 unbeaten egg and mix all well together. If not moist enough to mold, add a little milk or water.

Mold in cylinders, roll in egg batter, then in dry bread crumbs, and fry in deep fat. Serve with tomato sauce or lemon juice.

Pecan Souffle: Boil 1 pint of soft bread crumbs with 1 cup of milk and stir until smooth; take vessel from fire and slowly stir in 1 cupful of finely chopped pecan kernels, and season to taste with salt and pepper; fold in the stiffly beaten whites of 5 eggs and bake in a quick oven in the dish in which it is to be served. It can be baked in twelve to fifteen minutes and must be served while hot, or else it loses its lightness. It may be served as a substitute for meats.

Pecan Roast: Take cooked beans or peas, pass through a colander to remove the skins, mix with an equal quantity of finely chopped pecan kernels, and season to taste. Line an oiled baking dish with half the mixture and spread on a dressing made as follows: Take 4 slices of zwieback, pour over them boiling water and cover; let stand a few minutes; then break them up with a fork, add a half cup of sweet cream, and add salt and sage to taste. Cover the dressing with the remainder of the nut mixture, pour over all ½ cup of cream, and bake for 1½ hours. Serve in slices with cranberry sauce, and garnish with a sprig of green.

SALADS

Chicken Salad with Pecans: Marinate 2 cups of chicken cut in small pieces, drain, add an equal amount of chopped celery and 1½ cups of chopped pecans, toss together with two forks, add mayonnaise dressing to make sufficiently moist. Serve on crisp lettuce leaves and garnish with fringed celery and stuffed olives.

Lettuce-Pecan Salad: Scatter finely chopped pecan kernels thickly over shredded lettuce and serve with French dressing.

Apple-Pecan-Celery Salad: One cup of chopped apples, 1 cup of celery, 1 cup of pecan kernels, 1 cup of raisins. Mix well and pour over the salad dressing.

Fruit-Pecan Salad: Soak 1 box of gelatin 5 minutes in cold water, add 2 pints of boiling water and 2 cups of sugar, and set to cool. In large salad dish have ready 1 can of pineapple, ½ dozen oranges, ½ dozen bananas and 1 pint of pecan kernels, all cut in small pieces. When gelatin is cool, pour over fruit arranged in salad dish. Set away to get firm. Grated coconut may be sprinkled over top if desired.

Prune-Celery-Pecan Salad: A delicious fruit salad and an inexpensive one is made by soaking prunes overnight and then cutting them into small pieces with the scissors and adding diced celery and pecan kernels. Mix together with mayonnaise dressing.

Pineapple-Pecan Salad: One can of sliced pineapple, ½ cup of grated cheese, 1 cup chopped pecan kernels, 1 tablespoon chopped parsley, French dressing. Divide sliced pineapple into individual dishes, fill hole in center with grated cheese, cover with French dressing, and sprinkle over with chopped nuts and parsley.

Pecan Salad: Four tart apples peeled and cut into small dice; 2 cups celery chopped fine, 2 cups pecan kernels; mix and pour over the mixture dressing made as follows: 1 cup of good vinegar, 1 tablespoon sugar, 1 tablespoon butter, pinch of salt and pepper to taste, the yolks of 2 eggs. Put the vinegar in saucepan with ½ cup of water, add the butter and sugar, beat the yolks well and stir in quickly, removing from the fire before they curdle, and pour hot over the salad. Serve cold.

Pecan Cheese Balls: Grate or pass through a food cutter remnants of cheese; if dry, moisten with melted butter or cream. Mix with an equal quantity of finely chopped pecan kernels and half quantity of chopped candied cherries. Mold into balls, press whole nut meat on top. Serve in nest of lettuce leaves with salad dressing.

Pecan and Grapefruit Salad: Two large grapefruit, peeled and cut in quarters, 1 cup pecan kernels. Serve grapefruit and nuts on lettuce leaves with mayonnaise dressing. Garnish with Malaga grapes.

Baked Apples with Pecans: Take 6 large apples, 1½ cups of pecan kernels, and 1 tablespoon sugar for each apple. Chop the pecans fine and add to the sugar. Core apples, fill the cavities with the sugar and kernels, and place them in a dripping pan not too close. Pour a cup of boiling water into the pan and bake in a quick oven until the apples are tender but not broken.

DESSERTS

Prune Float: One pound of French prunes well cooked. Remove pits and add 1 pint of cream whipped stiff and ½ cup of pecan kernels chopped fine. Keep in a cool place until ready to serve.

Marshmallow-Pecan Cream: Cut up ½ pound of marshmallows; whip 1 cup of thick sweet cream; chop 1 cup of pecan kernels and

mix all together; put in a bowl and set on ice. This is better if made several hours before serving.

Pecan Charlotte: One pint of cream, ¼ box of gelatine, ⅔ cup powdered sugar, ¾ cup pecan kernels, finely chopped. Cover the gelatine with ½ cup of cold water and soak until soft, then dissolve over hot water. Whip the cream and sprinkle over it the sugar. Add 4 tablespoons of milk to the dissolved gelatin and strain into the whipped cream. Add the nuts, mixing it lightly. Stand the bowl in a pan of ice water and stir carefully from bottom and sides until the mixture begins to thicken, then turn at once into a mold lined with lady fingers, and stand in a cool place to harden.

Nougat Ice-Cream: Three cups of milk, 1 cup sugar, yolks of 5 eggs, pinch of salt, 1½ cups of heavy cream, whites 5 eggs, ⅓ cup each of pecans, filberts, and almond kernels, 1 teaspoon each of almond and vanilla flavoring. Make custard of first four ingredients; strain and cool. Add heavy cream beaten stiff, whites of eggs beaten stiff, nut meats finely chopped, flavoring; then freeze.

Pecan Ice-Cream: Make plain ice-cream by any desired recipe. When partly frozen, stir in 1 cup of finely chopped pecans to every quart of ice-cream. Be sure that none of the shell or dividing tissue adheres to the nut pieces.

COOKIES

Pecan Cookies, No. 1: One cup of brown sugar, ½ cup strained honey, ½ cup butter, 2 eggs, ½ cup of milk, ½ pound good pecans ground fine, 1 teaspoon vanilla, 1 teaspoon baking-powder, and enough flour to make a dough soft enough to handle. Cream the butter and sugar together, add the eggs one at a time, mix well and add the honey and vanilla extract, then add the nuts and milk and the baking-powder sifted into 1 cup of flour. Add enough flour to make dough that can be rolled out. Chill and cut into diamond shapes. Bake in brisk oven. The cookies will be better when kept a few days.

Pecan Cookies, No. 2: Beat 4 eggs very light, add ½ cup of sugar and beat again. Sift about 2 cups of flour with ½ teaspoon each of salt and baking-powder. Mix 1½ cups of chopped pecans with the flour mixture and stir into the eggs and sugar. Drop by teaspoonfuls on greased and floured pans. Place ½ pecan on each and bake slowly.

Oatmeal-Pecan Cookies, No. 3: Two cups of oatmeal, 2 cups of

flour, 1 cup of raisins, 1 cup of pecans, 1 cup lard and butter mixed, 1 cup sugar, 4 tablespoons sweet milk, 1 teaspoon cinnamon, ⅔ teaspoon soda, ½ teaspoon salt, 2 eggs. Chop raisins and nuts fine, beat the eggs, stir all together, then pour in tablespoonfuls on a buttered pan. Do not place spoonfuls too near together.

Pecan Wafers: To 3 cups brown sugar, add 1 cup lard, 1 cup hot water in which dissolve 1 teaspoon soda, pinch of salt, and flour enough to make a soft dough and roll thin. Sprinkle plentifully with coarsely chopped pecan kernels, and bake in a quick oven.

Chocolate Pecan Wafers: Mix in order given: 1 cup sugar, 2 squares chocolate, ½ cup melted butter, yolk and whites of 2 eggs beaten separately and then together, ½ cup of flour. Spread very thinly over cooking sheet and sprinkle on it 1 cup coarsely chopped pecan kernels. Bake not too brown. Cut in oblongs and remove.

Pecan Kisses: To white of 1 egg well beaten, add 10 teaspoons of pulverized sugar and 1 tablespoon brandy, or flavor with vanilla, a little ground cinnamon, and cloves; then add a cupful of pecan kernels chopped fine. Put tablespoonful of mixture on buttered paper on bottom side of pie pan, and bake ten minutes in a moderate oven. This makes one dozen.

CAKES

Pecan Loaf Cake: Take 1½ cups of sugar, ⅔ cup butter, ⅔ cup water, 3 cups flower, whites 5 eggs, 3 teaspoons baking-powder, 1 cup pecan kernels, 1 teaspoon vanilla. Cream butter and add sugar, sift flour and baking-powder, and add this and the water to the creamed sugar and butter. Stir well. Add nuts and vanilla. Fold in beaten whites and bake in a loaf.

Lady Baltimore Cake: One cupful butter, 2 cups sugar, 3 cups flour, 1 cup sweet milk, whites 8 eggs, 2 teaspoons baking-powder; flavor with vanilla or rose water and bake in layers. Filling: Dissolve 2 cups sugar with 1 cup water and boil until it threads. Pour over the stiffly beaten whites of 3 eggs and add 1 cup raisins, 1 cup figs, and 1 cup pecans. Chop all together and lay between the layers.

Pecan Layer Cake: Take ½ cup butter, 1 cup sugar, 2 eggs, a cup milk, 2½ cups flour, 4 teaspoons baking-powder, 1 teaspoon vanilla, 1 cup chopped pecans. Cream butter and sugar, then add eggs, and milk and flour alternately, adding the pecan kernels mixed with the last ½ cup flour. Flavor and bake in layers about an inch in thick-

ness. Filling: Take 2 cups granulated sugar and ⅔ cup rich milk, 1 cup pecan kernels. Cook milk and sugar to soft ball stage, beat until creamy, add nuts and flavoring, and when cool enough spread on cake.

Pecan Boiled Icing: Two cups granulated sugar, ½ cup water, whites 2 eggs, 1 cup pecan kernels, 1 teaspoon vanilla. Boil sugar and water to soft ball stage, then pour on beaten whites of eggs, add flavoring and nuts, and beat until cool; then spread on cake.

CANDY

Pecan Pralines: Take 1 pound of brown sugar, ½ pound pecan kernels, a tablespoon water. Cook sugar and water, stirring constantly, until it spins threads when poured from spoon. Then pour over little piles or heaps of pecan kernels arranged over a greased marble slab.

Pecan Fudge: Three cups brown sugar, 1 cup milk, 1 tablespoon butter, 1 cup chopped pecans. Boil sugar and milk until the mixture will harden when dropped in a cup of cold water; add butter and nuts; then boil 4 minutes longer, beat until creamy, and pour into buttered tins.

Pecan Balls: Take all the broken pieces of nut kernels, chop them up, mix with fondant, and roll into balls. When dry dip into melted chocolate.

Pecan Chocolate Fudge: Two cups sugar, 1 cup milk, ½ cup cocoa, 1 tablespoon butter, 1 teaspoon vanilla, 1 cup pecan kernels. Boil without stirring until the soft ball stage, then add vanilla and nuts, and beat until almost hard. Pour on greased tins and cut into squares.

Pecan Divinity Fudge: Two cups sugar, ½ cup cold water, ½ cup corn sirup, whites of 2 eggs, 1 cup chopped pecan kernels. Boil sugar, water and sirup until the soft ball stage is reached, then pour the mixture on the whites of eggs, beaten stiff, then add nuts and beat until cool. Pour into a deep buttered pan and cut in squares when hard.

Pecan Balls: Take ½ cup water, 1 cup sugar, ½ cup white karo sirup, 1 teaspoon vanilla. Cook until sirup threads well, drop in pecans, make into balls.

Frosted Pecans: Take ¾ cup sugar, 2 tablespoons water. Let cook until it ropes, add 1 cup pecans, stir until pecans are all frosted.

Pecan Stuffed Dates: Remove seed from any desired quantity of dates. Insert in cavity half of a pecan kernel and roll the date in granulated sugar.

SANDWICHES

Pecan Fruit Filling: Run cup of pecan kernels and cup of raisins or dried figs or dates through the food chopper together. Flavor with a little lemon juice and spread between slices of bread.

PIE

Pecan Pie: Take 5 eggs, 1 cup molasses, 1 cup sugar, 2 tablespoons of flour, 1 cup pecans, 2 teaspoons butter. Beat the eggs light, add sugar, flour, molasses, butter and pecans. This makes two pies.

CHAPTER XIV

BOTANICAL CLASSIFICATION AND VARIETIES OF THE PECAN

The pecan is a hickory, one of the Juglandaceæ or Walnut family. A half dozen genera comprise the family, of which the walnut and the hickories are represented in North America, the other genera being Asian and one Central American. With the exception of a recently discovered species in China, all the hickories are native from Canada to the highlands of Mexico. Seventeen species are now recognized.

At first the hickories were included in the genus Juglans, with walnuts. Linnæus, the founder of modern botanical nomenclature, included three species of Juglans in his "Species Plantarum," 1753,—the historic Old World walnut. *Juglans regia,* the American black walnut, *J. nigra,* and one of the hickories, *J. alba.* He did not know the pecan. In 1785 Humphrey Marshall, in his work on American trees, recognized the pecan and named it *Juglans Pecan;* and as *Pecan* is the first specific botanical name to be regularly applied to the plant it must hold in whatever genus the hickories may subsequently be placed. The pecan was published as *Juglans illinoensis* by Wangenheim in 1787, as *J. angustifolia* by Aiton in 1789, and as *J. cylindrica* by Poiret in 1797. These names are now synonyms, but they are worth record as indicating interesting stages in the technical recognition of the pecan as a distinct species (see page 16).

All botanists agree that the hickories should be separated botanically from the walnuts. In 1818, Nuttall founded the genus Carya, using the ancient Greek name for the walnut. The pecan he called *Carya olivæformis,* bringing down the name from Michaux's *Juglans olivæformis* (1803), the appellation being given in allusion to the olive-shaped fruit. But under all current rules of nomenclature the older name *Pecan* must displace *olivæformis,* and the combination becomes *Carya Pecan.*

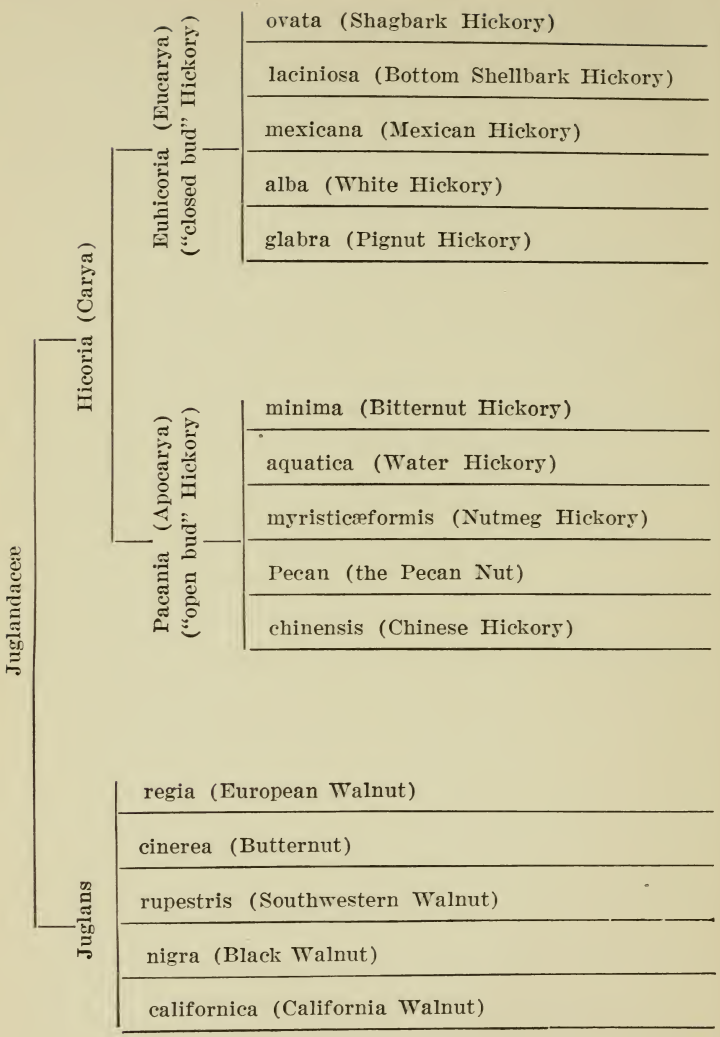
In 1838, Rafinesque published the name Hicoria for the genus, adopting the American Indian name of these trees, although he did not publish any species. In 1817, he had used Hicorius, and in 1808 the name Scoria. The word Scoria is apparently an error and Hicoria was undoubtedly intended. Under the genus Hicoria, the pecan becomes *H. Pecan.*

So it comes that the hickory genus is called Carya by some botanists and Hicoria by others. In the lists adopted by the International Botanical Congress held in Vienna, in 1905, the names of Rafinesque are rejected and Carya adopted. This practice is followed by European authors in writing of these American plants (Schneider in his standard "Handbuch der Laubholzkunde" used Hicoria in the body of the book, but changed it to Carya in the addendum to the same volume), and in this country by the Gray Herbarium of Harvard University, as in Gray's Manual, latterly by the Arnold Arboretum of Harvard University, as in the current edition of Sargent's "Manual of the Trees of North America" and Rehder in Bailey's "Standard Cyclopedia of Horticulture," by Bailey in his "Manual of Cultivated Plants," and by others. To them the pecan is *Carya Pecan,* this combination having been made by Ascherson and Græbner in 1910. The

other name, Hicoria, is used by the New York Botanical Garden, as in Britton's Manual and his "Trees of North America," in Britton and Brown's "Illustrated Flora of the Northern States and Canada," in Small's "Flora of the Southeastern United States," by the United States Department of Agriculture, by the recent "Standardized Plant Names," and by others. To them the pecan is *Hicoria Pecan*, this combination of names having been made by Britton, in 1888, although Sargent used the name *Hicorius Pecan*, in 1889.

The genus Hicoria or Carya is divided into two groups, Pacania, the "open bud" hickories in which the winter bud-scales do not cover the tiny leaf forms completely, and Euhicoria, the "closed bud" hickories, in which stout scales completely close the buds in winter. The pecan tree belongs in the "open bud" group of hickories. Its relation to the other common hickories as well as to the native walnuts is shown in the accompanying chart (see page 218).

All the Juglandaceæ are aromatic trees with scaly buds and compound unequally pinnate leaves, the leaflets increasing in size from the lowest upwards. The flowers are monœcious, opening after the unfolding of the leaves, and are on the previous season's growth; the staminate flowers in long slender catkins composed of a 3- to 6-lobed calyx, adnate to an acute bract, with numerous stamens inserted on the inner and lower face of the calyx in two or several rows, with short distinct filaments and oblong anthers opening longitudinally; the pistillate flowers in a terminal spike on the branch of the current season's growth, composed of a 1- to 3-celled ovary, a 1- or 4-lobed calyx inserted on the ovary, a short style with 2 stigmas, stigmatic on the inner face, and a solitary erect ovule. The fruit is a nut inclosed in an indehiscent or 4-


Juglandaceæ
Hicoria (Carya)
Eubicoria (Eucarya) ("closed bud" Hickory)
ovata (Shagbark Hickory)
laciniosa (Bottom Shellbark Hickory)
mexicana (Mexican Hickory)
alba (White Hickory)
glabra (Pignut Hickory)
Pacania (Apocarya) ("open bud" Hickory)
minima (Bitternut Hickory)
aquatica (Water Hickory)
myristicæformis (Nutmeg Hickory)
Pecan (the Pecan Nut)
chinensis (Chinese Hickory)
Juglans
regia (European Walnut)
cinerea (Butternut)
rupestris (Southwestern Walnut)
nigra (Black Walnut)
californica (California Walnut)

valved husk; seed solitary, 2-lobed from the apex nearly to the middle; cotyledons fleshy and oily, 2-lobed; radicle short, superior, filling the apex of the nut.

The characteristic marks of the genus Hicoria (or Carya, if one prefers that name) in contrast with those of Juglans are long slender long-stalked three-branched catkins, instead of single sessile or short-stalked catkins; husk of the fruit dehiscent by 4 valves rather than indehiscent as in Juglans; nuts not sculptured, and the pith of the branches solid instead of being in plates or layers. The staminate flowers of the hickories have the calyx 2- or rarely 3-lobed with from 3 to 10 stamens; the pistillate flowers, sessile, in 2- to 10-flowered spikes, with calyx 4-lobed, and short stout stigmas (see Fig. 33).

The pecan, *Hicoria Pecan,* is the largest of all the hickories and one of the largest trees of the forest. The trunk, like that of the shagbark hickory, *Hicoria ovata and H. laciniosa,* is very high, often measuring more than 50 feet and occasionally 80 or 90 feet to the first limb. Its bark is thick, light brown tinged with red, and deeply and irregularly divided into narrow forked ridges broken on the surface into thick appressed scales. The pecan differs from the other hickories in the fact that its catkins are produced from buds in pairs—one on either side of a lateral leaf-bud—of the previous season's growth; while the other hickories produce catkins from near the base of the terminal bud, or on the new growth near its base. The fruit of the pecan is in clusters of 2 to 8, pointed, 4-ridged and angled, from 1 inch to 2½ inches long and from ½ to 1 inch broad, dark brown with a thin, hard, and brittle husk splitting at maturity nearly to the base and often persistent on the branch during the winter after the

FIGURE 33.—Twig specimens of the pecan. *a*, Male flowers or catkin on one-year old wood; *b*, female flowers at terminal of new growth; *c*, pistillate flower in receptive stage; *d*, pistillate flower past receptive stage; *e*, enlarged staminate flower.

discharge of the nut; nut ovoid, nearly cylindrical or slightly 4-angled toward the pointed apex, bright reddish-brown, with irregular black markings, from 1 to 2 inches long, with brittle walls and papery partitions. The seed or kernel is sweet, reddish-brown, its nearly flat lobes furrowed from near the base to the apex by two deep longitudinal grooves.

The wood of *Hicoria Pecan* is heavy, hard, not very strong, brittle and close-grained, with numerous thin medullary rays and bands of one or two rows of large open ducts marking the layers of annual growth. It is light brown tinged with red, with thin lighter brown sapwood. The specific gravity of the absolutely dry wood is 0.7180, a cubic foot weighing 44.75 pounds. It is less valuable than the wood of most of the other species of hickory. It makes excellent fuel and is now occasionally used in the manufacture of wagons and agricultural implements.

VARIETIES OF PECANS

The Gulf Coast varieties are adapted to the southern pecan belt. In this group the planter has a long list from which to choose. The really meritorious varieties, however, adapted to a large part of the southern belt are comparatively few. Those which have withstood best the exactions of the grower and of the trade for a considerable time are the Schley, Stuart, Alley, Pabst, and Success. To this list might be added Moneymaker, Moore, Brooks, and Bradley. The last four varieties are very prolific. The trees come into bearing while young and the nuts ripen early in the fall, enabling the grower to catch the early trade. Other varieties that give satisfaction in the different sections of the southern pecan

belt are the Frotscher, President, Curtis, VanDeman, Teche, Delmas, and Mobile.

In the western belt, those varieties that have gained most favor are the Texas Prolific, Burkett, Halbert, Onliwon, Oliver, and San Saba.

For the middle belt, which borders the southern on the north, and for the northern belt, the following are recommended: Greenriver, Kentucky, Warrick, Major, Busseron, Butterick, Indiana, Niblack, and Posey.[1]

Alley.—Originated from planted seed of unknown origin, in Jackson County, Mississippi, in 1871. Widely disseminated and recommended for South Atlantic and Gulf states. Nut medium-sized, short, very plump, smooth, medium color with black markings toward the apex, very attractive; medium filler, thin shell, rich plump kernel, easily shelled, good quality, and excellent for candies because of the readiness with which it cracks into halves. Tree upright, round-headed, regular; prolific, vigorous, moderately early bearer, medium hardy; slightly subject to scab.

Bradley.—A supposed seedling of Frotscher, from Baker County, Florida. Fairly promising for southern part of pecan belt; does well also in section through middle Georgia and Alabama. Nut below medium size, ovate-oblong, with blunt point at either end, hard shell of average thickness, easily shelled and well filled; kernel plump, rich and attractive. Tree rather slender and not symmetrical; a very early and prolific bearer; not seriously attacked by insects and diseases.

Brooks.—Introduced from southwest Georgia recently. Not yet extensively planted but has done well where tested. Nut medium sized, fairly thin-shelled, and well filled.

Burkett.—Introduced from Callahan County, Texas; of comparatively recent origin but has done especially well in the western or semi-arid sections of the pecan belt. Its plantings are becoming more extensive in the West. Nut medium to large size, oval, thin-shelled; kernel plump and of excellent flavor. The tree is precocious and productive.

[1] See Chapter I.

Busseron.—From Knox County, Indiana; a nut adapted to the northern pecan territory. It is a rather old variety of the better grade of pecans but has not been disseminated in the South and probably will not be. It closely resembles some of the best northern varieties and is doubtless the parent of some of them.

Curtis.—From Alachua County, Florida. This is one of the most promising nuts of the Florida district, but not recommended north of that section. Used extensively in crackeries. Nut small, thin-shelled, easily cracked, pointed at ends, and attractive; kernel plump, very rich and sweet. Tree symmetrical and graceful, a slow grower and late coming into bearing, but thereafter very productive.

Delmas.—Originated in Jackson County, Mississippi; widely disseminated and among the most desirable of all nuts, except for its susceptibility to the scab for which reason it has been eliminated from plantings in many sections. It is a very desirable nut on the market. Nut very large, of a rich nutty-brown color, attractive, thin-shelled, and of good cracking quality; kernel plump, rich, and of a very pleasing flavor. Nuts mature late. Tree symmetrical, productive, prolific, but very susceptible to scab.

Frotscher.—From Iberia Parish, Louisiana, one of the oldest and best known of the modern varieties, widely disseminated, popular in southern Georgia, and parts of Louisiana. This variety is very sensitive to local conditions and is slow to be recommended; often it is reported as a shy bearer. It is losing favor in comparison with the best late varieties. Nut of large size, thin shell, showy and very attractive, among the best in cracking quality; kernel not attractive, fairly plump, often dark colored, flavor fair, quality fair. Tree a rapid grower, unsymmetrical, inclined to form forks which split badly, wood very brash, large limbs often breaking under strain of winds and fruit. Rather resistant to attacks of insects and diseases.

Greenriver.—A northern variety that originated in Henderson County, Kentucky. It is hardy and one of the most promising northern sorts. Its propagation began about 1915. Nut sub-medium in size, shell fairly thick; kernel plump, quality good, flavor rich; an excellent nut for domestic use.

Halbert.—From Coleman County, Texas, widely disseminated through the western part of the pecan belt. In habit of growth and character of parent tree, it is typical for western Texas, but

is not adapted to the more humid climates because of its tendency to scab. In ratio of kernel to hull, the Halbert ranks among the highest. Excellent for table cracking, though not suitable for commercial crackeries. Nut small-sized, very thin-shelled and plump; kernels very plump, of rich quality and excellent flavor. Tree very precocious and prolific, but severely attacked by scab when planted east of Texas. One of the very best varieties for west Texas.

Hollis.—One of the oldest of the Texas varieties, but neither widely disseminated nor well known, owing to the universal susceptibility of west Texas varieties to scab in the more humid climates. This variety is recommended only for central and western Texas planting, and for regions of similar climatic conditions. Nuts of medium to large size and attractive appearance, thick-shelled, plump-meated and of good quality.

Increase.—A southwest Georgia variety that is limited in the extent of planting, being confined almost to the immediate place of origin. Nut of medium size, fairly thick-shelled, tending toward spherical shape, promising.

Indiana.—From Knox County, Indiana, a strictly northern variety. It is considered hard to propagate, but is highly promising for planting in the northern belt. Nut of medium size, thin-shelled and of excellent cracking quality; kernel fairly plump, flavor sweet. The tree is symmetrical and a heavy bearer.

James.—From Madison Parish, Louisiana; not widely disseminated, but promising for planting in the northern range of the southern pecans. Nut medium sized, thin shell, of excellent cracking qualities, often poorly filled; kernel rich in quality and of sweet flavor. Tree very prolific, often over-productive; subject to severe attacks of scab in the lower sections of the southern belt.

Kincaid.—From San Saba County, Texas; well disseminated in central and western Texas; especially recommended for western Texas, and one of the standard varieties for that section. Because of its susceptibility to scab, it is to be avoided in all sections east of middle Texas. Nut large in size, attractive in appearance, with fairly thin shell, and of fair cracking qualities; kernel plump, of very good quality, flavor sweet, tree a thrifty grower, symmetrical, very prolific; highly susceptible to scab in eastern Texas and the Gulf states.

Major.—From Henderson County, Kentucky; not broadly disseminated; especially promising for planting in the middle pecan

belt. Nut below medium in size, shell thin; kernel unusually plump, quality good, flavor excellent.

Mantura.—From Surry County, Virginia; considered promising for the middle pecan belt; not highly recommended anywhere. Nut above medium size, thin-shelled, cylindrical and pointed at apex, but blunt at base; kernel not always plump at tip, often shrunken, quality and flavor good. Tree moderately vigorous, fairly prolific, comparatively free from disease and insect pests.

Mobile.—From Mobile County, Alabama; well disseminated, especially in southwest Georgia. The variety is generally objectionable after the second or third crop on account of the great percentage of defective kernels. Though it is profitable locally, extensive plantings are not recommended. Nut above medium size, typical color, irregular in outline, not smooth, largest near apex, tapering toward base, suddenly forming a blunt point, the apex is distinctly pointed but flat, not attractive, fairly thin-shelled, of good cracking qualities; kernels on young trees usually plump, but on old trees invariably poorly developed. Tree upright, compact, slender, a rapid grower and inclined to be unsymmetrical, a very early and prolific bearer. Tree breaks easily under a heavy load of fruit.

Moneymaker.—From Madison Parish, Louisiana; widely disseminated, and especially adapted to the northern range of the area suitable for southern varieties. It is a leader in range of adaptability, productiveness, and early maturity of nuts. Nuts of medium size, spherical at base, slightly elongated and smaller toward the apex, making an egg shape except for two slight depressions on opposite sides of the apex; fairly attractive in appearance, somewhat thick-shelled, though cracks easily; kernel fairly plump, quality medium, of pleasant flavor. Tree open and spreading, a thrifty grower, symmetrical, precocious and prolific.

Moore (synonyms: Long Moore, Moore No. 1, Moore No. 2).—Originated in Jefferson County, Florida, and well suited to northern Florida; disseminated in many sections and usually favorably considered. It is very desirable on account of its early bearing habit and its prolificacy. Nut below medium in size, long, cylindrical, smooth, symmetrical, with blunt point at base and four-cornered blunt point at apex, shell of average thickness, of fair cracking qualities; kernel plump, with pleasing quality. Tree moderately hardy, unusually productive, and one of the earliest to mature the nuts.

Niblack.—From Knox County, Indiana, in 1913; an exclusively northern variety which has much promise, though not widely disseminated as yet. Nut below medium size, shell moderately thick, cracking qualities excellent; kernel plump, somewhat dry, quality good, flavor very pleasant. Tree hardy, very productive.

Oliver.—A western variety from Junction, Kimble County, Texas; considered to be of special promise for central and western Texas plantings. Nut large, uniform, thick-shelled, and usually plump-meated.

Pabst.—A very old variety from Jackson County, Mississippi, that still holds a prime place among southern growers. It is widely disseminated, well known, much favored, and extensively recommended. It was slow in gaining popularity because of its lateness in coming into bearing; however, its uniformity in performance and its prolificacy when given a fair chance, together with its resistance to disease and insects, render it highly profitable. Nut large, oblong, oval at each end, apical and slightly smaller, with two depressions on opposite sides, attractive in appearance, shell of medium thickness, cracking readily; kernel plump, of high quality and pleasing flavor. Tree open, spreading, stout, vigorous, strong grower, and comes into bearing late.

Posey.—From Gibson County, Indiana, in recent years. It is probably the easiest to crack of all the northern varieties, and is promising for commercial plantings. Nut medium in size, shell thin, cracking qualities excellent; kernel plump, quality rich and pleasant in flavor.

President.—Originated in Duval County, Florida; well disseminated in northern Florida; productive in local sections of Florida, but a shy bearer in central and northern Georgia. It cannot be recommended for extensive plantings. Nut medium in size, obovate, with point at either end, symmetrical, shell of medium thickness, attractive; kernel plump, rich and of good flavor. Tree fairly thrifty, moderately hardy, but a shy bearer.

San Saba.—A west Texas variety from San Saba County; it is especially adapted to western Texas; an excellent nut for the table, but not desirable for commercial crackeries, being too small and too plump to crack successfully with machinery. Nut small in size, oblong, smooth, very plump, rounded at the basal end, and blunt pointed at the apex, shell unusually thin; kernel very plump,

and exceedingly rich. Tree close, dense-headed, somewhat upright in habit, a moderate grower but very prolific.

Schley.—Introduced from Jackson County, Mississippi; it has become one of the most widely disseminated and best known of all pecans. It is one of the most popular varieties and is the standard of excellence. It is one of the richest in oil-content, one-half nut containing sufficient oil to support a flame for eleven minutes when lighted on one end. Nut above medium size, oblong, obovate, irregular in outline, two broad depressions on opposite sides near the base, which is blunt pointed, the apex sharp-pointed and flat, shell very thin, brittle sometimes cracking while on the tree, kernels plump, very firm, unusually rich, of fine texture and excellent flavor. Tree upright, round-topped, regular, moderately prolific, vigorous, fairly early bearer, often variable in size and bearing qualities, subject to scab in southern sections.

Sovereign (synonym: Texas Prolific).—A variety from western Texas; originated in San Saba County, seedling of the San Saba. It is well known and highly favored in west Texas, where it is a standard. It is not adapted to the eastern sections. Nut large, long, enlarged towards apex, sharp apex, bright colored, attractive in appearance, thin-shelled, cracking qualities poor; kernel plump, rich, and medium in flavor. Tree slow grower, but very precocious and prolific.

Stuart.—Another very popular sort from Jackson County, Mississippi. It is more extensively planted than any other variety, and has succeeded in nearly all the southern belt. Nut above medium size, oblong, slightly obovate, symmetrical, very plump and attractive, well filled, shell rather thick, cracking quality poor; kernel medium plump, usually breaking into crumbs while being taken from the shell, quality medium and flavor pleasant. Tree upright, close-headed and tending to slender, moderately vigorous, comes into bearing rather late, prolific. Stuart will always produce some kind of a crop of nuts. It is markedly resistant to disease, though attacked by insects.

Success.—A nut from Jackson County, Mississippi, of more recent introduction than the Stuart. It is widely known and recommended in most pecan sections of the South, doing especially well when grown on a fertile soil. Nut large, ovate, spherical toward base, but extending to a blunt flat point at apex, very plump, shell moderately

thin, attractive, plump-meated; kernel clean, bright-colored, smooth, rich, and of very pleasant flavor. Tree vigorous, symmetrical, and early bearer, usually prolific. It is sensitive to poor soil.

Teche.—Introduced with the Frotscher variety, supposedly from Iberia Parish, Louisiana. Regarded as inferior to Frotscher because of its inferior kernel characters and frequent defective or black kernels. It is little better than many seedlings of Louisiana. The variety is widely disseminated.

VanDeman.—From St. James Parish, Louisiana; a widely dis seminated variety, and one of the oldest and best known. This variety requires very favorable conditions or it will succumb to the scab; otherwise, it is broadly and extensively recommended. Nut of large size, long, obovate, blunt point at base and acute at apex, smooth and symmetrical, shell of medium thickness, attractive, moderate cracking qualities; kernel bright colored, of high quality and excellent flavor. Tree symmetrical, handsome, sporatic bearer; comes into fruit tardily.

Venus.—Resulted from a cross between San Saba and Atwater at San Saba, Texas. Little known outside of place of origin.

Warrick.—From Warrick County, Indiana; a fairly promising variety for the northern part of the middle belt; not widely known. It is not recommended for southern planting. Nut below medium, shell moderately thin; kernel usually plump, quality rich, flavor excellent. Tree hardy and prolific.

Waukeenah (synonyms: Round Moore, No. 1, Moore No. 2).—Originated in Jefferson County, Florida. Adapted to central and northern Florida, and generally well known in those sections. Nut of small size, shell of average thickness, kernel commonly shrunken, quality below medium, flavor fair. Tree very prolific, and one of the earliest to mature the nuts.

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