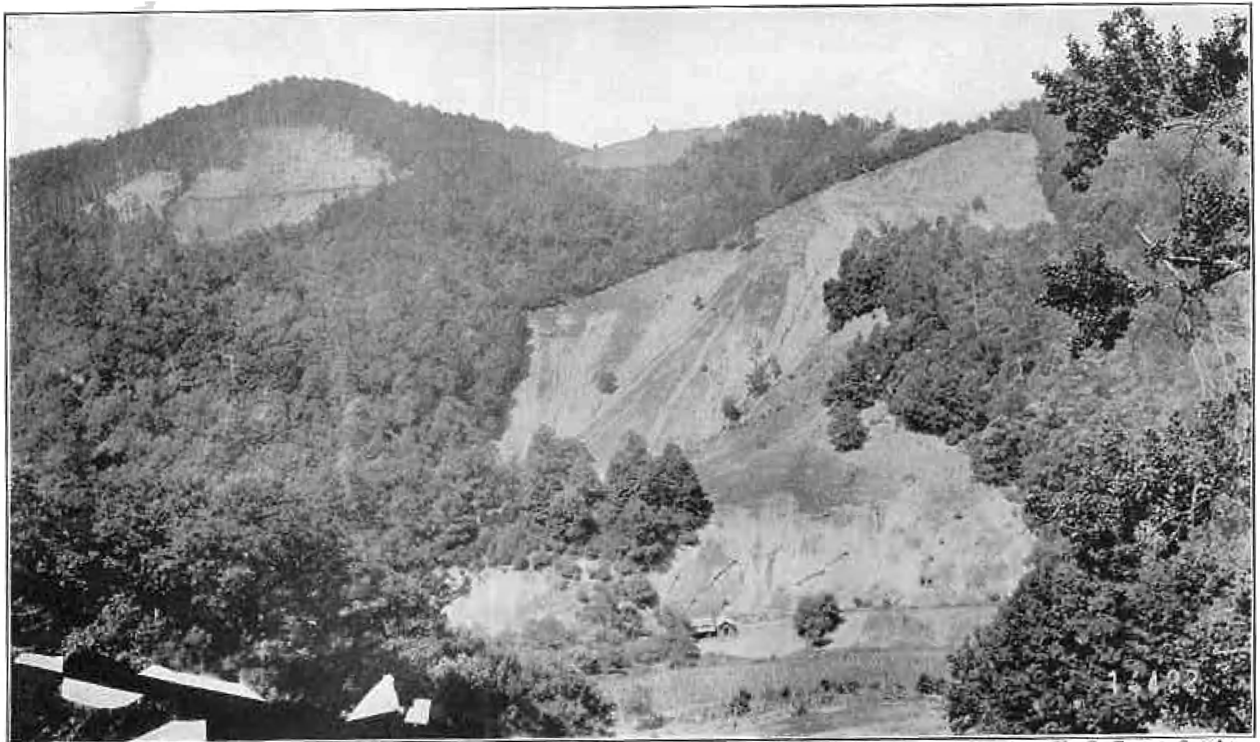
Tree Crops

A Permanent Agriculture

by J. Russell Smith

WALDEN LABS



Courtesy U. S. Forest Service

FIG. 1. Ruined in its beautiful youth. The Appalachian slope above the cabin has been reduced to desert while the logs of the original trees still sprawl, wasted, across its wasting gullies. The gullies also carry ruin to the meadows and navigation below. More deadened trees stand in the new clearing at far left. Will we complete this suicide?

TREE CROPS

A PERMANENT AGRICULTURE

BY

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This Book Is Dedicated to

CHARLES C. HARRISON
EDGAR F. SMITH
JOSIAH H. PENNIMAN

THREE PROVOSTS OF THE UNIVERSITY OF PENNSYLVANIA WHOSE SYMPATHETIC UNDERSTANDING AND PRACTICAL AID WERE OF GREAT ASSISTANCE IN THE PROSECUTION OF THE RESEARCHES WHICH RESULTED IN THIS BOOK

ACKNOWLEDGMENTS

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Professor Howard H. Martin of the University of Cincinnati spent many weeks searching for material.

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I remember with pleasure the warm and helpful interest in this, my avocation, that has been shown by my departmental colleagues, John E. Orchard, Louis A. Wolfanger, and George T. Renner.

J. RUSSELL SMITH.

Columbia University, New York City,
June 1, 1928.

PREFACE

HOW TO READ THIS BOOK

This book can be read in four ways—depending on your hurry or your interest.

First, look at the pictures and the legends and you have the essence of it.

Second, read the first three short chapters and you have the idea. This might be followed by the last two chapters to get a similar general statement of the applications.

Third, read the large print and you have the argument as an economist might want it.

Fourth, read the fine print and you have more details—of proof or of application—as a tree lover or a farmer or an agricultural scientist might want them.

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PART ONE: THE PHILOSOPHY

PART TWO: SOME FACTS ABOUT SOME CROP TREES

PART ONE

THE PHILOSOPHY

CHAPTER I

THE PROBLEM

I stood on the Great Wall of China near the borders of Mongolia. Below me in the valley, standing up square and high, was a wall that had once surrounded a city. Of the city only a few mud houses remained, scarcely enough to lead one's mind back to the time when people and household industry teemed within the protecting wall.

The slope below the Great Wall was cut with gullies, some of which were fifty feet deep. As far as the eye could see were gullies, gullies, gullies—a gashed and gutted countryside. The little stream that once ran past the city was now a wide waste of coarse sand and gravel which the hillside gullies were bringing down faster than the little stream had been able to carry them away. Hence, the whole valley, once good farm land, had become a desert of sand and gravel, alternately wet and dry, always fruitless. It was even more worthless than the hills.

Beside me was a tree, one lone tree. That tree was locally famous because it was the only tree anywhere in that vicinity; yet its presence proved that once there had been a forest over most of that land—now treeless and waste.

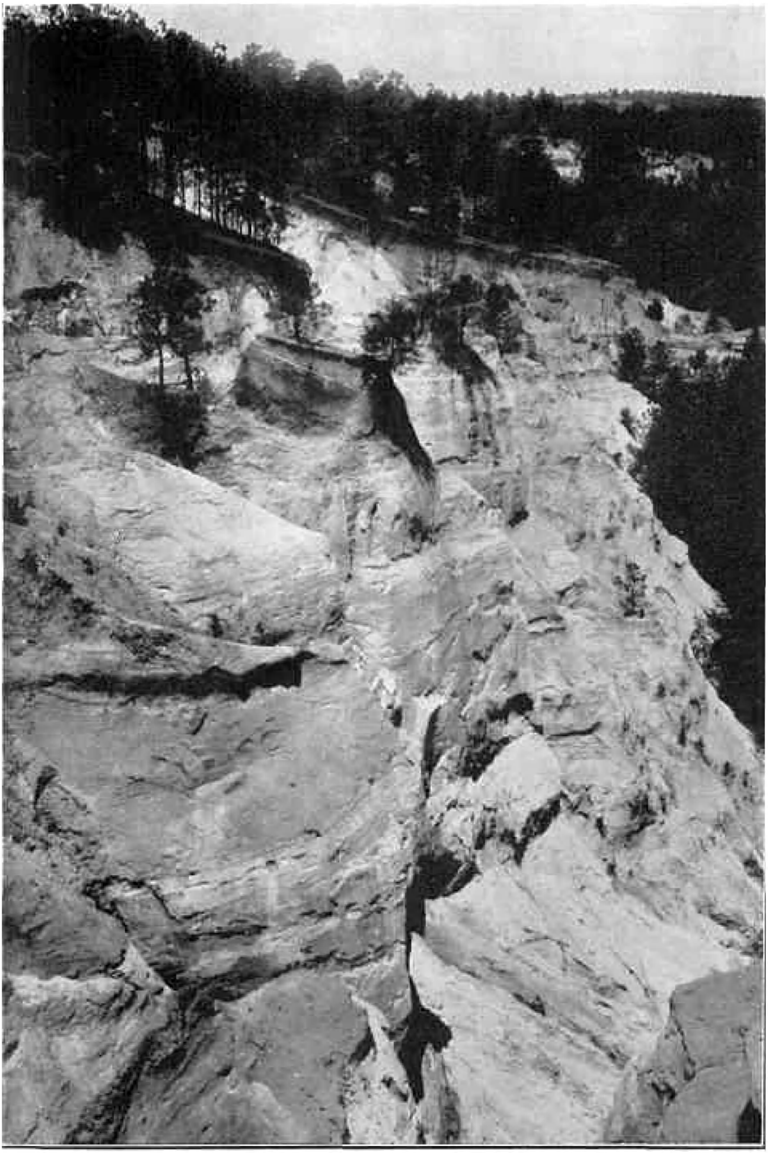
The farmers of a past generation had cleared the forest. They had plowed the sloping land and dotted it with hamlets. Many workers had been busy with flocks and teams, going to and fro among the shocks of grain. Each village was marked by columns of smoke rising from the fires that cooked the simple fare of these sons of Genghis Khan. Year by year the rain has washed away the loosened soil. Now the plow comes not, only the shepherd is here with his sheep and goats—nibbiers of last vestiges. The hamlets are shriveled or gone: Only gullies remain—a wide and sickening expanse of gullies, more sickening to look upon than the ruins of fire.

Forest—field—plow—desert—that is the cycle of the hills under most plow agricultures—a cycle not limited to China. China has a deadly expanse of it, but so have Syria, Greece, Italy, Guatemala, and the United States. Indeed we Americans, though new upon our land, are destroying soil by field wash faster than any people that ever lived—ancient or modern, savage, civilized, or barbarian. We have the machines to help us to destroy as well as to create.

We also have other factors of destruction, new to the white race and very potent. We have *tilled* crops—corn, cotton, and tobacco. Europe did not have these crops. The European grains, wheat, barley, rye, and oats, cover all of the ground and hold the soil with their roots. When a man plows corn, cotton, or tobacco, he is loosening the earth and destroying such hold as the plant roots may have won in it. Plowing corn is the most efficient known way for destroying the farm that is not made of level land.

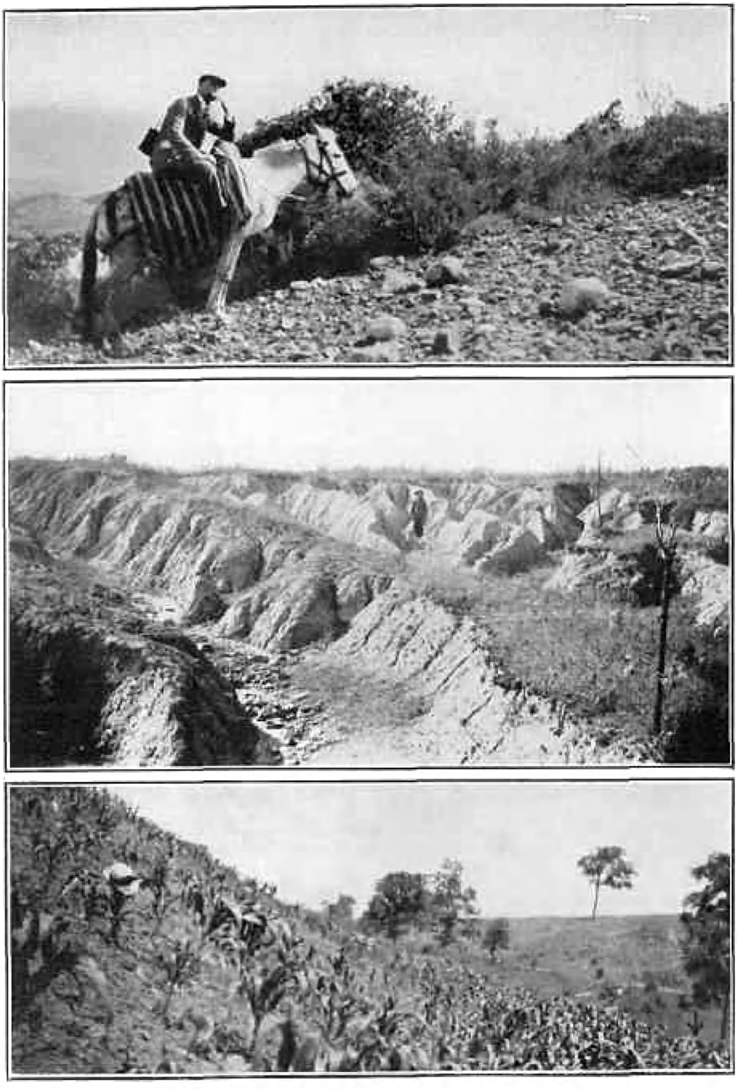
We in America have another factor of destruction that is almost new to the white race—the thunder storm. South Europe has a rainless summer. North Europe has a light rainfall that comes in gentle showers. The United States has the rippling torrent that follows the downpour of the thunder storm. When the American heavens open and pour two inches of rain in an hour into a hilly corn field, there may result as much erosion as results from two hundred inches of gentle British or German rain falling on the wheat and grass.

I asked county agents in a number of counties in the hill country of North Carolina the following question: "What is your estimate of number of cultivated crops secured on steep land after clearing and before abandonment of cultivation?" The answers from ten counties were as follows: "5; 20; 12; 10; 5 to 10; 10 or 12; 10 or more; 12; 5, extremely



Courtesy U. S. Dept. Agr.

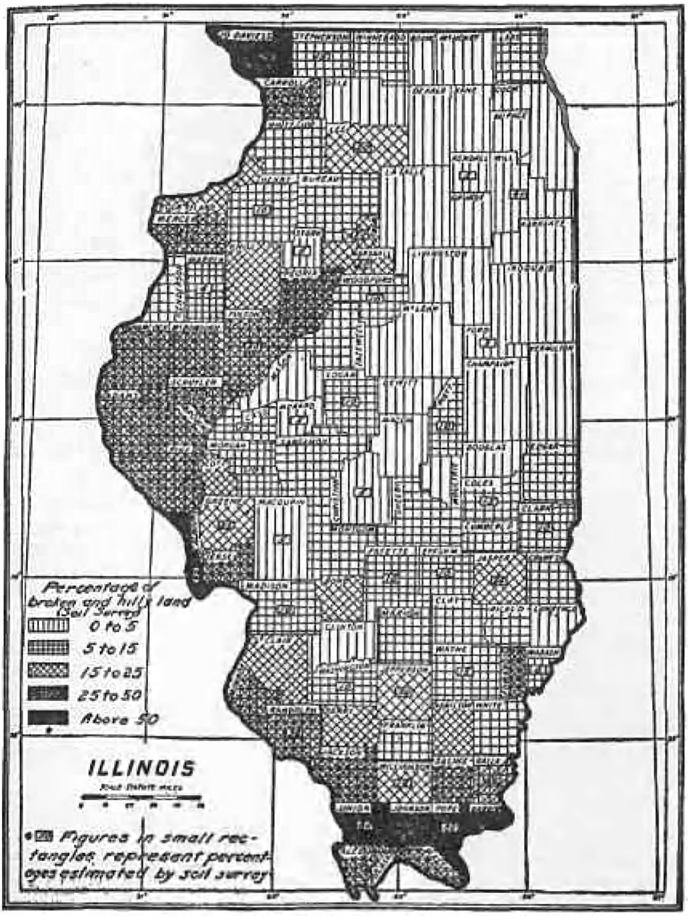
FIG. 2. How the Cotton Belt goes to economic Hades. This is not the Alps. It is Georgia, U.S.A. It was good crop land and forest land a few decades ago. It has been a field. It might have yielded crops for ages. Major Andrė, famous traitor in war, was not going to destroy any land; he would merely have changed the law-makers from one group to another.



"IS THIS A PERMANENT COUNTRY?"

FIG. 3. *Top.* No gully, but plucking raindrops have carried away many feet of top soil in this Algerian wheat land. (Photo J. Russell Smith.)—FIG. 4. *Center.* The most familiar type of erosion. Note the man and note the place—Illinois, the temporarily rich, the supposedly level. (From Univ. of Ill. Circular No. 290.)—FIG. 5. *Bottom.* A six-foot man stands in the corn beneath the arrow. The worthless stalks by the hat measure the ruin of the hill—typical of forty-five American states. (Photo J. Russell Smith.)

variable; and 10." (Fig. 1.) Ten tilled crops, and ruin has arrived!

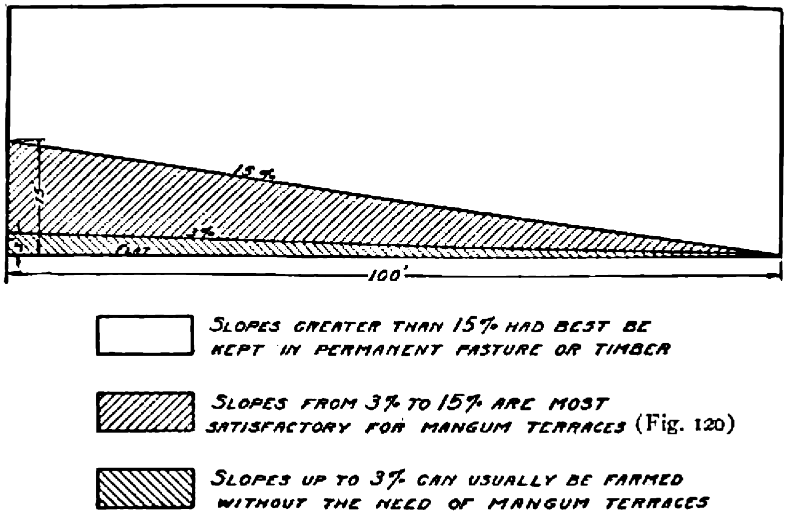


From University of Illinois Circular No. 290

We usually think of Illinois as level land, not subject to destruction by erosion; yet this Illinois bulletin states and shows by this map that "about 5½ millions of acres of land are subject to serious erosion." This is about 9000 square miles, an area larger than Massachusetts.

Even Oklahoma, newest of the new, so recently wrested from the Indian, who did not destroy it, has its million miles

of gullies and a kingdom of good land ruined and abandoned.[1]
Field wash, especially in America, is the greatest of all



From University of Illinois Circular No. 290

PROFILE OF SOIL AND RECOMMENDATIONS FOR ITS MANAGEMENT

University of Illinois bulletin states that "mangum terrace is best adapted to types of soil slope where sheet washing carries away vast amounts of soil fertility each season."

I challenge the Illinois statement that slopes up to 3 per cent, are safe for (from) farming. I do not believe it is proved, and I do not believe it is true in Illinois. See "Is America a Permanent Country like Europe?" by Arthur H. Mason of Homewood, Illinois.

[1] "Five years ago there was not a gully on the place . . . now it is badly cut by gullies . . . all the top soil washed away, leaving nothing but the clay. . . . If not terraced . . . the gullies [will] cut deeper until the rocks are touched or until all the clay soil is gone. . . . Five years ago it could have been saved by spending less than three dollars an acre to have it terraced. To-day it will cost five times as much in addition to getting nothing from it for at least two years."—*Oklahoma Extension News,* January, 1928.

For decades reports of ruin have come out of the hill section of the American cotton belt—thousands of square miles of ruin. Some counties were reported one-third worn out before 1850. Worst of all is the plight of the loess lands east of the Mississippi. This layer of rich, wind-blown soil, half as wide as the State of Mississippi, reaching nearly all the way

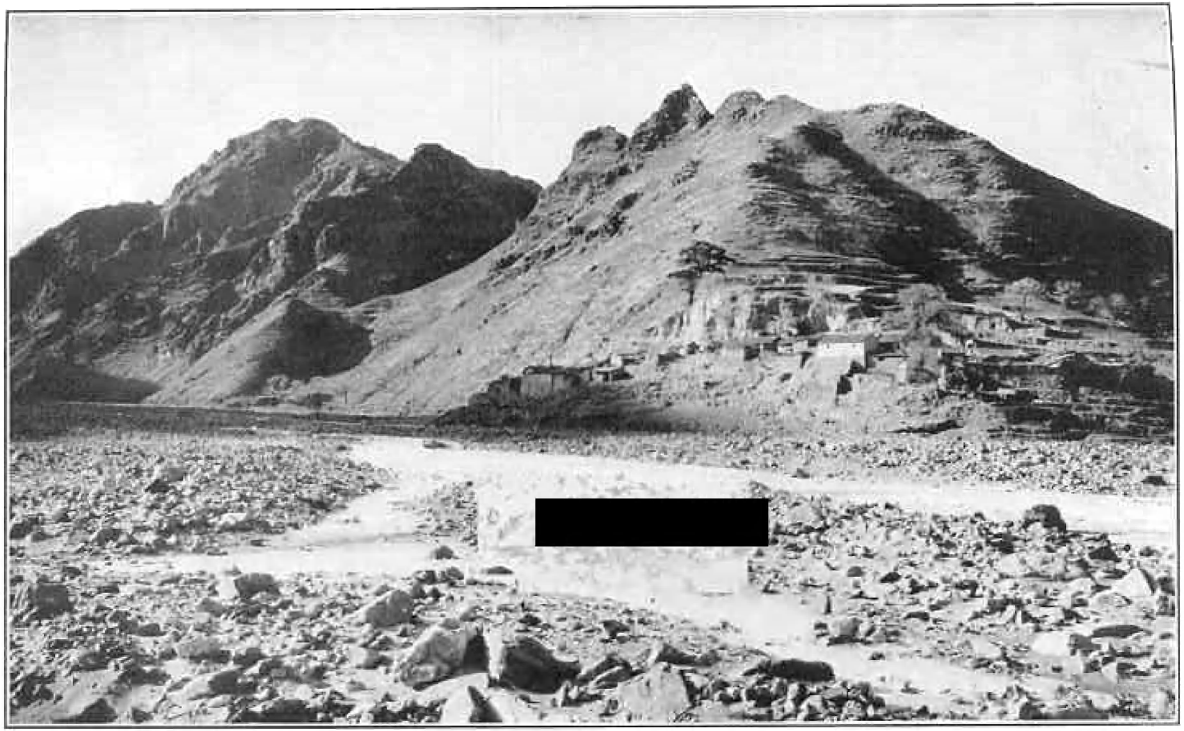


Fig. 6. Double ruin, and quick. This Chinese valley is completely ruined by the wash from the hill, which farmers after the Atlantic seaboard of the United Stating statement that this locality was settled by Chinese was also ruined. Dr. Wallis makes the further appalles. The valley was then good land for farms.

Oriental Penance. FIG. 7. *Top.* With great labor Japan reclaims her mountains denuded by past carelessness. Little trees planted by hand on terraces built by hand labor finally renew the forest and hold her mountain side. (Photo Shitaro Kawai. Courtesy U. S. Forest Service.)—FIG. 8. *Bottom.* By hand labor the Chinese near Nanking carry from a lake bottom back to the mountain side a small fraction of that which need never have left it. (Photo by Prof. Joseph Bailie. Courtesy U. S. Forest Service.)

resource wastes.[2] It removes the basis of civilization and of life itself. It is far worse than burning a city. A burned city can be rebuilt. A field that is washed away is gone for ages. Hence the Old World saying, "After man the desert."

Can anything be done about it? Yes, something can be done. Therefore, this book is written to persons of imagination who love trees and love their country, and to those who are interested in the problem of saving natural resources—the basis for civilization.

from the Ohio to the Gulf, is a kind of thin veneer lying on top of coastal plain sands. It is extremely rich and erodes very easily.

E. W. Hilgard, the great pioneer writer on soils *(Soils,* p. 218), says:

"The washing away of the surface soil . . . diminished the production of the higher lands, which were then (at the time of the Civil War) commonly 'turned out' and left without cultivation or care of any kind. The crusted surface shed the rain water into the old furrows, and the latter were quickly deepened and widened into gullies—'red washes.' . . .

"As the evil progressed, large areas of uplands were denuded completely of their loam or culture stratum, leaving nothing but bare, arid sand, wholly useless for cultivation; while the valleys were little better, the native vegetation having been destroyed and only hardy weeds finding nourishment on the sandy surface.

"In this manner whole sections, and in some portions of the state (Mississippi) whole townships of the best class of uplands, have been transformed into sandy wastes, hardly reclaimable by ordinary means, and wholly changing the industrial conditions of entire counties, whose county-seats even in some instances had to be changed, the old town and site having, by the same destructive agencies, literally 'gone downhill.'

"Specific names have been given to the erosional features of this district; a 'break' is the head of a small retrogressive ravine; a 'gulf is a large break with precipitous walls of great depth and breadth, commonly being one hundred or one hundred and fifty deep; a 'gut' is merely a road-cut deepened by storm-wash and the effects of passing travel."

In this way we have already destroyed the homelands fit for the sustenance of millions. We need an enlarged definition for treason. Some people should not be allowed to sing "My Country." They are destroying it too rapidly.

[2] For references on soil erosion in America, see pages 296-301.

CHAPTER II

THE IDEA

Again I stood on a crest and scanned a hilly landscape. This time I was in Corsica. Across the valley I saw a mountainside clothed in chestnut trees. The trees reached up the mountain to the place where coolness stopped their growth; they extended down the mountain to the place where it was too dry for trees.[1] This chestnut orchard (or forest as one may call it) spread along the mountainside as far as the eye could see. The expanse of broad-topped, fruitful trees was interspersed with a string of villages of stone houses. The villages were connected by a good road that wound horizontally in and out along the projections and coves of the mountainside. These grafted chestnut orchards produced an annual crop of food for men, horses, cows, pigs, sheep, and goats, and a by-crop of wood. Thus for centuries trees had supported the families that lived in the Corsican villages. The mountainside was uneroded, intact, and capable of continuing indefinitely its support for the generations of men.

Why are the hills of West China ruined, while the hills of Corsica are, by comparison, an enduring Eden? The answer is plain. Northern China knows only the soil-destroying agriculture of the plowed hillside. Corsica on the contrary has adapted agriculture to physical conditions; she practices the soil-saving tree-crops type of agriculture.

Man lives by plants. Plants live in the soil. The soil is a kind of factory in which the life-force of plants, using plant food and assisted by bacteria and the elements of the weather,

[1] In the Mediterranean lands, as in most other parts of the world, there js more rainfall upon the mountains than at sea level.

FIG. 9. *Top*. Zone of Corsican chestnut orchards (or forests) and the villages they support. Note village in left distance.—FIG 10 *Center*. Characteristic road and slope in Fig. 9. All trees are chestnuts and all are grafted.—FIG. 11. *Bottom*. Spanish Mediterranean island of Majorca. Limestone with fissures and pockets of earth in it The man stands by grafted wild olive. At left, grafted carob. At right acorn-yielding ilex. (Photos J. Russell Smith.)

Photos J. Russell Smith

FIG. 12. *Top.* Olive and fig trees on the hills of Kabylia, foothills of the Atlas Mountains, Algeria. Population twenty-five times as dense as on the same hills where there are no tree crops.—FIG. 13. *Center.* The pasture year on the two-story Majorca farm. Producing figs, wheat, beans, and clover.—FIG. 14. *Bottom.* Olive trees in Central Tunis planted (without doubt) by the Romans before A.D. 648 and still bearing—a long-lived property.

changes earth elements into forms that we can eat and wear, manufacture and burn, or use for building material. This precious soil from which we have our physical being is only a very thin skin upon the earth. Upon the hills and mountains it is appallingly thin. In some places there is no soil at all, and rocks protrude. Sometimes the earth mantle may be only a few inches in depth; rarely does the soil on hill or mountain attain a depth of many feet. Often soil is so shallow that one great rain storm can gash and gully a slope down to bare rock. Where man has removed nature's protecting cover of plants and plant roots, the destroying power of rain is increased a hundredfold, a thousandfold, even at times a millionfold, or perhaps even more than that.

The creation of soil by the weathering of rock is a very, very slow process. Years may have passed in making soil that, if unprotected, may be washed away in an hour. Therefore, today an observer in the Old World might see myriad landscapes once rich with farms where now only poverty-stricken men creep about over the ruined land, while their sheep and goats, scavengers and destroyers, pick the scanty browse that struggles for life in the waste. A handful of men are now living uncomfortably where once there were prosperous villages. Similar examples, even of large areas, can be found in almost any hill country with a long history of occupation by agricultural man.

Syria is an even more deplorable example than China. Back of Antioch, in a land that was once as populous as rural Illinois, there are now only ruin and desolation. The once prosperous Roman farms now consist of wide stretches of bare rock,[2] whence every vestige of soil has been removed by rain.

[2] Geikie, in modern times writing of a section of Palestine, gives a similar example:

"The ride from Eriha to the Jordan is about five miles over a stony plain, on which there is no vegetation. Year by year the winter rains sweep down the slope and wash away a layer of the wide surface, carrying it to the Jordan, there being little to check them but copses of the Zukkum

Greece, once so great, is shockingly ruined by soil wash. In parts of Europe people even pound stone to get a little bit of loose material in which plant roots can work.[8]

In our own South millions of acres are already ruined,[4] and the same destructive agency has caused ruin and abandonment of land in Ohio, Illinois, Indiana—indeed, in every one of our states. The total of this destruction has been estimated at 16,600 square miles, equal to the cultivated area of England.[5] And yet, as human history goes, we came to America only yesterday.

If we think of ourselves as a race, a nation, a people that is to occupy its country generation after generation, we must change some of our habits or we shall inevitably experience the steadily diminishing possibility of support for man.

FLAT LAND AGRICULTURE GOES TO THE HILLS

How does it happen that the hill lands have been so frightfully destroyed by agriculture? The answer is simple. Man has carried to the hills the agriculture of the flat plain. In hilly places man has planted crops that need the plow; and when a

tree and Apina Christi. Yet seven monasteries once stood on this now desolate tract, three of them still to be identified by their ruins. Until we reach the edge of the Jordan, only the stunted bushes I have mentioned, unworthy of the name of trees, and a few shrubs with dwarfed leaves are to be seen after leaving the moisture of Sultan's Spring. Not a blade of grass softens the dull yellow prospect around." Quoted from *Gila River Flood Control,* p. 18, Secretary of the Interior, 1919.

[3] Von Schierbrand, Wolf, *Austria Hungary,* Chap. XIV.

[4] "Land too poor for crops or grazing, such as old abandoned fields, of which Brazos County (Texas) alone has thousands of acres." H. Ness, Botanist, Texas Experimental Station, *Journal of Heredity,* 1927.

"In many sections of Iowa, Missouri, Nebraska, and other corn belt states water erosion has a tendency to form deep, steep-sided ravines which will sometimes make farming almost impossible in a field as large as twenty or forty acres." Letter, Ivan D. Wood, State Extension Agent, Agricultural Engineering, University of Nebraska, July 19, 1923.

[5] National Conservation Congress. See also "Soil Erosion: A National Menace," H. H. Bennett, U. S. Dept. Agr. Circular, No. 33, 1928. This is a document of great value.

plow does its work at an angle instead of on flat lands, we may look for trouble when rain falls.

Whence came this flat land agriculture of grass and grains? The origin of wheat, barley, and many of our important food plants is shrouded in mystery; but we know that our present agriculture is based primarily on cereals that came to us from the unknown past and are a legacy from our ancient ancestress —primitive woman, the world's first agriculturist. Searching for something to fill little stomachs and to hush the hunger cries of her children, primitive woman gleaned the glades about the mouth of her cave. Here she gathered acorns, nuts, beans, berries, roots, and seeds.

Then came the brilliant idea of saving seed and planting it that she might get a better and more dependable food supply. Primitive woman needed a crop in a hurry, and naturally enough she planted the seeds of annuals. Therefore, we of today, tied to this ancient apron string, eat bread from the cereals, all of which are annuals and members of the grass family.

As plants the cereals are weaklings. They must be coddled and weeded. For their reception the ground must be plowed and harrowed, and sometimes it must be cultivated after the crop is planted. This must be done for every harvest. When we produce these crops upon hilly land, the necessary breaking up of the soil prepares the land for ruin—first the plow, then rain, then erosion. Finally the desert.

CAN WE GET ECONOMICS INTO BOTANY?

Must we continue to depend primarily upon the type of agriculture handed to us by primitive woman? It is true that we have improved the old type. Many of the present day grains, grasses, and cereals would scarcely be recognized as belonging to the families that produced them. Present day methods of cultivation but dimly recall the sharpened stick in the hand of primitive woman. But we still depend chiefly on her crops.

We are now entering an age of science. At least we are scientific in a few respects. It is time that we made a scientific survey of the plant kingdom—still the source, as always, of a very large proportion of that which is necessary to the existence and comfort of man. We should carefully scrutinize types of agriculture in relation to environment. Agricultural America should scientifically test the plant kingdom in relation to potential human use and do it as carefully and patiently as industrial America has tested cement. We test cement in every possible way, make it of all possible materials, mix all possible combinations, test it by twisting it, pressing it, pulling it; test it thousands of times, hundreds of thousands of times, millions of times, and in a few years our whole physical equipment is made over by reënforced cement made possible by these millions of tests.

THE TREE AN ENGINE OF NATURE—PUT IT TO WORK

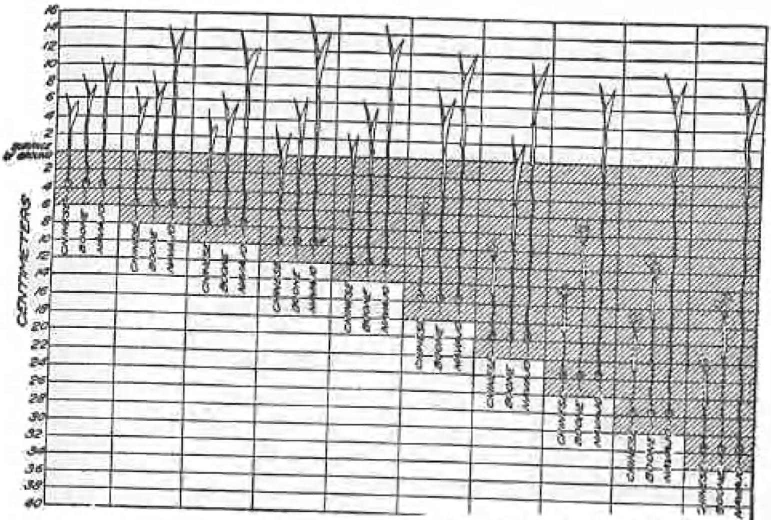
Testing applied to the plant kingdom would show that the natural engines of food production for hill lands are not wheat and other grasses, but trees. A single oak tree yields acorns (good carbohydrate food) often by the hundred weight, sometimes by the ton. Some hickory and pecan trees give us nuts by the barrel; the walnut tree yields by the ten bushels. There are bean trees producing good food for cattle, which food would probably make more meat or milk per acre than our present forage crops now make.[6]

These wonders of automatic production are the chance wild trees of nature.[7] They are to be likened to the first wild animal

[6] It is even now probable that the king of all forage crops is a Hawaiian bean tree, the keawe. (Chapter V.)

[7] I wish to suggest a little explored line of experimentation, namely girdling, ringing, or otherwise injuring the tree in such a way that it will recover the injury but will, because of it, yield a larger quantity of fruit. This is a regular practice of the Greek growers of a grape that enters

that man domesticated and to the first wild grass whose seed was planted. What might not happen if every wild crop-bearing tree was improved to its maximum efficiency? Burbank and others have given us an inkling of what may result from well-planned selection, crossing, or hybridizing.



From Journal of Agricultural Research

An example of variation through artificial selection within the species. Diagram shows an average size of seedlings of Chinese, Boone County, and Navajo maize planted at different depths. The Navajos, living in a dry country, have selected a strain of corn capable of sprouting from a very great depth and thus having better moisture opportunities. This picture shows how the other corns failed to push out through the sand.

The possibilities, at present quite incalculable, that lie in such work are hinted in one almost unbelievable statement of the great authority, Sargent, who says of the English walnut, which we all know is so good and meaty:

"The nut of the wild tree is small, with a thick hard shell and small kernel, and is scarcely edible; but centuries of cul-

the world market tinder the name of currant. It appears that the quantity of fruit a tree bears is in part a matter of habit. I have no idea that most trees bear all the fruit they are physiologically capable of producing. Careful experimentation along this line might be very productive.

tivation and. careful selection have produced a number of forms with variously shaped thin shells, which are propagated by grafting and budding." *(Silva,* Vol. VII, p. 115.)

We now know how to breed plants. In the short space of a few years we can surpass the results of centuries of chance breeding. The plant kingdom has become almost as clay in the hands of the potter. Where we now have one good crop plant, we may some day have five or ten. We need to start in earnest to apply some of our science to producing genius trees—trees that are to other trees as human geniuses are to other men.

Genius trees produced either by chance or design can be propagated a million or ten million times as was done with the one chance navel orange tree.

THE TREE A BETTER CROP PLANT

We need a new profession, that of the botanical engineer, which will utilize the vital forces[8] of plants to create new mechanisms (crop yielding trees) as electrical and mechanical

[8] This creation of new types by plant breeding depends upon three facts —first, the variation of different offspring from the same parents; second, the varying combinations in offspring of the qualities of the parents; and third, the appearance in offspring, especially hybrid offspring, of qualities possessed by neither parent.

First, variation of offspring. Look at the children of almost any family you know. *This tendency to variation runs deep into both animal and plant life*. For example, Texas Agricultural Experiment Station, Bulletin 349, "Variation in certain lint characters in a cotton plant and its progeny" shows that the average length of lint in the individual plants of the progeny of a certain boll (seed pod) varied from 19 millimeters to 28.5 millimeters, a variation of 50 per cent. This is very suggestive of the way by which through a selection of parents we have changed the cow so marvelously for milk production. The object of selection here is to find desirable strains that produce uniform progenies. Page 15 shows that tree breeding has a more easily attainable objective—namely, *one* good specimen.

Second, varying combinations in offspring of qualities of parents. A hybridization of hazels and filberts (Fig. 20) produced plants ranging from 12 inches to 12 feet in height—suggestive of variations in great degree for each quality a plant can have.

Third, the appearance in hybrid offspring of qualities possessed by neither parent. Some of the above-mentioned hazel x filbert hybrids bore engineers use the forces of electricity and the elements of mechanics to create new mechanisms for the service of mankind.

For breeding experiments the tree has one *great advantage* over most of the annuals. We propagate trees by twig or bud, by grafting or budding. Therefore, any wild unstable (though useful) freak, any helpless malformation like the navel orange which cannot reproduce itself, can be made into a million trees by the nurseryman. With corn, oats, or alfalfa the breeder must produce a type true to seed before the farmer can use it.

Not only is the tree the great engine of production, but its present triumphant agricultural rivals, the grains, are really weaklings.

All plants require heat, light, moisture, and fertility. Give these things and the tree raises its head triumphantly and grows. But in addition to these requirements the weakling grains must have the plow. A given area may have rich soil and good climatic conditions, but be unsuitable for grain if the land happens to be rocky. Nor are steep lands good farm lands for grains. Trees are the natural crop plants for all such places.

Moreover the grains are *annual* plants. They must build

larger fruit than either parent. It is common for occasional plant hybrids to exceed either parent in speed of growth, size, earliness of fruiting.

Further experiments with cotton breeding show the dynamic and creative tendency of hybrids.

"Not only was there all manner of recombination of the characters of the parent types but many of these characters were expressed in an exaggerated form. Moreover, numerous characters not observed in either parent appeared in the second generation, some of these having been decidedly abnormal. Many individuals were so strikingly different from either upland or Egyptian cotton that a botanist unaware of their hybrid origin would take them to represent new species."

"A remarkable character was the bluish white color of the practically glabrous foliage. There was no suggestion of this color in either parent and it does not occur in any cultivated cotton known to the writer."

(Extracts from "A Hybrid between Different Species of Cotton," by Thomas H. Kearney, U. S. Department of Agriculture, published in the *Journal of Heredity,* July, 1924.)

themselves anew for each harvest. They may, therefore, become victims of the climatic peculiarities of a certain short season. It is rain in July that is so vital to the American corn crop. The rains of June cannot bring a good crop through. Also, if most of the rain due to fall in July happens to come in August, it comes too late. The corn has shot its bolt; it cannot be revived. Trees are much better able than the cereals to use rain when it comes. They can store moisture much better than the annuals can store it because they thrust their roots deep into the earth, seeking moisture far below the surface. They are able to survive drought better than the annual crops that grow beside them. For example, a drought that blasts corn or hay or potatoes may have little influence on the adjacent apple orchard. Trees living from year to year are a permanent institution, a going concern, ready to produce when their producing time comes.

Therefore, the crop-yielding tree offers the best medium for extending agriculture to hills, to steep places, to rocky places, and to the lands where rainfall is deficient. New trees yielding annual crops need to be created for use on these four types of land.

TWO STORY AGRICULTURE FOR LEVEL LAND

The level plains where rainfall cannot carry soil away may continue to be the empires of the plow, although the development of two-story agriculture[9] (trees above and annual crops below) offers interesting possibilities of a greater yield than can be had from a one-story agriculture.

[9] This type of agriculture is actually in practice in many Mediterranean lands. In the Spanish island of Majorca I estimated as a result of several journeys across the island that nine-tenths of the cultivated land carries an annual crop growing beneath the tree crops. I recall a typical farm planted to figs in rows about forty feet apart. Beneath the fig trees was a regular rotation of wheat, clover, and chick-peas, one of the standard articles of Mediterranean nutrition. The clover stood two years and was pastured by sheep the second year.

Other two-story Majorca farms had as a top crop almonds, one of the staple exports of the island. Other lands were in olives, and a few were in

Fig. 15. *Top*. Photo George F. Ransome.)—FIG. 16. *Bottom*. (Photo Arthur Keith.) I am grateful to Dr. George Otis Smith and Messrs. Ransome and Keith of the U. S. Geological Survey for this remarkable pair of pictures. They show essentially similar geologic formations. Both are old granite. In the dry climate of Powers Gulch near Globe, Arizona were is no vegetation to hold the rotting rock. At Roan Mountain Station, Carter County, Tennessee, the rain supports vegetation, and the vegetation holds the earth in which it lives and covers up the bare bones of granite.

If careful, very careful, man can keep his earth.

FIG. 17. *Top*. This very thin layer of clay loam resting on solid granite in Chekiang province, China, supports the rapid-growing bamboo with its myriad uses, including edible shoots. How long would that slope last if treated as the land in Fig. 1 is treated? (Photo F. N. Meyer, U. S. Dept. Agr.)—FIG. 18. *Bottom*. Silt pits in a Sumatra rubber plantation. This invention rivals the plow in its possible importance to man if he thinks of himself as a *race* with some hundreds of thousands of years ahead and then calculates the rate at which he is now destroying soil. Pits made by hand by coolie labor. (Photo Goodyear Rubber Co.)

A VISION FOR OUR AMERICAN HILLS

We have large areas of hilly land where the climate is good. We have such an area of great beauty with excellent climate and good soils, reaching from Maine to Alabama, from Alabama through Kentucky and Tennessee to central Ohio, from central Ohio through southern Indiana and Illinois into Missouri and Arkansas. Again such an area appears on the foothills of the Rockies and the mountains of the Pacific Coast. Then too there are hilly bits of land in nearly all sections of our country. When we develop an agriculture that fits this land, it will become an almost endless vista of green, crop-yielding trees. We will have small plowed fields on the level hilltops. The level valleys will also be plowed, but the slopes will be productive through crop trees and protected by them—a permanent form of agriculture.

SOME CROPS FOR THE HILLS

Chestnuts and acorns can, like corn, furnish carbohydrates for men or animals. To many it may seem ridiculous to suggest that we moderns should eat acorns, and I hasten to state that the chief objective of this book is to urge new foods for animals rather than for men. Food for animals is the chief objective of the American farmer. Our millions of four-footed brethren who neigh and bray and squeal and bleat and butt

the acorn-bearing oak. The people said that the farmer did not get the greatest possible crop of wheat or the greatest possible crop of olives or figs, but that he got about a 75 per cent. crop of each, making a total of 150 per cent. It is like the ship which fills three-fourths of her tonnage capacity with pig iron and five-sixths of her cubic capacity with light wood manufactures.

The two-story type of agriculture has another advantage. It divides the seasonal risks which everywhere beset the farmer. If frost kills the almond, it probably will not injure the wheat. If drought injures the wheat, the almond may come through with a bumper crop.

In some cases the landlord rents the ground crops out to a tenant for a share and keeps all of the tree crops for himself, the tenant having contributed no labor in their production.

eat much more than the two-footed population consumes. Their paunches receive the crop from about four-fifths of our farm acres.

When tree agriculture is established, chestnut and acorn orchards may produce great forage crops and other orchards may be yielding persimmons or mulberries, crops which pigs, chickens, and turkeys will harvest by picking up their own food from the ground. Still other trees will be dropping their tons of beans to be made into bran substitute. Walnut, filbert, pecan, and other hickory trees will be giving us nuts for protein and fat food.

Even this partial list of native tree products shows nearly all of the elements necessary to man's nutrition, and that without introducing a single new species from foreign countries where dozens of new crop trees are waiting for the time to come when they can be made useful in American agriculture.

This permanent agriculture is much more productive than mere pasture, or mere forest, the only present safe uses for the hill fields. Therefore, tree crops should work their way into the rolling and sloping lands of all sections. New crop trees need to be created. Extensive scientific work in the plant kingdom should begin at once.

DOUBLING THE CROP AREA

As the deep-rooting, water-holding trees show their superior crop producing power in dry lands, we may expect some of our now arid lands to become planted with crop trees. Thus by using the dry land, the steep land, and the rocky land, we may be permitted to increase and possibly double our gross agricultural production and that too without resort to the oriental miseries of intensive hand and hoe labor. Tree crops also have a special advantage in their adaptability to a field reservoir system of irrigation which is at the same time of great promise as a means of flood control. (See Chapter XXII.)

The great question is, how can we shift from the grain type of agriculture to the permanent tree agriculture in those localities where the change is necessary to save the land from destruction? In the next chapter the attempt is made to find an answer to this question.

CHAPTER III

THE PLAN—AN INSTITUTE OF MOUNTAIN AGRICULTURE

A Chance for Imagination and a Million—Also a Chance for Any Creative Intellect Plus a Back Yard

Here is a chance for a man of wealth to have some fun and at the same time to make a world reputation that will last and will increase for generations because of the great service he will have rendered to the world by creating crop trees and a tree-crop agriculture.

Perhaps you think that the creation of a tree-crop agriculture should be the work of state agricultural experiment stations and the United States Department of Agriculture. Theoretically that is true. It is also true that they cannot do it. They cannot get the money for such work. This is a democracy. We are governed by politicians. A politician is a vote getter and not often also a man of vision. Look around you and see if this is not true.

THE GOVERNMENT WILL NOT DO IT

For years I worked on the theory that a tree-crop agriculture would be created if I let people, including the state experiment station staffs, know about it. I disseminated the idea a dozen years ago to the extent of millions of copies in widely read magazines,[1] but at the end of a dozen years I find that

[1] See page 295 for twenty-three titles.

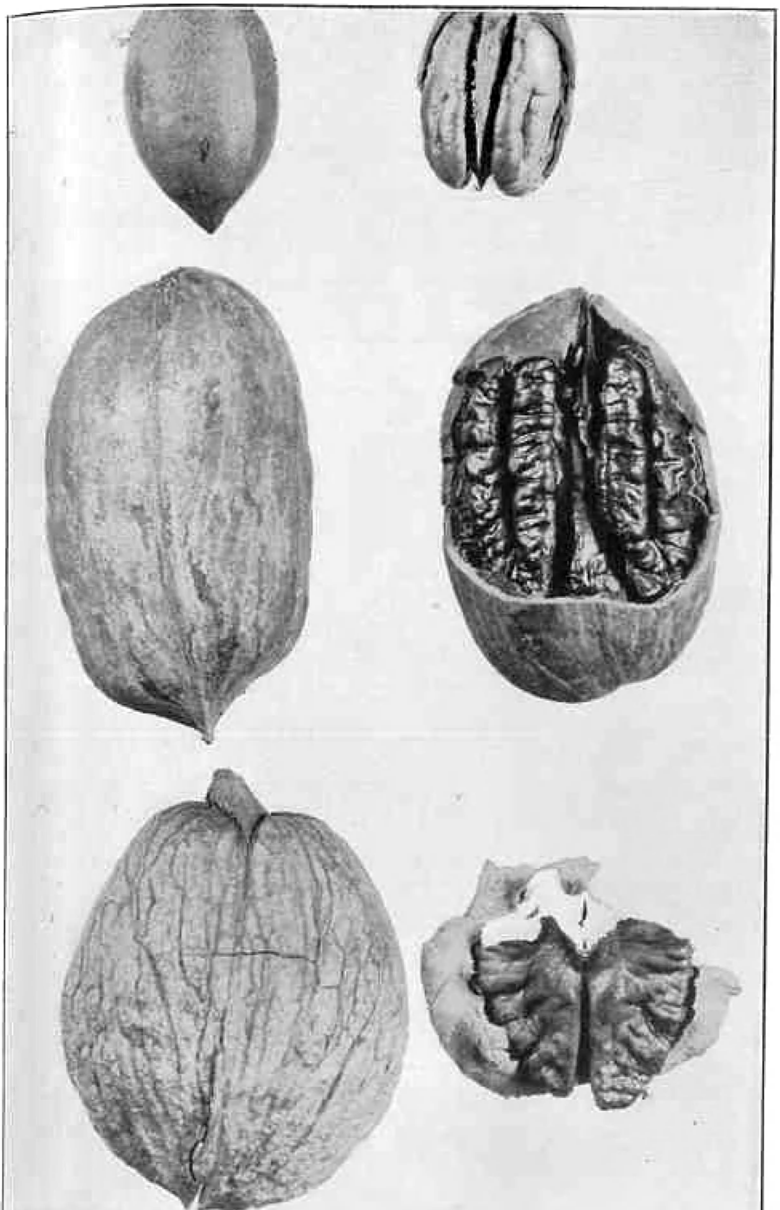


FIG. 19. Father, mother, and child, life-size. McAllister hiccan, Indiana, center, a chance natural hybrid almost certainly produced by crossing trees of low quality. A good Indiana pecan above, a good shellbark (laciniosa) below. (Photo E. R. Deats.)

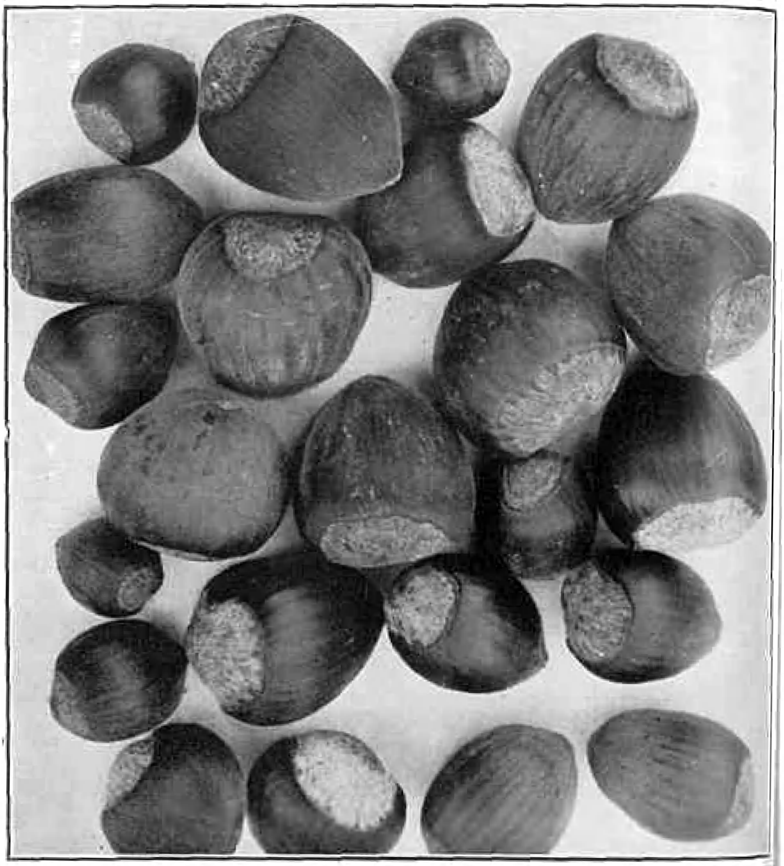


FIG. 20, FIG. 21. *Top.* The trees in front of this hat, left, and behind the man, right (J. F. Jones), are hybrids (filbert x hazel) of same origin. (Photos J. Russell Smith.)—FIG. 22. *Bottom.* Bottom row, nuts of parent trees. Progeny above. Compare size of parents and offspring.

almost nothing has happened[2] save at the hands of a few private individuals who are working for the joy of creating.

Mr. Jardine, Secretary of Agriculture, told me very simply and directly why no step had been taken in his department. The department is busy with urgent matters, curing the troubles of crops that are already established. They have no money to expend on breeding crop trees for the future and for saving the soils by which future crops must live. We should not criticize Mr. Jardine or the Department. There are men there who yearn to do such work, but we must remember that the Department of Agriculture gets its money by way of the lord of the budget. Budget makers are not primarily men of creative instinct. They are money savers with an instinct to discourage and block new enterprises. If the man who made the budget should happen to be convinced of the efficacy of tree crops, something might be started; but the succeeding budget chief would probably have a mind quite impervious to trees, and the experiment would be blocked.

State experimental stations have, here and there, men who would like to do this kind of work; but the stations are dependent for the money they get on state legislatures, and it should not be forgotten that the first necessity of the legislator is to get elected, and his second concern is to get reëlected. In view of these two urgent and even pressing necessities we

[2] Ten years after this wide dissemination of the idea the United States Department of Agriculture was trying to get a private citizen of small means, one J. Russell Smith, to furnish the ground to test out a number of varieties of nut trees and also asked him to take care of the nut trees—Smith, a private citizen. Further than that they asked him if he wouldn't send them ten pounds of hickory nuts. This is no impeachment of the men in the Department of Agriculture, but it does prove that we cannot depend upon that system to get this big thing done. The Department has begged and begged for money, but our Congress instead builds warships and post offices and constructs a wondrous pork barrel. Votes do not grow on trees. Congressmen must get elected, and, yet worse for us, in some respects, they must get reëlected.

can see that it is a rare accident when money is to be had for the prolonged task of developing tree crops. Neither by theory nor by practice are we justified in expecting democratic legislation to look far forward[3] in its appropriations save for education and military defense.

For America tree crops are a new thing, a new idea. No elected legislature can possibly be expected to appropriate regularly for such creative work. Was there a state appropriation or congressional appropriation back of Morse when he created the telegraph, or Edison working wonders with electricity, or Langley working out the theory of flying, or of Orville Wright, the first to make successful flight, or of Lindbergh when he flew from continental mainland to continental mainland? No! These things were done with private money urged by an idea. By this means also must come most of the creative work in making a tree-crop agriculture.

Some person of prophetic vision is needed to finance an institute of mountain agriculture. There, protected from the variations due to change of officials, new things could be developed to the point where state experiment stations and governmental bureaus could take them up, test them, and pass them along.

THE KINDS OF WORK. TO BE DONE

Such an institute would have a variety of work to do:

1. Finding parent trees from which to start crops.
2. Hybridizing to produce better parent trees.
3. Maintaining testing grounds to try out the new trees as

[3] As an evidence of the low intellectual and civic level of legislation in America, I will not refer to the psychology and facts of municipal elections in Chicago, for example. Instead I cite the widespread American practice of taxing young forest. Tax the forest and you put a premium on neglect and on cutting the forest. This continues despite a well-known fact of coming lumber scarcity and much preaching. If legislation should tax the lumber and exempt the forest there would be a premium on its preservation. Most American state legislatures cannot be made to see so simple a proposition as this. No, it is foolishness to expect state legislatures to do the big thing in tree-crops creation.

trees—testing them by ten thousands to find the good *trees.*

4. Operating experimental farms to try out the new *trees* as *crops.*
5. Carrying on publicity work to get the new idea into the conservative mind.
6. Making studies in soil erosion and its prevention.

1. Finding Parent Trees

The one original parent Baldwin apple was born by chance in a fence corner. It was propagated by grafting until there were millions of Baldwin apple trees. If this same process were applied to the best wild crop trees now growing in the world, I am sure that the hill fields from Massachusetts to Texas could become more valuable than the best nearby farm land, and be covered with orchards of bearing trees like the best wild

(a) Shagbark hickory trees and their natural hybrids,
(b) Shellbark hickory trees and their natural hybrids,
(c) Pecan hickory trees and their natural hybrids,
(d) Butternut trees,
(e) Black walnut trees,
(f) Chinese walnut trees and natural hybrids,
(g) Chestnut trees and already created hybrids.

These crops would be for humans. For animals the much wider expanses of hill land should be covered with

(a) Acorn-yielding oaks,
(b) Honey locust trees,
(c) Chestnut trees,
(d) Persimmon trees,
(e) Mulberry trees, and many others.*

It is easy to speak of an orchard of best shagbarks or acorn-

[4] Professor C. C. Colby, of the University of Chicago, says the Highland Rim County of East Tennessee is "alive with food in the fall—butternuts, walnuts, hickory nuts, chestnuts, persimmons, and papaws, all in great abundance and lying on the ground."

yielding oak, but where are the best wild parent trees for these orchards? No one knows where they are. The task of finding the parent trees may be long and difficult. We see how great it is when Sargent mentions fifty species [5] of oak trees as being native to the United States. Sudworth, United States Forest Service, said there were one hundred and seventy species of oaks. There are many varieties of hickory. The honey locust tree and the persimmon, species of great promise for crop production, are each growing over a million square miles of land. How would you find the best tree? When it comes to persimmons we need a half dozen best trees; one ripening in August, one in September, one in October, one in November, one that drops its fruit in December, and yet another which drops it in January. There are such wild persimmon trees already growing in the United States.

Yet more! Foreign countries need to be carefully searched in the quest for parent trees. Something has already been done, but the task is only begun. It may be that the best crop trees are growing in some little valley in Spain, Portugal, Jugoslavia, Asia Minor, Persia, the Himalayas, or the remote interior lands of southwestern China, which seems to be such a wonderland of trees.

2. *Hybridizing to Produce Better Trees*

There is little doubt that we could start a good tree agriculture by merely propagating the best wild trees, but if agricultural science has worked out any result it is this: the purposeful hybridization by man of existing trees can produce trees that are much better for agricultural purposes than those nature has produced. This work should use both native and introduced trees. A dozen men could at once go to work on the various oak species, a half dozen on the chestnuts, and an-

[5] There are also natural hybrid oaks scattered about the United States. No one has any idea where or how many.

other half dozen on the hickories. The magnitude of such an undertaking may be grasped when we realize that one species of apple has given rise *in America* to over seven thousand named varieties, and new ones and better ones are being made every year.

The hybridization work of an institute of mountain agriculture should amount to hundreds and thousands of cross pollinations every year. Each hybrid seed would have to be planted and grown to fruiting age.

3. Testing Grounds

The best hybrids should be tested to determine their possibilities as crop producers. This would cover many acres of ground and need a considerable staff of men.

4. Experimental Farms

It is one thing to tell the farmer that here are good black walnuts or chestnuts or acorn-yielding oaks or honey locust trees, and it is quite another matter to organize these into an effective farm. That is a matter of agricultural economics and farm management; so the institute should have a number of farms in which tree crops were worked out into a system to make a well-balanced and profitable use of land, well-balanced use of a man's time, and good safe living for the family who depended upon it.

5. *Publicity*

An institute of mountain agriculture, as outlined above, needs an expert in publicity on its staff. In the beginning years he could be chiefly employed in the very difficult task of getting the attention of almost every land owner in the United States, of every tree lover, and of every hunter, so that we might find those rare parent trees that are standing in fence corners, back fields, distant pastures, and remote mountainsides.

Another task for the publicity expert would be to attract the attention of the American farming public to the fact that there could be such a thing as tree-crop agriculture, and that some crops are now ready to use. This is just as much a task for a publicity expert as is a press campaign for a candidate for the senate or a corporation that wishes to raise fares. The sedate government bulletins already published are helpful, but experience shows that they do not fill a very big place. The task of spreading a new idea in agriculture is most difficult.[6]

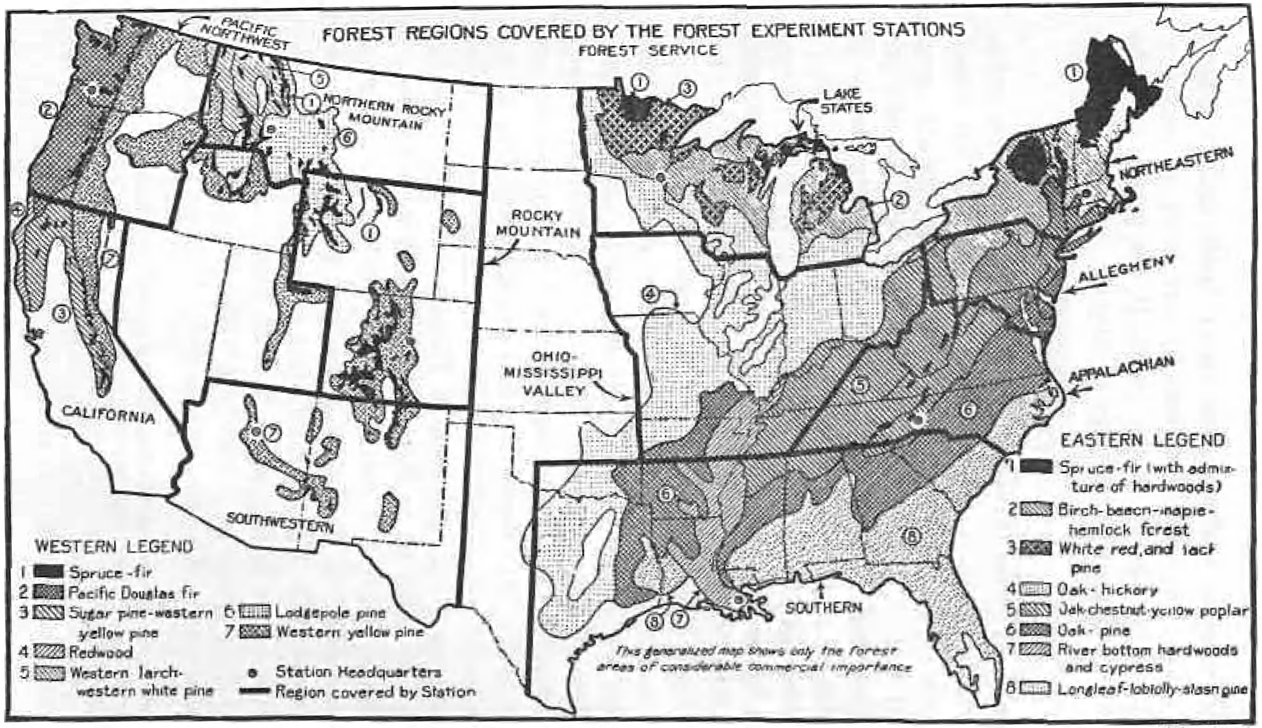
MANY INSTITUTES OF MOUNTAIN AGRICULTURE NEEDED

Suppose the man who started an institute of mountain agriculture lived in North Carolina and worked out a North Carolina agriculture; the interested farmer from Massachusetts discovers that few of the North Carolina varieties and practices fit his conditions. This shows at once that we need several institutes of agriculture in locations where their findings are adaptable for considerable areas. (See page 27 and Fig. 136.)

6. *Erosion Survey*

The objects of an institute of mountain agriculture might be classed as twofold—to create a new wealth through new crops and to save our soil resources from destruction by erosion. For the latter purpose we need to know what the danger really is. The thoughtful part of the American public might be shocked into doing something about it if they could be made to understand what soil erosion has done to China, Syria, Greece, South Carolina, Mississippi, and Ohio. A few well-planned and well-manned expeditions making an erosion survey of foreign lands and our own country would bring back material which might be one of the scientific sensations of the day. In the hands of good publicity experts it might make this reckless American people see that we are today destroying

[6] "The history of agriculture shows a conservatism probably unequaled in any other phase of human activity."



From the Forest Service, Department of Agriculture

This map shows fifteen different types of forests having areas of considerable commercial importance. Each type of forest represents a type of tree growth and might require a special experiment station to work out tree crop possibilities for that type of area. This same map shows that our Federal Government has 11 forest experiment stations covering the 15 types of forest.

the most vital of our resources (soil) faster and in greater quantity than has ever been done by any group of people at any time in the history of the world. If our people could be made to *feel* this, they would try to stop it.

A PLEASANT RECREATION

As outlined above this work can employ heavy endowments. On the other hand experiments with trees can be on almost any scale. Two trees, for example, might produce great (hybrid) results. There are thousands of individuals who can experiment and have pleasure,[7] recreation, and perhaps do something of great value to the human race.

Experimentation with nut trees is especially to be recommended for people in middle age and upward. One of the pains of advancing years is the declining circle of one's friends. One by one they leave the earth and the desolating loneliness of old age is felt by the survivors. But the man who loves trees finds that this group of friends (trees) stays with him, getting better, bigger, and more lovable as his years and their years increase. This perhaps explains the delightful enthusiasm of some of the septuagenarian and octogenarian tree lovers whom I know and have known, such as the late E. A. Riehl and Benjamin Buckman, both of Illinois, who were plunging ahead in their eighties as though they were in their forties.

Mr. Riehl began nut tree pioneering on some Mississippi bluffs near Alton at the age of sixty-three and actually made money out of nuts. He was really just getting started when he died at the age of eighty-seven. I knew him for eleven years. It was a great pleasure to associate with such a youthful and enthusiastic spirit. He was the youngest old man I ever knew,

[7] I have altogether something like thirty-five varieties of walnuts, hickories, pecans, persimmons, papaws, and honey locust on test on my rocky hillside, and I find that I am having an amount of fun out of it that is as perfectly unreasonable and genuine as is the joy that remains for a month or two after making a good drive at golf.

NUMBER OF VARIETIES UNDER TEST BY SOME PRIVATE EXPERIMENTERS

	Almond	*Bitternut*	*Black walnut*	*Butternut*	*Chestnut*	*Chinese pistache*	*Chinquapin*	*Corylus*	*Hazel*	*Heart nut*	*Hickory and hybrids*	*Juglans seedling trees*	*Pecan*	*Persian walnut*	*Walnut*	*Filbert*
Dr. Robert T. Morris, Merribrooke Farm, Stamford, Connecticut			8		*	1					5		10	*		*
Mr. Willard Bixby, Baldwin, New York	5	2	33	4	6		1	6	50	5	46	7	17	11	6	
Mr. J. F. Jones, Lancaster, Pennsylvania	2		10						3	7	13		9	12		32

* No count, but a large number of different varieties.

still living in the future, not in retrospect as is so common with old age.

The danger of loss to society by leaving this work to private individuals is well illustrated by these collections of trees listed above.

Mr. Jones, a nurseryman, had a good collection of parent trees in bearing. He got a thrill out of hybridizing. He wanted to do nothing else. As I finish this book, Mr. Jones dies leaving a widow and three young daughters who may not happen to be situated to carry on his work. It is to be hoped that some one can carry on his breeding work with his collection of trees.

The trees of Dr. Morris stand in one of the choicest tracts of suburban land anywhere near New York City. Dr. Morris is seventy years young.

Mr. Bixby's tree collection is the finest of its kind in the world. The land on which it stands in a suburb of Brooklyn, is worth one hundred and fifty thousand dollars, and is rapidly increasing in value. In addition to this loss of interest Mr. Bixby is spending two or three thousand dollars a year in taxes and an equal amount in hiring men to conduct this private experiment station, to which he also gives some of his own financially valuable time. He contributes his findings freely to the public. This is fine for society while it lasts, but unfortunately it will take decades of years and a great deal more land, labor, and money to get the full results out of this unique planting.

HELP WANTED!

PART TWO

SOME FACTS ABOUT SOME CROP TREES

Should I begin with the nut crops, the well-known pecans, walnuts, and hickories with which every American is somewhat acquainted?

This book is primarily an attack upon the gully. To succeed in this we must have millions of acres of tree crops replacing the destructive plow crops. Now the nuts that people eat are fine and worthy of much improvement, but a few hundred thousand acres of them would glut the market. Not so with stock food. Once we get a cow-feed tree crop established we have a guaranteed outlet, and twenty or thirty million acres will not glut the market. We would simply convert thirty or forty million acres of our hundred million acres of corn to a more profitable and soil-saving crop.

Therefore, I start this part of the book with stock foods.

There is another reason also. Some of the stock-food crops seem to be in the class of sure things with which the farmer can safely begin without waiting for a lot of scientific work to be done.

Then, too, stock foods start on an honest-to-goodness basis. They don't begin five prices high like a human food novelty and then come down bumpety-bump as soon as a few carloads are produced.

CHAPTER IV

SOME STOCK-FOOD TREES—THE PRODUCERS OF BRAN SUBSTITUTES

Who has not pitied John the Baptist because he had to eat insects (locusts) in the wilderness, and the Prodigal Son because he was brought so low that he was forced to feed upon the husks that the swine did eat?

But the locusts that John the Baptist ate were not insects; they were the beans of the carob tree, sometimes still spoken of in the Near East as "locust." The husks eaten by the Prodigal Son were not the dried husks of corn, as the American farmer naturally believes. They too were the pods of the carob bean.

Like our own maize, the carob bean is food for animals. It has been used for that purpose throughout the Mediterranean region for several thousands of years. Like maize it is also used for human food. My son, when three years of age, ate, without invitation, the samples of carob that I had brought home. Carob beans are regularly sold for human food by little shop keepers and pushcart vendors on the streets in some parts of New York and other American cities occupied by Mediterranean peoples. They have long been used in American factories to add both flavor and nutriment to certain patent calf foods, live-stock conditioners, and dog biscuit. Four hundred tons per year are used in the United States to flavor chewing tobacco.[1]

The trees and the beans have been introduced into California, and it is an astonishing fact that promoters of Los

[1] U. S. Department of Agriculture, Bulletin No. 1194.

Angeles claim that their products make good food for the American table. John the Baptist and the Prodigal Son might easily have fared worse.

The bean-producing carob tree is one member of a group of leguminous trees all of which are equipped to gather nitrogen from the air and make sugars from earth materials and air and to make forage for beast (if not food for man) in nearly all the climates that circle the globe in the latitude of Washington, St. Louis, Santa Fé, Los Angeles, Shanghai, Kabul, Teheran, Jerusalem, Rome, and Gibraltar. In the southern hemisphere a similar band of bean-tree climate covers large areas in Australia, South Africa, Argentina, and Chile.

Three entirely different types of climate are found in this bean zone. See map in this book (Fig. 136.)

First Climate Type

The Mediterranean climate, on the western coasts in middle latitudes. This climate has a mild, slightly frosty winter with some rain which is followed by a hot dry summer. Here the carob thrives.

Second Climate Type

On the eastern coasts of the continents in middle latitudes, the American Cotton Belt, and South China, also southeastern Australia, southeastern Africa, and southern Brazil, is a climate with a frosty winter and rainy, humid, hot summer. This is the climate of the honey locust tree (gleditsia), bearing beans a foot or more in length, and also good for forage.

Third Climate Type

Between these two type regions, California and the Cotton Belt, is an area of arid interior, typified by Arizona, New Mexico, and western Texas. In the Old World this between-region of drought includes large areas of Syria, Persia, and Afghanistan, with similar regions of large size in Argentina, Australia, and South Africa. This is the climate of the mesquite, native to America, and of certain allied species which thrive amazingly in the arid lands of both North and South America (page 69). For map, see Fig. 136.

All of these bean-bearers have very ingeniously bedded their seeds in a sugary pod which is greedily eaten by many ruminants. The seed itself no beast can bite, bruise, or digest. It passes with the excreta, dropped on every square rod of pasture land and bedded down in fertilizer to help it start its new life. Nature is indeed ingenious!

All of these beans and their pods are much alike in food service and in food analysis. In nutritive value, both protein and carbohydrate, they are much like wheat bran—that standard nutrient of the dairy cow. (See table, page 302.) Therefore, it seems fair to call these bean trees "bran trees" because some are already used as bran substitutes and others may be made to afford a commercial substitute for bran. This gives the possibility of their being major crops of American agriculture.

CHAPTER V

A STOCK-FOOD TREE, THE KEAWE, OR HAWAIIAN ALGAROBA

I shall begin my discussion of the stock-food trees with the Hawaiian algaroba, commonly called keawe in those islands. I start with keawe because the facts about it have been worked out by American agricultural officials; because the evidence that these men have produced is official; and because of the astonishing, convincing, and yet almost unbelievable nature of that evidence. I shall present much of the material in the exact words of officials of the American Agricultural Experiment Station in Honolulu.

E. V. Wilcox, Special Agent in charge, Agricultural Experiment Station, Honolulu, said:[1]

"The algaroba, or keawe (prosopis juliflora)[2] is commonly recognized as the most valuable tree which has thus far been introduced into the Territory of Hawaii.

"There are eighteen or more species of prosopis, the natural

[1] Press Bulletin, No. 26, Hawaii Agricultural Experiment Station, *The Algaroba in Hawaii.*

[2] The botanists have long had a hot dispute as to whether this Hawaiian tree was American or Chilean in its origin. Certainly it was introduced about a century ago, and there are at least three good rumors as to its source.

"I have become very much interested in the identity of this species and have succeeded in obtaining related species from many parts of the world and have these growing in seedling form on our station here in Honolulu. I feel pretty sure that ours is a South American species, possibly prosopis chiliensis. I am quite certain that it is neither the true mesquite nor the true carob."

(A letter signed J. M. Westgate, Agronomist in charge, Agricultural Experiment Station, Honolulu, Hawaii, July 5, 1916.)

See Figs. 27 and 38 for pictures of beans of keawe and carob. It is one of the jokes on horticulture that they have been called the same—even in Bailey's good *Encyclopaedia of Horticulture*.

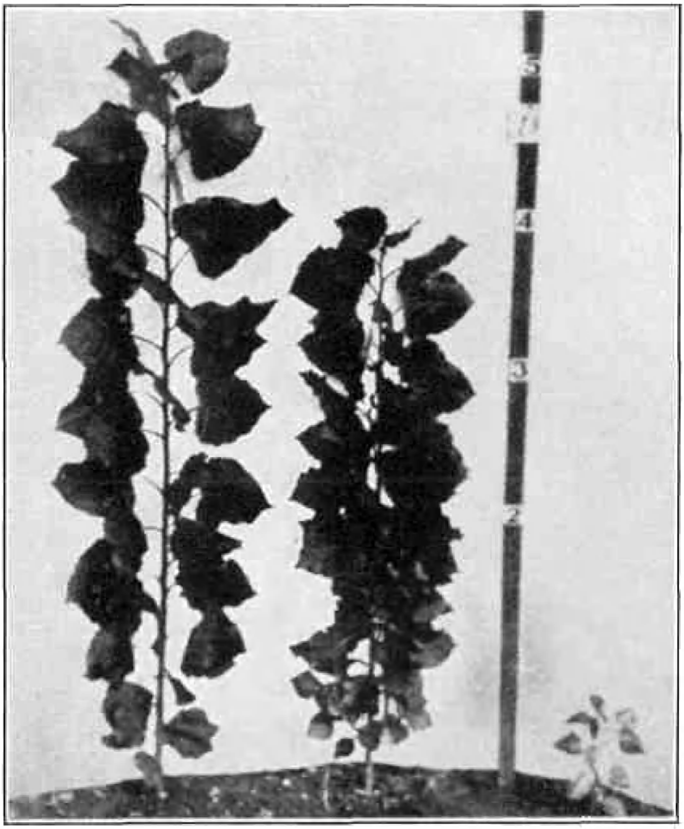
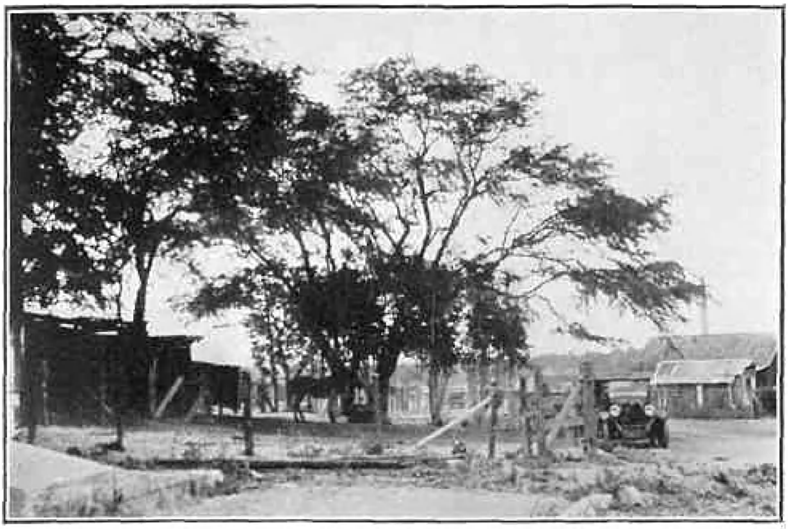


FIG. 23. *Top*. Water-holding terraces made by machinery in clay hillside orchard of Lawrence Lee, inventor. This is one of the great inventions. The moisture substitute for cultivation is evident. (Courtesy J. R. Linter.)—FIG. 24. *Bottom*. Three hybrid poplars from same parentage. Project by McKee, a chemist—quite a joke on the foresters. Some of these grow with great speed. (Courtesy Ralph McKee, A. B. Stout, and E. J. Schreiner.)



Photos J. Russell Smith

FIG. 25. *Top.* The spreading keawe tree above the automobile was shown by Mr. Williams as one yielding from two to three tons of beans in a year. The mass of thick leaves near the horse is the tops of other trees in background.—FIG. 26. *Bottom.* A fruiting branch of keawe showing one of the two crops per year, Island of Maui, Hawaii. See Fig. 38.

habitat of which is in tropical and semi-tropical America. The algaroba[3] occurs from Texas to Chile and in the West Indies. . . .

"Algaroba or keawe thrives best at low altitudes, but is everywhere in Hawaii gradually extending to higher levels, and it is found in some localities at altitudes as high as two thousand feet."

Dr. J. M. Westgate has not seen it above 1,000 feet and reports 600 feet to be its usual upper limit on the island of Oahu. Apparently it is gradually becoming acclimated to higher altitudes, but it bears most abundantly at lower levels. On the whole its distribution has been largely accomplished by stock.[4]

"Practically all of the islands have enormous belts of algaroba forest extending from the seashore on the leeward side up to an altitude of 800 or 1,000 feet.[5]

"There are few trees which are distinctly useful for more purposes than is true for the algaroba.[6]

[3] For further discussion of identity see Chapter VIII, The Mesquites

[4] Some of the rough areas unsuited to cultivation on the windward side of the island are being planted to algaroba since the demand for the meal is gradually increasing." (Letter, March 12, 1913, E. V Wilcox Special Agent in charge.)

[5] "The algaroba in Hawaii occupies at least 50,000 acres of land, growing satisfactorily with a rainfall of from 12 to 15 inches per year." (Letter from E. V. Wilcox, Special Agent in charge, Agricultural Experiment Station, Honolulu, March 12, 1913.)

"This tree grows under rainfall conditions varying from ten inches per annum to as high as fifty inches. In altitude it grows from the sea level to about eight hundred feet." (Letter from J. M. Westgate, Agronomist in charge, July 5, 1916.)

[6] "Algaroba wood also constitutes one of the best and chief sources of fuel m the Territory. Its growth is comparatively rapid and the larger trees can be removed for fuel, thus making room for the growth of another generation of trees. In addition to these uses of the algaroba, it might also be stated that the bark contains tannin, and the gum is suitable for use in varnish. Being a legume and of remarkable penetrating power in the soils, it is also a soil-maker of some importance. As a shade and ornamental tree it is highly appreciated. The form of the tree is graceful and spreading. The small branches furnish excellent material for making charcoal. Piles made from algaroba are relatively free from the attack of the teredo. Moreover, since the pods contain a high percentage of sugar, they may be used in the manufacture of denatured alcohol and

Its flowers furnish the most important source of pure honey known in the Territory. The bee-raisers of the Territory have shown an active interest in securing the rights of placing apiaries so as to utilize to the fullest extent the algaroba forests. The yield of honey is recognized as large and important and occurs at two seasons, there being two crops of flowers and pods annually.

"As a forage crop algaroba is of far greater financial value. The pods are everywhere recognized as one of the most important grain feeds of the islands and are greatly relished by all kinds of live stock, including chickens. The quantities of pods produced by the algaroba forests cannot be estimated even approximately, for a large proportion of the pods are allowed to fall on the ground and are eaten by cattle, hogs, and horses without being previously picked up. Wherever the belts of algaroba timber are large, it has been found possible to maintain stock for a month or two of each season without any other forage than algaroba beans.[7]

"It has been estimated that approximately 500,000 bags of the beans are annually picked up and stored, particularly for feeding horses and cattle. On two or three estates at least 15,000 bags of beans are annually stored for this purpose."[8]

As to yield Mr. Wilcox said,[9] "It has been found that the yield per acre varies from two to ten tons. This yield varies

vinegar." (Hawaiian Agricultural Experiment Station, Press Bulletin 26, p. 4, *The Algaroba in Hawaii.)*

[7] "The algaroba bean industry is getting to be a very important one here in the Islands, the ground pods being regarded as equal to barley or oats for feeding purposes pound for pound. It is rather difficult to get any definite figures on the production as so many of the companies utilize their own grinding plants and feed the ground beans to their own stock. Thousands of head of stock in certain seasons of the year are allowed to eat the pods as they fall from the trees in the native pastures." (Letter from J. M. Westgate, Agronomist in charge, Agricultural Experiment Station, Honolulu, July 5, 1916.)

[8] "The business which has developed this year from the sale of algaroba bean meal amounts to about $350,000." (Letter signed E. V. Wilcox, Special Agent in charge, March 12, 1913.)

[9] Letter, March 12, 1913.

but little from year to year and occurs in two crops per year, the figures given covering the sum of both crops."

In another connection[10] Mr. Wilcox said, "The yield of beans per acre of good algaroba forest is about four tons per acre." [11]

Mr. J. E. Higgins, Horticulturist at the Honolulu station, said,[12] "It has taken possession of large tracts of otherwise unoccupied land, prospers where the soil is too dry for any other crop,[13] and produces a verdure and shade where otherwise there would be an almost barren waste, and yields a pod of high feeding value."

Mr. Wilcox, above mentioned, said,[1*] "Thus far there has been no cultivation of algaroba. The large areas of trees which we have stand, for the most part, in rock soil where cultivation would be practically impossible." [15]

"We therefore have no evidence as to whether the increased yield obtained by cultivation in tillable soil would pay for the added cost of cultivation. At present the cost of gathering and grinding is about eighteen dollars per ton, allowing ten dollars per ton for gathering, five dollars for grinding, and three dollars for transportation. The regular price paid for picking up the pods from the ground under the trees and delivering them in bags at the roadside is one-half cent a

[10] Letter, June 18, 1912.

[11] In 1927, Mr. J. M. Westgate, Director of the Hawaiian Agricultural Experiment Station, weighed the beans from a yard tree, 17 inches in diameter, 30 feet high, 60 feet spread—500 lbs. of beans. (Letter, Feb. 1, 1928.)

[12] Letter, July 3, 1916.

[13] C. K. McClelland, Experiment, Georgia, June 19, 1916. "In Hawaii the algaroba tree, growing in coral rock which in many places has no soil covering—the trees being in pockets dissolved or worn out of the coral—furnishes valuable products in the way of honey, cattle feed, and fuel."

[14] Letter, June 18, 1913, E. V. Wilcox, Special Agent in charge, U. S. Department of Agriculture, Experiment Station, Honolulu, Hawaii.

[15] U. S. Department of Agriculture, Honolulu, Hawaii, September 12, 1916. "A great many of the algaroba trees grow where the soil is two feet deep, being underlaid with solid lava rock." (Letter signed J. M. Westgate.)

pound. At this rate men, women, and children make from one dollar and twenty-five cents to one dollar and seventy-five cents per day."

Speaking of the value of the beans, Mr. Wilcox said,[18] "The feeding value of twenty-five dollars which I have placed upon algaroba meal is to be compared with bran or rolled barley at about forty dollars per ton at present prices in Honolulu. At these prices it is worth more than twenty-five dollars per ton, since its analysis shows it to be practically equal except for the fact that the crude fiber is a little more."

The two sets of beans require two sets of blossoms, all of which are rich in honey, which Mr. Leslie Burr estimates at 2½ pounds per year for a tree with thirty-foot spread. See *Gleanings in Bee Culture,* January, 1917. Honey by the ton is one of the products of a Hawaiian algaroba pasture.

THE ALGAROBA MEAL INDUSTRY

Owing to the fact that no animal can digest the bean it is estimated that most of the protein value (see table of food analysis, page 302) is lost. Some estimate that about forty per cent. of food value is wasted when the animals eat the beans under the trees. This loss, combined with the desire to have food in the off season, led to attempts to grind the beans. Owing to the fact that the sugar of the pods has the consistency of molasses, it stuck to the parts of the grinding machine and looked like vulcanized rubber. For a long time it interfered with attempts at successful grinding. After years of work a technique [17] for grinding was evolved.

[16] Letter signed E. V. Wilcox, Special Agent in charge, Agricultural Experiment Station, Honolulu, July 20, 1912.

[17] The experiment station recommends a fine spray of water on the rolls, which prevents the meal from sticking and does not wet the meal enough to cause it to spoil.

Mr. Ben Williams of the Hawaiian Commercial & Sugar Company on the Island of Maui worked out a different technique. He heats the beans to a temperature of 600° to 800° F. by superheated steam in a rotary kiln. This turns the molasses to a white powdered sugar; the beans are then

Hawaii Agricultural Experiment Station reported,[18] "The feeding test made by this Station showed that the seeds thus cracked are completely digested by horses, mules, and cattle.

"The keeping quality of the meal is quite sufficient for the ordinary demands of the trade. When kept in sacks or open containers, it retains its original odor and flavor, without change, for six or eight months; and the meal is no more subject to the attacks of insects than is any other grain feed."

E. V. Wilcox said (letter, August 12, 1913), "The algaroba beans have been formerly shipped to Japan as a food for cavalry horses, but the product is now all used in Honolulu. It has been adopted as a part of the rations for army horses of this Territory."

The evidence in the passages quoted above is truly astonishing when compared with that of the standard crops of the American field. In considering these facts one should remember the necessary restraints and conservatism of statement which must and do mark the official representatives of the Depart-

ground in a swing-hammer sand machine, a machine made to crush soft sandstone.

In 1912 Mr. Ben Williams, ranch manager on the above-mentioned estate on the Island of Maui, told me that he was having one thousand to one thousand four hundred tons of beans per year picked up. Women picked up eight or ten forty-pound sacks of beans a day and received an average of one dollar for the day's work. Many women picked up twenty sacks daily, thus making two dollars to two dollars and twenty-five cents a day, which was more than they made in the sugar fields. It cost Mr. Williams twelve dollars and fifty cents per ton to have the beans picked up and put in the storehouse, five dollars to take them from the storehouse, have them ground and bagged, the bags cost two dollars; total cost was nineteen dollars and fifty cents. Allowing ten per cent. for shrinkage, the meal cost a little over one cent per pound.

Six men ground ten tons per day with electrically driven machinery and one-quarter of a barrel of oil. The total cost was three dollars per ton; itemized as follows:

Costs—Labor	$12.00
Power	12.00
Capital charge	6.00

It could be done for less if the plant were worked more continuously.

[18] Press Bulletin No. 26. *The Algaroba.*

ment of Agriculture. Even more astonishing evidence was given me by Mr. Ben Williams, a Welshman, fifty-five years of age, ranch manager of the Hawaiian Commercial & Sugar Company's estate on the Island of Maui.

This estate has fifteen thousand acres in cane land, twenty-one thousand three hundred acres classed as waste and pasture, of which none is real waste and none real pasture. The area involved, thirty-six thousand three hundred acres—nearly sixty square miles—is as large as some of the smaller counties in the United States. Its population is in thousands, and its organization is a vast group of industries, well subdivided, with a superintendent of cane fields, a factory superintendent, a chief engineer in the sugar mill, a foreman of machine shop, and the ranch manager, Mr. Williams, in charge of two hundred dairy cows, eight hundred cattle, seven hundred horses and mules, and two hundred and fifty pigs.

Of Mr. Williams' ranch domain eight to nine thousand acres are in algaroba, planted by the cattle as they scattered the beans from one tree that stood by the windmill and its attendant drinking trough. By rule of thumb observation Mr. Williams said that one hundred pounds of keawe meal, when fed to pigs, horses, and cattle, were about equivalent to eighty pounds of good barley, which had long been the standard horse feed of the islands. Mr. Williams said that each acre of good keawe will fatten at least six head of cattle. If the animals weigh six hundred pounds when turned in, in ninety days they will weigh over eight hundred pounds. I expressed my doubts. "I have seen it done," declared Mr. Williams. "I know this, that you can take cattle, lean ones, that do weigh five hundred pounds and should weigh seven hundred pounds; and if you put six of them on an acre of good keawe, they will average better than two pounds a day on raw beans which they pick up for themselves. You can take the season from the middle of July, and the six cattle will gain twelve hundred pounds and sometimes will go to sixteen hundred pounds of beef per acre on land with rainfall of twenty inches a year."

Mr. Williams reiterated these figures and saw me write them down. It should be mentioned that this man has a corps of accountants which keeps books on every field for crops, for purchases, for sales, and for every bit of labor employed, just as you would expect to find in the Standard Oil Company or in other highly organized corporations.[19]

When one considers that a good acre of Kentucky blue grass pasture or the rich pasture of old England will produce one hundred and fifty pounds of mutton per year, and an Illinois farm in corn and alfalfa will make about four hundred and fifty pounds of beef and pork per acre per year,[20] the keawe bean tree looms up as one of the king crops of the world.

In explaining the prodigious yields Mr. Williams pointed to a particular tree (see Fig. 25), which he said would yield from two to three tons. I measured the tree. It had a reach of eighty-four feet. The tree hung full of beans (see Fig. 26). Many were dropping, and the tree was still blooming. It was then the fourth of August, but Mr. Williams assured me the tree would keep on blooming for some time and that it would drop beans for five months, from July to December.

We walked through the copses of keawe where the sand was merely held in place by protection of keawe root and keawe tops which kept the wind from getting at the sand; but before the reader jumps to the conclusion that this was a desert waste, he should consider the geologic origin of the sand. It was volcanic sand blown up from the shore of the sea and mixed with perhaps ten to fifteen per cent. of shells. There is no richer soil combination known on the face of this earth than certain volcanic sands and lavas mixed

[19] This particular ranch was one of several properties operated by the same management.

[20] Information from Herbert Mumford, Professor of Animal Husbandry, Urbana, Ill. (Letter, Oct. 11, 1913.)

with limestone. This richness of the fresh unleached lava soil of Hawaii should be kept in mind when one thinks of applying Hawaiian facts to many other areas of semi-arid frostless lands in which the algaroba may probably find a suitable climate.[21] (See further discussion of this point in Chapter VIII on The Mesquites.)

The Hawaiian keawe seems truly tropical, but the genus to which it belongs is by no means limited to lands without frost. (See the findings of Dr. Walter S. Tower in the next chapter.)

The surprising performances reported in this chapter may almost without exception be said to be products of wild trees, although the process of thinning out may sometimes leave the better ones. It should be noted that nine thousand acres of trees on the sugar plantation mentioned above were scattered by cattle from one chance tree at the windmill. What a shame that it was not an exceptionally good tree! [22]

There is every reason to think that the keawe produced by chance is capable of much improvement by selection and breeding. Then the propagation of orchards from the best trees should give a still better crop than is at present obtainable.

The chief value of the keawe in this book is that it is an example—a successful tree crop in a world that needs many other tree crops to fit particular places and keep its scanty soil upon its rocky ribs.

[21] "In Cuba, where I lived a number of years, one of the locusts, called a 'guasima,' furnishes considerable food for cattle, and they are introducing from the Hawaiian Islands a locust with a sweet substance in the pod as a food for horses, cattle, and swine. I believe this tree is called an algaroba." (Letter signed N. S. Mayo, Animal Husbandman, Virginia Agricultural Experiment Station, Blacksburg, Virginia, May 22, 1913.)

[22] "There is a great difference in the yielding capacity of different trees. They begin to bear profitably at four or five years of age." (Letter signed E. V. Wilcox, Agricultural Experiment Station, Honolulu, Hawaii, August 12, 1913.)

CHAPTER VI

A STOCK-FOOD AND MAN-FOOD TREE— THE CAROB

AN INDUSTRY, AGE-OLD AND WIDESPREAD

The carob,[1] the food of the Prodigal Son, of Mediterranean people, of the Mediterranean farm animals, and of the calves and dogs of America, also fed the cavalry of Wellington in his Peninsular campaign and that of Allenby in Palestine during the World War.[2] Carob beans are sold in many American cities where Mediterranean peoples live. They are eaten from the hand as are apples, peanuts and chestnuts. In Sicily they serve as candy. Almost any American child will eat them if he gets a chance.

The tree has been cultivated in the Mediterranean region from an unknown antiquity and both the wild and cultivated trees still grow throughout that region. I have seen carobs in South Portugal overlooking the Atlantic; in Valencia, eastern Spain, overlooking the western Mediterranean; in Majorca, overlooking the northern Mediterranean; in Algeria, the south Mediterranean. On the stony slopes of Mount Carmel I saw gnarly old specimens and young newly grafted trees overlooking the eastern Mediterranean. Because the carob is easily injured by frost, it hugs close to the sea shore in Mediterranean lands and is especially important in Mediterranean islands—Sardinia, Cyprus, and Sicily—(90,000 tons per year). It even rises to the point of chief export of the

[1] "Fruit of this tree is variously known as carob, carob bean, algaroba, algarroba, karoub, caroubier, locust, sweet bread, sugar pod, and St. John's bread." *(Scientific American,* January 11, 1913.)

[2] John S. Armstrong, *Orchard and Farm,* February, 1919.

Mediterranean island of Cyprus[3] where its per capita export value in 1924 ($4.00) was greater than that of grain and grain products and forest products from the United States.

The carob is an evergreen tree with rich glossy evergreen foliage. It blooms in the autumn and, like the orange, carries the young fruit to the end of the next summer.

This tree is in itself an example of two parts of the tree crops thesis; namely, the tree is the best means of getting harvests from *steep land* and also from *arid land*.

THE CAROB's PLACE IN MEDITERRANEAN AGRICULTURE

Everywhere the carob takes second-class land, either rocky or dry. On the plains of Valencia the irrigable land is in oranges and garden crops, but ten feet above the last irrigation ditch the carob and the olive begin making a crop on the rocky hillside of the semi-arid land. This is the case in Majorca, in Cyprus, in Algeria, and on Mt. Carmel, and most Mediterranean lands. Sometimes carob trees cling to hillsides which seem to be almost pure rock.[4] In Sicily it is an indispensable shade tree.

[3] "Wild carob trees abound all over the island." (Report of Director of Agriculture for Cyprus, p. 81, 1898.)

University of California Publication, "Feeding Dairy Calves in California," Bulletin No. 271, September, 1916, p. 32, by F. W. Woll and E. C. Voorhis, says:

"According to Pott (*Futtermittellehre,* Vol. II, pp. 453-55), the crushed carob pods are frequently used in England for fattening sheep, and for ewes with lambs, also in connection with other concentrates for fattening steers. It is used in France as a feed for milch cows and young stock, and in southern Italy and other countries as a concentrate for horses and for growing pigs. British horses are at times fed as much as three kilos (6.6 pounds) per head of carobs daily, either cooked and mixed with cut straw or raw. Fattening steers are also fed preferably cooked carobs towards the end of the fattening period. For horses it is not even necessary to crush the pods. In southern Italy nobody would think of doing it, although the strong pony-like horses do not receive any other concentrates and are fed only hay or green feed in addition."

[4] M. Trabut, the government botanist at Algiers, told me that he had seen carob tree roots at a depth of sixty feet on the hills of northern Algeria,

In Tunis I have seen them in arid locations where the rainfall was about ten inches.

Unfortunately the carob is injured by winter temperatures of 20^0 F. or even a little above.[6] This limits the crop to approximately those lands where the temperature is suitable for the orange. However, as the orange is a water-lover, it requires good irrigable land, while the carob is a drought-resister, and it therefore occupies the rocky land above. The climatic relationship of the carob and the orange is well illustrated in the Valencia district of Spain, which contains four-fifths of the Spanish orange acres and two-fifths of Spanish carob acres.[6]

Nearly everywhere in the Mediterranean countries the carob is a supply crop. It is like corn on the American farm, something to be fed to the farm animals. A few localities export it. A few thousand tons are exported from Algeria, but it reaches its greatest commercial importance in Cyprus, where

[5] The *Origin of Cultivated Plants,* by Alphonse de Condolle, says, "It does not pass the northern limit beyond which the orange cannot be grown without shelter. This fine evergreen tree does not thrive where there is much humidity."

The following statement seems to show that carobs vary in resistance to frost:

"Eighteen degrees of frost do not injure the carob to any extent. Frost conditions that did marked damage to citrus trees made no impression on carobs growing within a few feet of them." (Monthly Bulletin, State Commission of Horticulture, Sacramento, Calif., Vol. V, No. 8, "The Carob," p. 292.)

[6] An unpublished report of American Consul C. I. Dawson at Valencia, Spain, January 28, 1913, "The carob is a leguminous growth, indigenous to the shores of the Mediterranean Sea and particularly to the east coast of Spain, where for centuries it has been the principal forage crop of this intensely cultivated region. The tree is not frequently cultivated as a crop of primary importance. Except for a few well-kept plantations it usually occupies the least valuable parcels of land in the irrigated plain.

"The tree apparently flourishes equally well in any soil except stiff clays or other compact formations.

"The flowering period begins at the tenth or twelfth year, but forty or more years pass before the tree is in full bearing. Then under normal conditions the hardiest varieties will yield crops with little variation from year to year, for generations and even hundreds of years.

"The average annual yield of carobs per tree is placed at no pounds, the carob furnishes twenty per cent. of the exports. The export next in importance is animals, which are in part the product of carob food.

THE YIELD OF THE CAROB TREE

How much do carob trees yield? It is very difficult to get reliable figures of yield of crops. This is true even for apples in the United States. Since most Mediterranean carobs are grown helter-skelter in chance and irregular locations, most figures are estimates and in making estimates it is easy to let the influence of the phenomenal tree [7] run away with the lead pencil.

and in cultivated plantations 24 trees are set out to the hectare (2.47 acres). At the current market price of the fruit—76 cents a bushel (60 lbs.)—the crop would return $33.44 gross per hectare. Cultivation is estimated to cost $14.00 per hectare, leaving a net income of $19.44 to which may be added $2.20 for the prunings (which are sold as fire wood). This gives a profit of 8.65 per cent. on an estimated investment of $250 per hectare including the cost of the land, budded stock, cultivation, and compound interest on the actual outlay until the tree begins to bear profitable crops. In 1910, 271,000 acres in this consular district were reported to yield an average of 1,180 pounds of carobs per acre.

"In the vast irrigated plain of Valencia there exist a few important plantations which produce per tree far in excess of the no-pound average above stated. Individual trees frequently yield 600 to 900 pounds of carobs every year, and instances are known where crops of two and three times these figures were gathered from single trees. Cultivated plantations are quite profitable to the owners and amply demonstrate the possibilities of the carob tree under the most favorable conditions of care and cultivation.

"The carob is commonly used in conjunction with fresh and dry alfalfa as fodder for draft animals in heavy agricultural and industrial work and less extensively as forage for sheep, goats, cows, and hogs. It undergoes no process of manufacture or treatment whatever, being fed to the stock as gathered from the trees. Sometimes the meat of the finer varieties is ground and used with wheat flour in the daily diet of the poorer classes.

"Despite the economic value of the carob tree, its easy and inexpensive cultivation in soils often valueless for more remunerative crops, the regularity of yield, and the simplicity of the harvest, it is doubtless true that both acreage and production are declining. The reason is said to be the improved conditions in the orange and olive industries, the extensions of which are made at the expense of the carob."

[7] "The yield of these pods per tree is often great. Some trees frequently

The United States Consul Dawson at Valencia got a Spanish figure of one thousand one hundred and eighty pounds per acre as the average annual production.

As the result of a conference between a leading dealer and the local agronomist official in the town of Faro in South Portugal, I was told that the ordinary carob tree would yield one hundred to one hundred and thirty pounds; a very good tree three hundred to four hundred pounds; and an unusual tree sixteen hundred to eighteen hundred pounds. They further said that ordinary land with carob would bear on the average about forty-four hundred pounds per acre, and that a good stand of carob trees raised the value of rocky ground from three hundred to seven hundred dollars per hectare (2.47 acres).

In this locality the carobs were very common. They were almost always in sight and almost invariably standing at random where a tree had sprung up by chance and then had been grafted. Personally I prefer to cut this figure of average yield in two.

Mr. Louisides of Larnaca, Cyprus, says, "We very often see large trees yielding nine to ten hundred weights," and he claims that there are farms in Cyprus that make more than one hundred hundred weights per acre per year on the average. This gentleman, who was a leading steamship agent of Larnaca and an esteemed correspondent of the American Consul at Beirut, reiterated this and other strong statements after I had expressed some doubt about the statements being accurate.[8]

produce as much as eight hundred or nine hundred pounds." *(The Scientific American,* January 11, 1913.)

A circular on cultural directions for the carob issued by the U. S. Department of Agriculture, January 21, 1908, speaks of trees that may reach sixty feet height, seventy-five foot spread, and a yield of three thousand pounds of beans.

[8] Letter from P. J. Louisides, Larnaca, Cyprus, August 29, 1913:

"As the carob tree in Cyprus is self-planted, it is rather difficult to estimate the exact yield per acre.

"Generally there are fifty to sixty trees in an acre of land at the age of

ACTUAL FIGURES AND A TWO-STORY AGRICULTURE

Of only one regularly planted carob orchard have I had an absolutely measured record of which I am reasonably sure. The owner was an educated Frenchman, M. Chouillou, living a few miles up the river from Bougie on the northern coast of Algeria. His trees, which were twenty years old, were planted on well-drained alluvium. They were interplanted with grapes. There was still almost a full stand of grapes. Often only one vine was missing where the carob tree stood. From the sixteenth to the twentieth year in addition to a full crop of grapes this orchard produced on the average eight hundred and seventy-five pounds of carob beans per acre. The selling price was the same as that of corn, and taking fifty-six pounds to the bushel it figures up to 15.6 bushels per acre and compares favorably with 19.7 bushels of corn reported by the United States Department of Agriculture for the five years, 1921-25,

fifty to five hundred years, and each tree brings in one to eight cwt. a year according to the age of the tree and fertility of the ground.

"After a careful inquiry in the matter we find that these trees yield seventy to eighty cwt. in an acre each season, and this quantity is considered out here quite normal.

"Trees which are grown in fields yield much more fruit than those on the mountains, and we very often see large trees yielding nine to ten cwt.

"The quality of carobs produced in the fields is much inferior to those on the mountains.

"It occurs that the crop is sometimes less than the usual outcome, but at any rate there is always a crop. We do not take into consideration the large trees which yield more than two cwts., and we can assure you that there are farmers who earn more than one hundred cwt. per acre every year.

"P.S. One cwt. is equal to one hundred and twelve pounds."

Letter from P. J. Louisides, Larnaca, Cyprus, May 22, 1913:

Locust tree, Supplementary Report submitted by U. S. Consul at Beirut, dated April 24, 1913. "The annual rainfall of the region in Cyprus producing the locust beans varies from 21.88 to 27.25 inches. As we have already said, the locust tree can be planted in any land except in marshy places. It grows in rocky places and in limestone too and withstands the driest weather.

"The locust tree in Cyprus is found self-planted on unplowed rough land."

in North Carolina; 14.3 reported for South Carolina; and 12.3 reported for Georgia.

The above figures of yield, eight hundred and seventy-five pounds, should be compared with the eleven hundred and eighty pounds per year reported by Mr. Dawson for the Spanish crop.

I wish to emphasize the great value of this French testimony as to accuracy and also as to its significance as an example of the two-story type of agriculture. The plantation was run by an intelligent Frenchman assisted by his educated grown son. Their plantation of grapes, interspersed with carob trees at a distance of fifty feet, was as regular as a geometric diagram and as clean as a Chinese garden. The grapes were sprayed by American machinery. I asked about the yields of the carob. The men took me into a neat stone building. Near the door stood a good platform scale suitable for weighing sacks or packages. We went to the office in one corner and there they showed me books in which were recorded tables of yields for a dozen years. A druggist could not have seemed more exact.

They emphasized the fact that barley grew well right under the carob trees and said that the yield of grapes was absolutely the same as that of similar lands alongside which did not have carob trees. The appearance of the grapevines gave support to the claim. The effects of the open top of the carob trees and the blazing Algerian sun need to be considered. Fifteen hectares of newly planted carob demonstrated the satisfaction of these French farmers [9] with the twenty years' experiment.

They told me that work mules doing full labor did well on the straw of oats and all the carob beans they would eat.

[9] Their method of planting was: Get seeds from a manure heap. Plant them in pots. Transplant to the field when one meter high. Bud the next year. Get the first fruit four or five years later. It should be noted that their plantation (Fig. 31) was only twenty years old, which would be considered young for carob.

THE ABILITY OF THE CAROB TO STAND ABUSE

After having traveled through the carob districts of Spain, Portugal, and Algeria, I wonder that many of the trees can yield at all, so shocking is the treatment to which the soil has been subjected for centuries. The trees almost invariably were scattered at random on rough land that was pastured. Pasturage is a steady removal of fertility. In most cases the good soil has been removed by the erosion of tillage, by hoof beats, and by the pattering of rain drops. Often little but a rocky framework remains. The bean crop is also usually carried away from the trees—another removal of fertility.

Certainly the soil of an average Mediterranean carob plantation has been treated worse than the test plats of Rothamstead Experiment Station, England, which have been continuously in wheat for generations in order to test the fundamental and enduring fertility of the soil, which in that case proved to be about enough to yield eight bushels of wheat per acre, a quarter of the average English yield.

THE CAROB IN CALIFORNIA. WILL IT BE A HUMAN FOOD?

After these many centuries of Old World experience the carob has joined the procession of Mediterranean crops emigrating to that section of the United States (California) having the Mediterranean climate. California suddenly discovers that it has carob trees, much carob land, and the possibility of an industry.

In hustling California this millennial crop tree is still in the introductory stage, but it has received the scrutiny of the inventive Yankee mind, and discoveries which may help to revolutionize the industry have already been made and put to work.

One of these discoveries applies to the growth of the trees, and others to the use of the beans. For years I have been

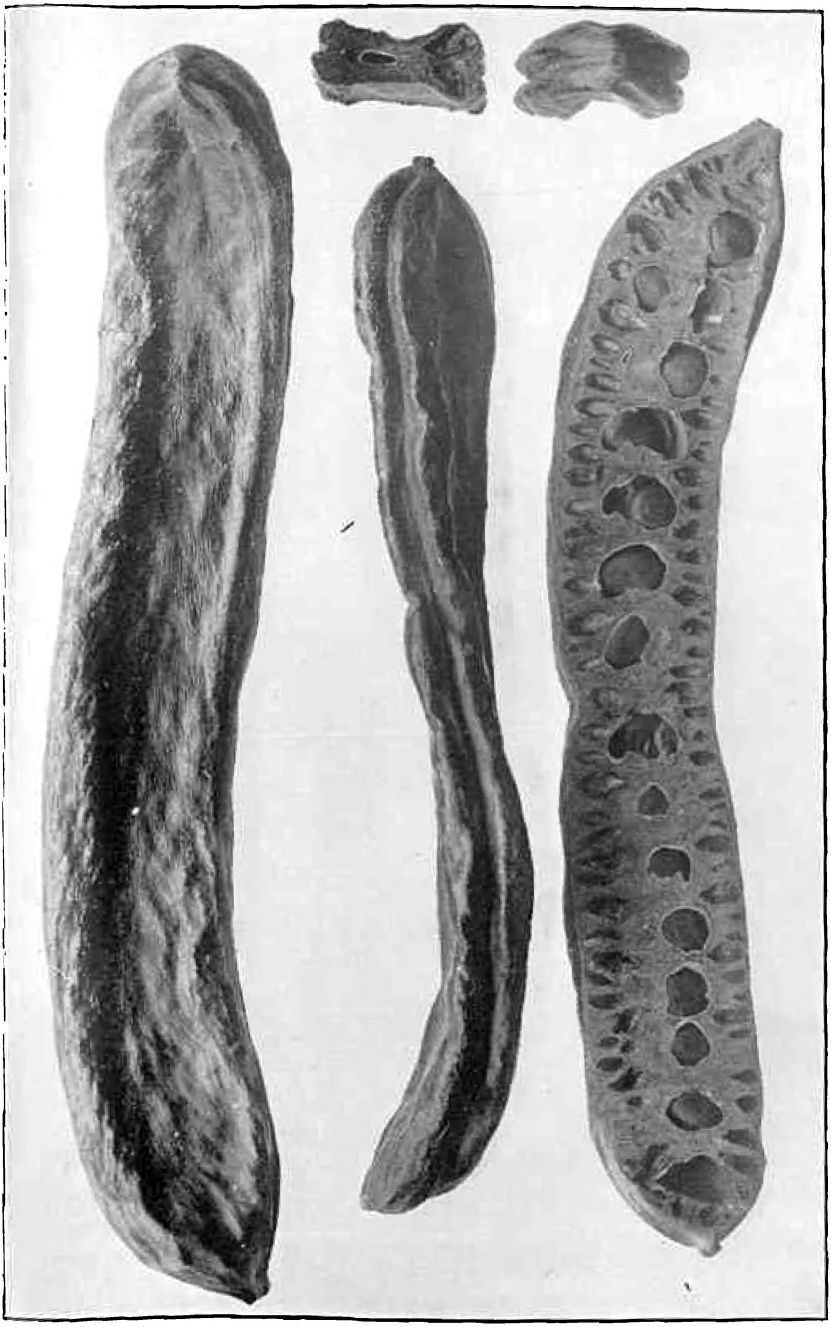
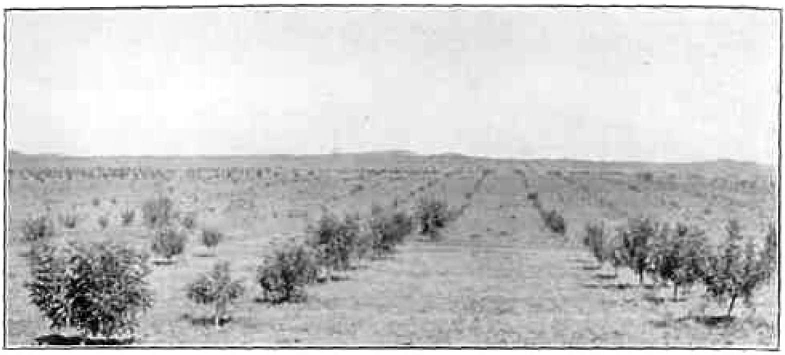


FIG. 27. Carob beans, showing their great pod development, and small seeds. Life size. (Courtesy U. S. Dept. Agr.)



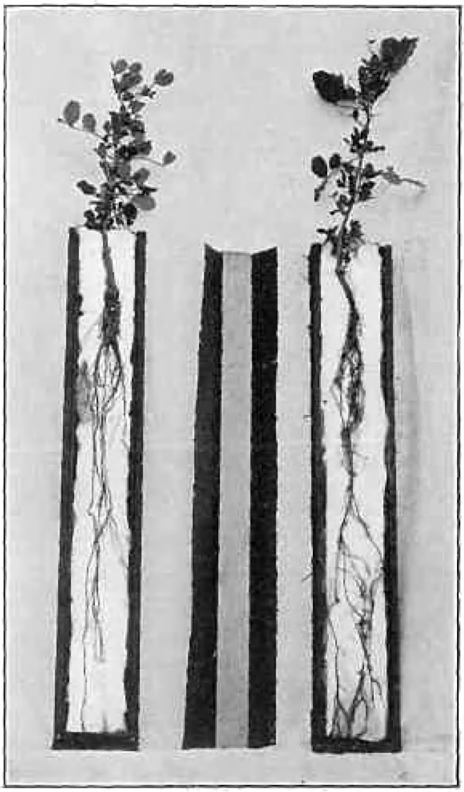


FIG. 28. *Top*. An expanse of young carobs on the eastern foothills of the Great Valley of California.—FIG. 29. *Bottom*. Young carob plants showing root development resulting from growth in slats. This long root, in combination with ability to plant it uninjured in a vertical position with minimum of effort, is an invention of great importance for tree crops in dry land agriculture. (Photos H. J. Webber.)

stating that it was possible that tree crops such as chestnuts and acorns might be made into acceptable human foods by machine manufacture in factories. Nevertheless, it was with some surprise that I found some Californians of 1927 turning out acceptable factory-made food products from the carob beans imported from Europe. In 1927 one Los Angeles company claimed an output of many loaves of carob bread a day.[10]

It is said that the carob makes excellent cereal, candy, and syrup[11]—a pound of syrup from a pound of beans—a fact that is almost staggering. The candy, which seemed also to have coconut in it, as well as the easily recognized carob flavor, was an instant success in my family; and we all liked the flavor of syrup made from carob.

The analyses of carob (page 302), with its very high sugar

[10] I call this rainbow bread. I could never quite find the end of it. As the story came to me first it was one thousand loaves per day by one company, and I saw an airplane picture of a vast factory labeled "The Home of Carob Bread." It looked almost as large as an automobile factory. I tried to verify. I could never find that factory, but I was credibly informed that the bread industry had been primarily brought about by persons trying to sell new-planted carob land—new bait in an old, old, yet ever new game. Latest reports indicated (January, 1928) that the land-selling idea had collapsed and that the bread industry was surviving, 1,200 one and one-half pound loaves per day—25 per cent. carob in the recipe.

Lest I should appear unsympathetic, I wish to state my belief that carob beans are good material for human food. This is true of at least two hundred other materials not now used to any large extent or not used at all for food in the United States. The question is, who can make us eat these new things? A pig or calf eats what is set before him. People in rich America eat what pleases them, and one of the last things any reformer can do is to change food habits. Apparently there is no reason other than inertia why carob bread should not come to great importance. Food factories now open the way (Cf. p. 153), but don't forget inertia.

[11] Mr. Lawrence Holmes, a large grower at Arlington, California, wrote June 16, 1927:

"Every pound of carob makes a full pound of carob syrup, which I consider far superior in flavor to maple sugar. It is sweeter and goes further. It mixes exceedingly well with milk and preserves the milk to keep twice as long; and if one did not know that the milk was mixed with carob syrup, he would mistake it for a chocolate malted milk."

content, show remarkable food values and even suggest the possibility of rivalry to cane sugar and beet sugar.[12]

Human foods from carobs must stand at present on the list of perfectly good possibilities. Meanwhile there is an open door for their use as a stock food. Carob stock food has the outstanding and perfectly established qualities.

THE EARLY CAROB TREES IN CALIFORNIA

The carob tree is demonstrating itself in California in a manner much like that by which so many other Mediterranean crop plants have come to the front. Early plantings [13] in the first few decades of American occupation resulted in fruiting trees by 1885. As a result the California State Horticulturist reported in 1890, "No tree distributed by the stations is more likely to make a popular shade or ornamental tree for dry rocky situations." [14]

In 1912 Dr. Aaron Aaronson visited California and reported that individual carob trees in Palestine produced three to five hundred pounds, and five tons to an acre might be produced.[15]

[12] The cane sugar production of Louisiana per acre for the five year period, 1921-25, was 1,988 pounds, while the beet sugar fields of the United States yielded about three thousand pounds. It may be easier to produce a ton of carob beans than of sugar beets or sugar cane. The process for manufacturing carob sugar is entirely unsolved, but in this age of chemical engineering it should be a comparatively simple matter to develop a technique if desirable.

[13] H. J. Webber, Professor of Sub-tropical Horticulture in the University of California and Director of the Citrus Experiment Station at Riverside, says in a letter of February 14, 1927:

"The carob has been planted more or less all over southern California, largely as a street tree, but in some places commercial plantings have been made. The tree has proved hardy and very drought-resistant. After it is once started it thrives fairly well without irrigation, which indicates that it is quite drought-resistant, as it is very few plants, for instance the pepper tree and eucalyptus, that manage to survive at all here in southern California without irrigation."

[14] P. 431, Bulletin 9, California Agricultural Experiment Station, article entitled *The Carob in California,* I. J. Condit, June, 1919.

[15] "Dr. Aaronson, of Palestine, who attended the Fresno Convention in 1912, said that seedling trees will produce an average of 350 to 500 pounds

This statement seems to have started the Californian mind to examining the Californian carobs. The Experiment Station reported that carob beans tested out a little better than barley when mixed with milo and fed to calves for 13 weeks as a grain ration supplementing the milk and alfalfa hay ration fed in addition.[18]

Mr. C. W. Beers, Horticultural Commissioner at Santa Barbara, went up and down the state studying carob trees. He told me in June, 1917, by letter, that twenty-year-old seedlings, fourteen feet across the tops, had produced one hundred and fifty pounds of beans for three consecutive years.[17]

per tree. Twenty trees to the acre will thus produce three and a half to five tons each year. He reports grafted trees, eighteen years old, bearing nine hundred to eleven hundred pounds each." (The Monthly Bulletin, State Commission of Horticulture, Sacramento, California, Vol. V, No. 8, p. 290, *The Carob.*

[16] University of California publications, Bulletin No. 271, September, 1916, by F. W. Woll and E. C. Voorhis:

Lot I, Carob pods and ground milo, 1:1 by weight.

Lot II, Ground barley and ground milo, fed in the same proportion.

SUMMARY OF RESULTS OF TRIAL IV

Average age at beginning, Lot I, Carob and milo . . . . 28 days
Average age at beginning, Lot II, Barley and milo . . . . 30 days

	Lot I	*Lot II*
Average weight per head, at beginning, pounds	131.8	116.7
Average gains in body weight per day, pounds	1.81	**1.70**

[17] C. W. Beers, Horticultural Commissioner, Santa Barbara, June 14, 1917, "The carob trees that are bearing one hundred and fifty pounds each are about twenty years old. They have never had any attention since having been planted and have fought their way in land well grassed over, never having been irrigated. They are about twelve feet to fourteen feet across and about the same in height."

Letter from Mr. Beers, June 30, 1917:

"The carob mentioned as bearing one hundred and fifty pounds a year has been very regular in this production for the past three years, which is as long a period as I have been observing them. I believe they can be considered as regularly bearing this quantity.

"The ground upon which these trees are growing is overlaid with a very heavy deep clay hard pan, which precludes the probability of sub-irrigation. The rainfall is about fourteen inches a year. The land is sloping towards

CALIFORNIA CAROB POSSIBILITIES

The geographic possibilities for carob culture in California seem to me to be excellent. The carob grows in orange climate. California has a large area with orange climate. As a thermal belt above the frosty valley floors it stretches for a great distance along the eastern edge of the Great Valley. It also rings around much of the shore and lowland between San Francisco and San Diego. Please note that I am speaking of orange *climate* (temperature). Since the orange trees are water hogs and California is a land of almost rainless summer, the orange can only be grown where irrigation is possible. Naturally this is but a small fraction of the land with orange temperature. Therefore, the major part of California land having orange temperature cannot become orange land, but much of it may become carob land, since this tree can survive and even bear a light crop in the rainless summer. Sample plantings years ago have proved that the carob will thrive over an area much larger than the possible orange area.[18]

the ocean and is a heavy soil, but is probably not over two hundred feet elevation above sea level. It is about three miles to the ocean front.

"The remark about being grassed over may need this explanation, namely, that the grass is green only through the winter and early spring, while at this time of the year it is brown and apparently dead."

Mr. Beers had published a similar summary in the *California Cultivator* of April 9, 1914.

[18] University of California publications, *The Carob in California,* by I. J. Condit, Bulletin No. 309, June 1919, says:

"Experience has shown that the trees when young are no hardier than orange trees. When once established, however, the carob is more frost-resistant than the orange. . . . Even if the blossoms escape injury from cold and rain, the developing fruit is liable to be killed by frost later on. For this reason the successful production of carob pods in the interior valleys is practically limited to the citrus belts along the foothills. The carob tree thrives in regions of intense heat, such as the Imperial and Coachella valleys where the winters are mild."

Mr. G. P. Rixford, Physiologist at U. S. Department of Agriculture Field Station, Crop Physiology and Breeding Investigations, San Francisco, California, said in a letter of February 6, 1917, "It frequently happens that the flowers which are produced in late fall or early winter are destroyed by frost, which does not affect the tree itself but prevents its fruiting.

Can California have a vast carob industry? Probably, but it will take years of experiment to prove it.

(a) *Most of the roadside carob trees of California have been watered a little*. Therefore, we cannot predict too much from them. The carob *industry* must depend on rain and rain only. Twenty-five years of test in twenty-five localities may tell how good the carob is for an industry in California. This book is being written to urge *testing* and improving. It does not urge large-scale commercial plantings of things that do well in single trees.

In favor of the carob is the fact that Californians know little of the tree-crop possibilities of their unirrigated land because they have not yet tried the complete conservation and use of all rainfall (see Chapter XXIII on farm practice, especially water-pocket irrigation).

(b) The roadside tree or any isolated tree is a liar (almost) anyhow. The tree itself is of course innocent, but it is a great aid to a liar. One of the greatest lie recipes on earth is as follows: Take

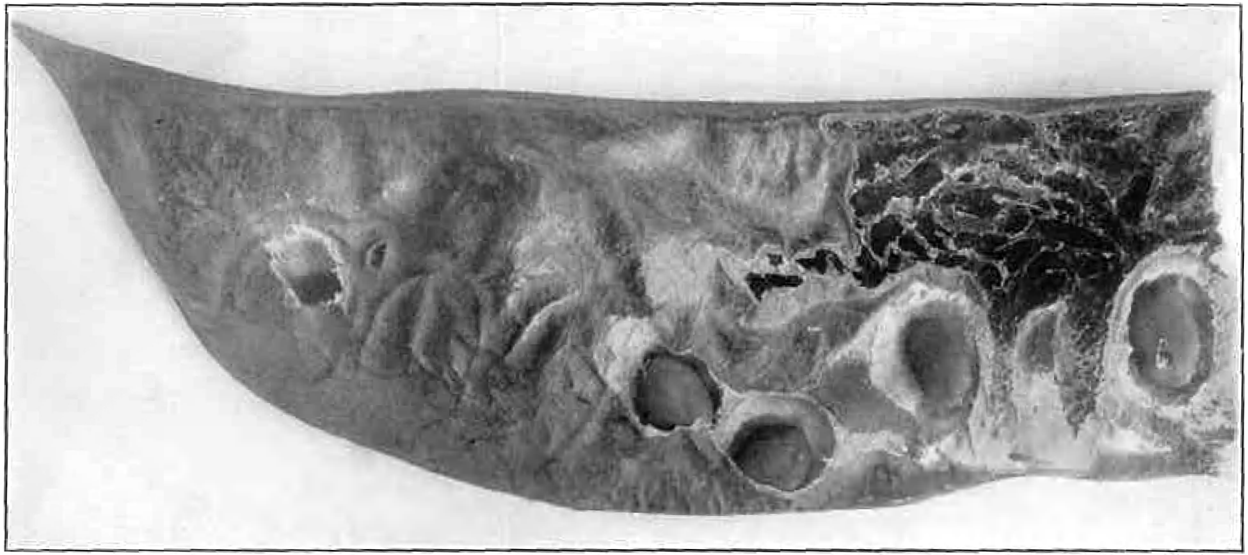
(1) A single tree

(2) A number of trees per acre

"There are trees near Centerville, Alameda County, planted by the late Professor E. W. Hilgard, University of California, that are now thirty years old and are annually producing regular crops of pods. The cold wave of January, 1913, was the severest frost in thirty years. Trees growing as far north as Biggs, Butte County, were somewhat injured but have fully recovered. I think this may be considered, perhaps, the northern range of the tree in California. In most parts of California, the tree must be planted in the least frosty localities, which are usually not far from the sea, or in the citrus belt of the Sierra foothills. The tree will certainly endure as much frost as the orange, but for the reasons mentioned above may fail to produce its crops of pods. However, it is a beautiful tree and is worth growing for ornament and can be successfully grown over a large part of California, and where the conditions are favorable it will be a very profitable producer of pods, which are equal in nutrients to barley for all kinds of stock and even for poultry when ground."

Mr. G. P. Rixford in another letter of February 26, 1917, said:

"I have no doubt there are large areas about and above the citrus belt where the tree could be planted with reasonable expectations of success."



Courtesy American Genetic Association

Fig. 34. Life-size part of honey locust bean winning prize given by American Genetic Association, 1927. The beans are grown in a thin edge of bean containing little nutriment. The sugar grows in black masses at the side of pod, shown by cutting away part of husk. (See Fig. 35.) This picture shows a little more than one third of the whole bean.

trees for highway planting with excellent results. A careful investigation shows, however, that many of these seedling trees are maturing crops ranging up to eight hundred pounds. Quite a number have been reported as yielding three hundred and fifty to six hundred pounds.

"I have experimental plantings aggregating about seven acres, some of which are four years old, budded and beginning to bear. My experience in bringing them on is what makes me interested in the proposed economic unit."

A particular tract of land that was yielding less than one-half ton of barley to the acre on the California continuous-soil-rubber-gully-washing system has been planted with carob. These pioneer planters are figuring on three tons to the acre. In the absence of all acreage data they would do well to divide this in two. In considering yields it should be remembered that the carob is a legume furnishing its own nitrogen, and nitrogen shortage is one of the great troubles of California agriculture, as it is of most other agricultures.

The conservationist should note that since the carob tree lends itself admirably to the small reservoir system of water conservation described on page 262, we may expect two checks on erosion—one with its roots and one with its field reservoirs. This latter might be one of its greatest advantages to the state through increase of water supply (page 289).

A NEW METHOD OF PLANTING TREES

A very important Yankee discovery in connection with the carob is a greatly improved system of transplanting the trees. The young carob, like most trees of arid lands, has a root several times as long as the top. Thus it survives drought. But transplanting becomes a problem in a climate of 100° F. in summer, where there is no rain from April until October or November, and then only twelve to twenty inches in a season of winter rain. Planting the little seeds in place is slow and difficult, and the rabbits eat the leaves of seedlings if they can reach them. Growing in a pot is exasperating and at times injurious to a tree that yearns to send roots straight into the ground and needs such a root when it gets to the field. Some California genius invented the so-called splint system. The tree is grown in a little tube of earth an inch or more square and two or three feet long, walled in by four plastering laths. These lath tubes are arranged in banks inclined at an angle of sixty degrees. One lath is soaked in nitrate of soda solution, and to this the little tree clings as ivy to a pole. Thus the little four-inch tree with two feet of roots sticking fast to the lath may have its whole long root system inserted into a crow-bar hole deep in the ground.

This discovery alone may make success where before a very high percentage of loss might have meant delay and greatly increased cost.

ACTUAL PLANTINGS FEW

In addition to roadside trees a few plantings have been made, some of them over large areas.[20]

A carob boom may be expected any time, and I would not be surprised if this tree becomes the basis of another series of extensive land swindles of which there have been so many in the history of American agriculture—a swindle based upon small tracts planted by the promoter for absentee owners. There are few surer bases of loss for the investor. This hard statement has been proved over and over again with apples, oranges, and pecans and probably will be proved several more times. Perhaps the carob will be the next demonstrating

[20] Mr. Lawrence Holmes, Box 253, Arlington, California, in a letter of June 16, 1927, said, "Carob pods grown here which I have had analyzed by food chemists give the fruit from one tree located in the city of Riverside 24 per cent, protein and 47½ per cent. carbohydrate; hence we have a food that becomes a headliner and which has a greater variety of uses than any product that I know of growing on earth.

"I have about 1,500 acres planted, all of which have been budded to the best varieties. Most of these buds were taken from the tree mentioned above."

medium. The stage could scarcely be set better—cheap land, good for little else; an exotic plant; an old industry; the charm of the word California; the magic of distance, for swindles brighten as the miles increase. Comparatively few people get stuck by the industry around the corner.

There is little reason to believe that we are growing carobs of the best varieties obtainable. We are probably propagating nothing but chance seedlings. The slowness with which many of the best varieties come into bearing would indicate that proper breeding might produce much more precocious strains. Like many other trees they vary in resistance to cold—offering the possibility of more frost-resistant varieties.

The table of analyses on page 302 shows remarkable variation in content. See especially in that table the figures in No. 2201 and 2371, and the protein variation between the maximum and minimum of the whole bean (pods and seeds); these offer interesting possibilities of breeding carobs of special qualifications such as high in sugar for sugar manufacture or high in protein for milk-making and growth-making foods.

Carob improvement offers two lines of work:

(a) Crossing carobs.

(b) Hybridizing carobs with some of the numerous allied species, particularly some of the American mesquites and the South American algaroba (page 73), which have so much greater resistance to frost. A strain of the Hawaiian algaroba might add both precocity and productivity. This is work for individual enthusiasm,[21] for private endowments, and for state experiment stations supported by legislatures with vision. Where are these stations?

[21] One Californian is said to have devoted a private fortune to breeding avocados. I'm sure he had a lot of fun and rendered a great service.

CHAPTER VII

A STOCK-FOOD TREE—THE HONEY LOCUST

A TREK OF WIDE RANGE

The algaroba (keawe) of Hawaii is limited to the arid and semi-arid lands of the frostless tropics, and apparently it must be situated close to sea level. The carob is limited to the orange-growing sections of regions with the Mediterranean type of climate. But the Creator did not neglect the humid East. The honey locust (gleditsia triacanthos), a cousin to the carob and keawe, offers a great crop possibility to a million square miles of the eastern United States in the climates of corn and cotton. This promising tree is native from New York to Nebraska, from Louisiana to Minnesota, and has proved its adaptability beyond this area.[1] It does well in California, for example.

[1] "Of all the species tested in many parts of western Kansas, the honey locust is the most conspicuous success.

"Its rate of growth is only moderate, but the rate is maintained for many years. A large proportion of the trees planted have good form; and they are strong in stem and branch, not often injured by wind or ice storms.

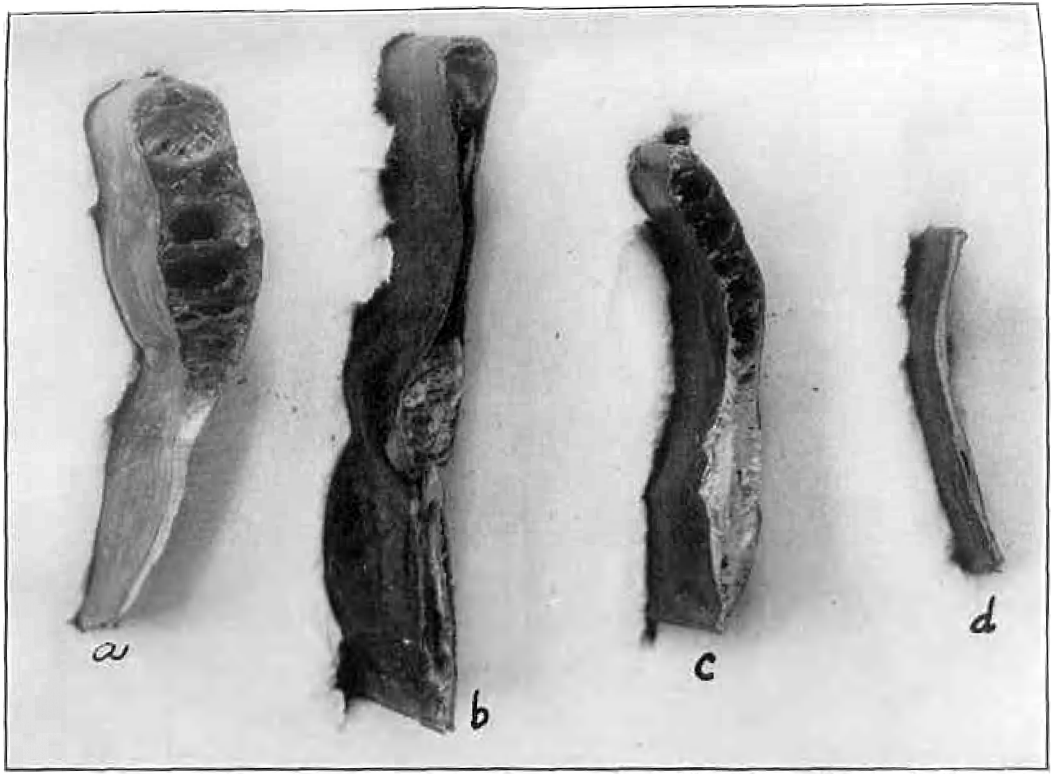
"In a demonstration block planted eighteen years ago and neglected for so long a time that the buffalo sod had gained a secure foothold, the honey locust has made a very creditable growth. The best trees have reached a height of twenty-three feet and a diameter of six inches. At Dodge City the honey locust trees have done very well indeed." (Kansas State Agricultural College Experiment Station, Bulletin 165, pp. 316-17.)

Ft. Collins, Colorado,
September 11, 1916.

"It will stand as much exposure as any other forest tree that we have. We have some groves in this section doing well without irrigation with a normal rainfall around fourteen inches.

"(Signed) E. P. SANDSTEN."

"This species is particularly adapted to the West, as it stands considerable drought and low temperature. It grows very well on the high table



Courtesy American Genetic Association

FIG. 35. Cross sections of different prize-winning honey locust beans, exaggerated 50 per cent. to display the variations in cross section, therefore variations in place where sugar is concentrated. That marked *a* is the prize-winning bean shown in Fig. 34. This tendency to vary suggests interesting possibilities to result from breeding experiments.

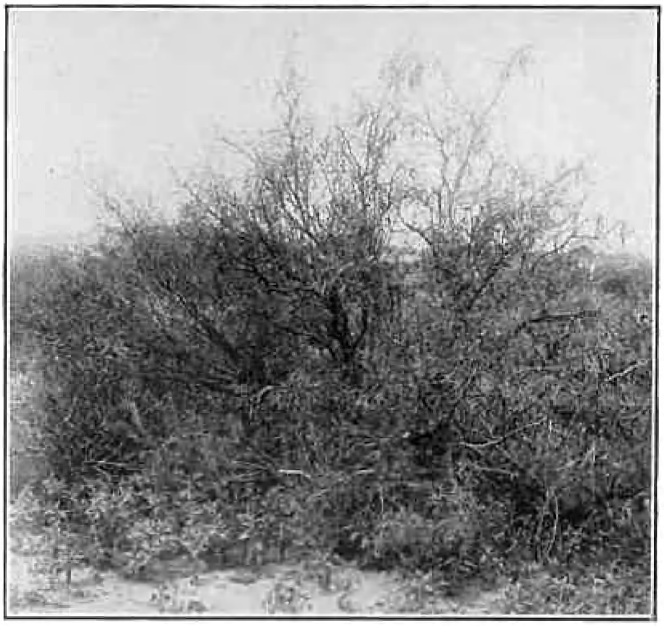


FIG. 36. *Top.* The top of an old fallen honey locust tree at Wake Forest, N. C, showing the full crop of beans that this species sometimes bears. (Photo J. Russell Smith.)—FIG. 37. *Bottom,* Mesquite bush showing the scanty development of the leaves and full crop of beans which, being about six inches long, show that the bush is larger than it appears; perhaps eight or ten feet in height. (Courtesy U. S. Dept. Agr.)

A VALUABLE STOCK FOOD

Like the algaroba and the carob, the beans of the honey locust are greedily devoured by farm animals and sometimes are eaten by the children.[2]

Compare its analysis with that of wheat bran and corn, page 302.

Speaking of his locust beans a farmer said affectionately, "They hang on the tree close as your fingers. They hang on there till a freeze comes and then they turn black and fall off and the cows get in then and eat 'em. Maybe they don't like 'em!"

He pointed to a honey locust tree in his field that had filled a two-horse wagon full of beans, which was about ten bushels. The tree had a girth of sixty-four inches and a spread of forty feet. An acre would hold twenty such trees.

land in western Nebraska, where the annual rainfall is only about sixteen inches. More than almost any other tree that we have, it will also grow in a soil that is alkali. While we do not have a great deal of alkali soil in the West, there are some of the valleys where the honey locust will do very well and where other trees will fail." (Letter, Chet G. Marshall, Marshall's Nurseries, Arlington, Nebraska, March 24, 1928.)

For distribution see reports of prize contest in *Journal of Heredity,* 1927 and 1928.

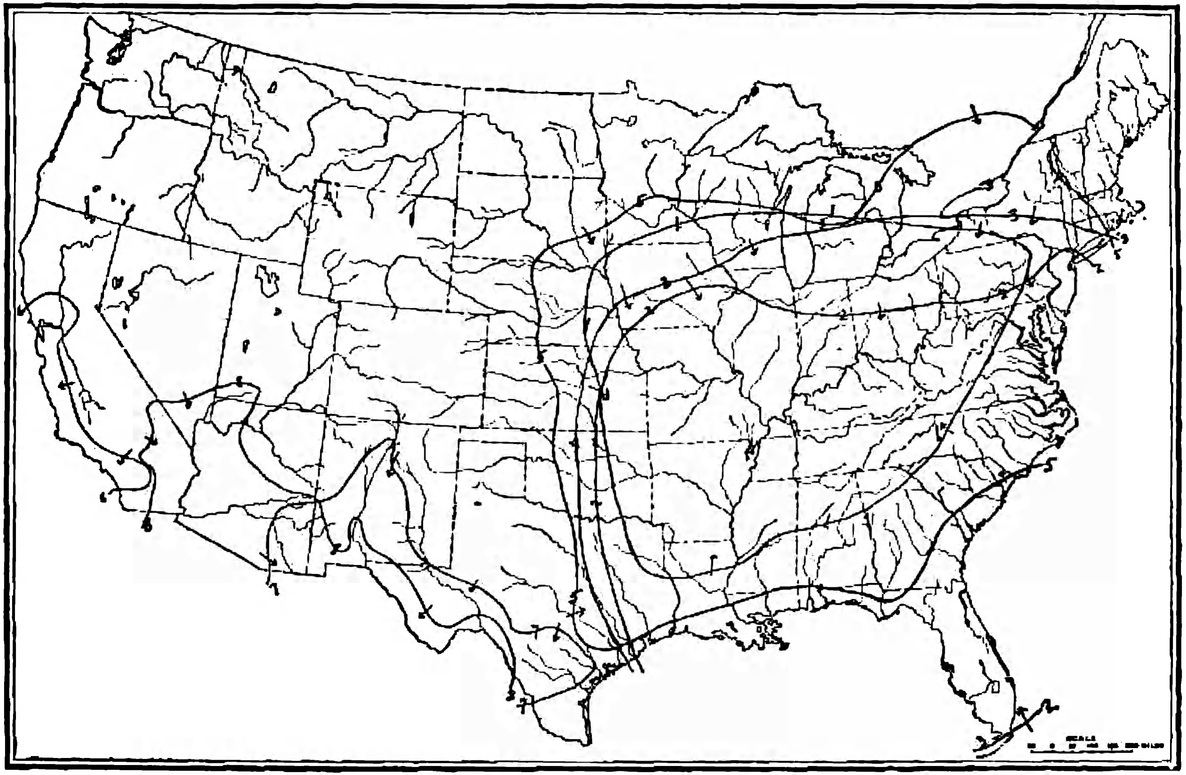
[2] Speaking of customs on the Georgia plantation of her youth, a Southern woman wrote, "One of those customs was in regard to the honey locust. Not only the pigs and cows ate the pods that dropped from the honey locust, but the negroes and the white children ate them as well. I can't say if all the grown-up white people ate them, but I know that my mother approved of our eating them, for she liked to eat them herself." (A letter from Mrs. J. W. Carlin, Alva, Oklahoma, Aug. 3, 1914.)

Much interesting correspondence about honey locust has come into the office of the *Journal of Heredity* in response to offers for prizes for the best honey locust tree. There seems to be a widespread conviction that the beans are prized by nearly all kinds of American live stock. Several excerpts from these letters are as follows:

"The cows eat the beans as fast as they fall."

"And all bear an awful big crop of beans which the stock like so well that they will break down the fence to get them."

"The cattle ate the pods I gave them with great relish."—*Journal of Heredity,* Vol. XIX, p. 223.



MAP EXPRESSLY PREPARED BY MR. W. H. LAMB

Forest Service, U. S. Department of Agriculture

Lines enclose areas showing natural ranges for the following species, as named by Mr. Lamb:

1. Honey Locust, Gleditsia triacanthus
2. Persimmon, Diospyros virginiana
3. Mulberry, Morus rubra
5. Black Walnut, Juglans nigra
6. California Walnut, Juglans californica
7. Mesquite, Prosopis juliflora
8. Screwpod mesquite or screw bean, *Prosopis odorata*

I have found one man who had planted some honey locusts that his cattle might eat the beans in the field and also that he might harvest the beans for winter forage. That man is Lamartine Hardman, Governor of Georgia.

THE FINE QUALITIES OF THE HONEY LOCUST TREE

This tree has a remarkable list of qualities.

(1) It is beautiful and a good timber tree with a strong, durable, and beautiful wood.[3]

(2) It is a rapid grower.[4]

(3) Like the carob and the algaroba, it is a legume gathering nitrogen from the air to make its own proteins. This also enables it to fertilize the earth for other plants.

(4) It is an open-top tree through which much light can pass to crops below, thereby favoring a two-story agriculture, like the carobs of Algeria (page 50). This is especially valuable for pastures. It is possible that in some situations a pasture might be as good with honey locusts as without them.[5]

[3] "This wood is heavy, hard, and strong, generally ranking with or above white oak in these properties but somewhat below those for black locust. Honey locust is not important from the lumberman's standpoint, although a few logs are occasionally sawed into lumber. The principal use of the wood is for posts and railroad ties, as it is quite durable in the ground. The lumber is generally used for furniture and inside finish of houses and is said to be often mixed with sycamore for these uses." (A letter from H. S. Betts, Engineer in Forest Products, U. S. Department of Agriculture, Forest Service, Washington, Jan. 28, 1927.)

[4] "It is a rapid grower; an annual increase of two feet in height and one-half inch in diameter is not uncommon in favorable locations for a score or more years, and in less favorable locations it will generally add a foot or more in height, and in diameter fully one-third of an inch." (Elliott, *The Important Timber Trees of the United States,* pp. 324-25.)

[5] An editorial in the *Breeder's Gazette,* 1926, emphasizing this point, led to the following detailed report about a hillside planted to the *black* locust, robinia pseudacacia, a tree with agricultural characteristics greatly like the honey locust:

"The ground on which the locusts were planted consisted of a hillside, sloping abruptly to the south. It has two rough gullies in it. The land is unsuitable for cultivation both because of the roughness of the two gullies and the steepness of the slope. The virgin timber had been removed before the farm was acquired by my father. The soil was covered by a good bluegrass sod; but the exposure to the sun was such that the grass dried up

(5) It is a productive tree. One correspondent tells me of a tree producing six consecutive crops estimated at twenty bushels each.[6]

Mr. J. M. Preston[7] of the Branch Experiment Station at Hays, Kansas, gathering seeds for planting, reports a tree with seven-inch or eight-inch trunk, producing eighty pounds of beans, and another tree in Manhattan, Kansas, from which he gathered "about four hundred pounds of pods." He reported that this tree had a trunk of two and one-half feet in diameter, broad top, and bore in 1911 and 1912, but failed in 1913.

(6) Frequent reports of consecutive crops[8] seem to indicate that the honey locust is a regular bearer as trees go, and apparently it can be expected to produce crops with greater regularity than most fruit or nut trees.

early in the summer. It was with a view to making this land valuable for pasture that the locusts were planted. Young locusts were planted early in the spring and the ground covered with straw to hold moisture until the trees became properly rooted. The locust trees soon shaded the ground, and the pasture on that hillside has been excellent ever since. Aside from the pasture this tract has yielded a large number of fence posts." (Letter from Llewellyn Bonham, the Bonham Engineering Company, Oxford, Ohio, February 23, 1927.)

[6] "This tree has borne uniformly large crops for six years consecutively to my knowledge. I have never measured or weighed the pods but I have thought that twenty bushels would be a minimum estimate.

"It is a big nuisance as far as the lawn is concerned.

"As the pods are falling through a long season, many lodge on the roofs and are blown to quite a distance sometimes." (A letter from S. P. Thomas, Ashton, Maryland, August 4, 1913.)

[7] Letter, August 18, 1913.

[8] "In regard to the honey locust, will say that the fruit of this tree is rarely injured by spring frosts and the result is we have a heavy crop every year." (A letter from C. C. Newman, The Clemson Agricultural College of South Carolina, Clemson College, South Carolina, July 17, 1913.)

"It has so many beans that the branches bend down like a fruit tree." (L. F. Quisenberry, R. No. 2, Moberly, Mo.)

"The tree grows in a Bermuda pasture and is always loaded in the fall with luscious fruit. The cows and hogs stand under it, always ready to devour every pod that falls. The tree is very large and very, very beautiful. The cows improve in milk and the hogs in weight when the locusts ripen, for there are always bushels and bushels on the tree." (Ellen Williams, Goldworth Farm, Villa Rica, Ga., R. No. 4, Box 10.)

(7) The honey locust bean is of large size. This should make the crop easy to harvest. The beans are often one foot or more in length [9] and 17 prize beans in the *Journal of Heredity* contest 1927-28 weighed a pound when bone-dry after weeks in the house.

This large size, taken in connection with their tendency to curl up, should make them easy to harvest, possibly even with a rake. I have not tried it, but I think that large quantities could be raked up in a short time, even on ground that was not entirely smooth. Perhaps a special rake would need to be devised. Apparently the beans could then be picked up with a pitchfork and handled somewhat like hay.

Experience with the gummy keawe (page 40) would indicate that some easy method of grinding these could be found. Thus another concentrated food could be added to the dietary of the American farm animals.

(8) Once a good honey locust tree has been found it is easy to propagate [10] either by grafting or the still more simple system of root suckers, which bear the characteristics of the mother tree.

THE URGENT NEED OF SELECTION, TEST, AND BREEDING

In view of the above facts about the honey locust and the established industrial facts of the carob and keawe, I sug-

[9] "The beans or pods are flat and black and measure as long as sixteen inches and about one and one-half inches wide; the honey lying in the thicker portion of the pod and the beans in the thin. I have seen them (trees) over eighty feet in height." (From a letter from F. F. Bessoe, Natchez, Mississippi, *Scientific American,* February 22, 1913.)

[10] "The inclination of this tree to sprout whenever the roots are broken or cut by the plow or cultivator would indicate that it could be readily propagated from root cuttings, though I have never known this to be done.

"So far as is known to us all trees propagate as true to parent type by root propagation as through budding or grafting. It would seem quite likely that honey locust would propagate readily from cuttings, though experimentation might be necessary in this." (Letter from Wm. A. Taylor, Assistant Chief of Bureau, United States Department of Agriculture, Bureau of Plant Industry, Office of Chief of Bureau, Washington, D. C, February 21, 1913.)

gest that the honey locust tree is worthy, more than worthy, of extensive investigation and experiments. If the hill farmer has a chance of raking up a one-ton or a two-ton crop of bran material per acre from his blue grass pasture, at the same time that he gets good pasture and an annual increment of wood, we should certainly test out the possibilities.

We need to select the best native trees and propagate them, and at the same time we need to breed better varieties because this species, like many other species, has much variation[11] among its millions of specimens.

Breeding from among selected specimens should produce much better strains. Then there is the indefinite but suggestive field of hybridization with other species, possibly carob, keawe, or the many species of mesquite and screw bean. (See Chapter VIII.)

James Neilson, Professor of Horticulture, Fort Hope, Ontario, wishes to hybridize the honey locust with the Siberian pea tree (caragana arborescens), because this hedge plant is very hardy at Winnipeg and bears small pods of beans.

How fine it would be if a million hills now gullying with corn or cotton or tobacco could be held in place by the roots of honey locust trees and an attendant crop of grass which ate nitrogen from the locust roots, while the landscape was made green and beautiful by the feathery tops of these trees, which at the same time yielded their ton or two of bran substitute per acre per year and also added to the accumulating sawlogs and firewood.

And yet Secretary of Agriculture Jardine tells me that his department cannot get funds for experimental work necessary to test such a possibility.

[11] "There are in certain localities in Kansas, and probably in other states, strains of the honey locust which are almost entirely thornless, and some of these are quite productive of fruit." (Letter from S. C. Mason, Aboriculturist, United States Department of Agriculture, Bureau of Plant Industry, Crop Physiology and Breeding Investigations, Washington, D. C, January 23, 1913.)

CHAPTER VIII

A GROUP OF STOCK-FOOD TREES—THE MESQUITES

Southern California has the carob for its bran tree, the corn and cotton belts have the honey locust for their bran tree, and the area between has the frost-resisting mesquites with their crops of beans. When one considers the ancient use of the mesquite, its present use, and its remarkably useful and promising qualities, it becomes difficult to understand why it also has been so greatly neglected by the scientific world.

VALUE TO INDIAN AND FRONTIERSMAN

In analysis and use the mesquite beans are much like those of the old carob in the Old World. (See analysis, page 302.) They have chiefly been food for beast, but food for man also to a considerable extent. Some Indian tribes have had mesquite bread as a staple food for an unknown period of time.[1]

A caravan of forty-niners[2] seeking the golden sands of California lost some of their oxen as they toiled under terrible privation down the Gila River valley in southern Arizona; but when they reached the Colorado, near the present city of Yuma, they came upon a "grove of hundreds of acres of Mosquit Beans. These trees were full of beans and hundreds of bushels lay on the ground. These beans were reputed to be excellent feed for the cattle. . . . We remained at this place seven days, and our cattle gained strength and flesh remarkably fast, and with the two hundred bushels of beans we had

[1] "The Pima and Papago Indians in Arizona have always made use of mesquite beans as food for themselves and their stock, particularly horses; and I think they are yet quite an important article of subsistence among the Papagos." (Levi Chubbuck.)

[2] Unpublished journal of Charles Pancoast of Salem, N. J.

loaded into our wagons, we felt warranted in making our start across the desert." [8]

As the mesquite aided the forty-niners, so it has aided many a prospector,[4] by feeding the beast that bore his equipment, but its chief use has been for animals on the range.[5]

USE OF MESQUITE AS FORAGE FOR PASTURING LIVESTOCK

Mesquite beans are especially valuable because they ripen in August at the very time when drought may be expected to reach its worst. The beans are greedily eaten by cattle, horse, and goats. As a rancher[6] put it, "I have mesquite in my pasture and value a crop of beans very highly. I let the stock eat the beans on the trees and a good bean crop means fat stock."

Similar testimony of the importance of the mesquite as range fodder comes from many parts of the Southwest. Some

[3] Unpublished journal of Charles Pancoast, Salem, New Jersey. I continue to quote: "These Yuma Indians had a bad feeling towards the white people, and their hostility had lately been increased, in consequence of the acts of a lot of Texas emigrants, who, being too indolent to gather mesquite beans from the trees, broke open a number of Indian caches where they had stored their winter supply of the best screw beans, and loaded them in their wagons, for feed for their cattle. We did not do this, but picked up two hundred bushels or more from under the trees, and our cattle ate as much more, which did not please them very well, for it helped to diminish the supply they relied upon for their winter's bread. The soldiers had some of the bread made by the Indians from these beans. It looked like rich cake made from the yolk of eggs or nice corn bread. I ate a little of it and found it sweet and palatable, having, however, a little of the astringent twang of the acorn. . . ."

[4] "The mesquite is another bush or tree which is very abundant in the section lying southwest of the southern border of Utah, extending southwest over nearly to the coast. The mesquite bean is used in that section of the country quite extensively by the prospector and miner as food for their burros." (L. M. Winsor, San Luis Valley, Alamosa, Colorado.)

[5] "It was very noticeable during my work in Sulphur Spring Valley that the cattle were always in the mesquite bushes from the time they began to leaf out until the rainy season began, very few animals being found on the prairie; while as soon as the rains began, they transferred their grazing ground to the prairie." (R. W. Clothier, University of Arizona, Tucson, Arizona.)

[6] Letter, August *4,* 1913, C. W. Underwood, Chillicothe, Texas.

persons of responsibility report that the working horse does well on mesquite and that hogs have fattened satisfactorily on grass and mesquite beans.[7]

[7] The following information is furnished by Mr. N. R. Powell, Pettus, Bee County, Texas:

"About six years ago one thousand pounds of mesquite beans were gathered and ground with the hulls and were then pressed by the Beeville Oil Mill into cakes the same size as cottonseed cake. Some of these cakes were kept two years and fed to cattle, which seemed to do them as much good as cottonseed cake. The difference between mesquite beans and cotton seed is that the former does not have to be ground as it breaks up easily.

"Some seasons, it is stated by Mr. Powell, as much as a trainload of mesquite beans are produced by him. This is when a dry spring and summer occur. A good bearing mesquite tree will produce from fifty to one hundred and fifty pounds. Mr. Powell states that he thinks the value of mesquite beans in southwest Texas, if properly cared for, would be more than one million dollars annually." (Letter, Rex E. Willard, Assistant Agriculturist, Brownsville, Texas, February 11, 1914.)

"However, the mesquite grows more on the flats than it does in the mountains; but it does grow to some extent in the foothills; and when there is a good crop of beans, these furnish a great amount of feed for hogs and also cattle and horses. When the mesquite beans get ripe along in August, and where they are very thick, you can see the cattle and horses grazing on them a great deal all over the ranges; and especially if the grass is short, which occurs in a dry year, a great many animals get their sustenance from these beans. Mesquite beans have an exceptionally high value as feed for all classes of stock, and they are looked upon as very fattening. I know of several cases where swine were turned out on the sand hills during August and September, and though they secured practically nothing else but the beans and what little grass they could get, they have been fattened sufficiently for market. There are other places in the mountains where they turn the hogs out just as they would cattle, and give them absolutely no feed, other than what they get themselves. The hogs range through the canyons and in the brush. I have seen a great many hogs gathered along before Christmas from places like this, and they were in as high finish as any you would find that had been fed in the lot. These are usually fattened on acorns.

"In some places where the mesquite bushes are exceptionally thick the people, especially the natives, gather them and feed to their horses and cattle. I have used mesquite beans to feed to horses myself on trips over the country when we had no grain, and I find that they are not only relished by the animals, but they are very good feed." (Letter from W. H. Simpson, Professor of Animal Husbandry, New Mexico College of Agriculture and Mechanic Arts, State College, New Mexico, June 3, 1913.)

"In the western and southwestern sections of the state the mesquite bean affords during some years a large proportion of the feed supply of the horses and cattle of those sections." (Letter from John C. Burns, Professor of Animal Husbandry, Agricultural and Mechanical College of Texas, College Station, Texas, June 6, 1912.)

The wild mesquite is a crop plant of great promise if scientifically used and improved. It covers a wide territory and grows under very adverse conditions and in the unimproved state contains many good productive specimens.

THE NATURAL HABITAT OF THE MESQUITES

Robert C. Forbes, Director of Arizona Agricultural Experiment Station, says,[8] "The mesquite tree (prosopis juliflora), known in some localities as the algaroba, honey locust, or honey pod is found,[9] roughly speaking, from the Colorado and Brazos Rivers in Texas, on the east, to the western edge of the Colorado desert in California on the west, and from the northern boundaries of Arizona and New Mexico southward as far as Chile and the Argentine Republic."

The plant endures in all kinds of soil except that which is wet, resists great drought by means of small water consumption and a root system of great depth. Roots fifty and even eighty feet long have been credibly reported.[10]

[8] Bulletin 13, Arizona Station.

[9] *The American Naturalist,* Vol. XVIII, May 1884, "The Mesquite," by Dr. V. Havard, U. S. Army: "It flourishes in the southwestern territory of the United States, especially in Texas, New Mexico, and Arizona, being by far the most common tree or shrub of the immense desert tracts drained by the Rio Grande, Gila, and Lower Colorado."

[10] University of Arizona, Agricultural Experiment Station, Tucson, Arizona, letter, October 22, 1913, from Robert H. Forbes, Director.

"Although mesquite grows abundantly in regions of the lowest rainfall, it is found for the most part in the washes, where occasional flood waters undoubtedly penetrate to considerable depths and thus afford a water supply far in excess of that which would be available on elevations. Standing on a mountainside and looking off across the country, one can easily trace the drainage by the long lines of dusty green mesquite which thus occupy the drainage lines.

"The mesquite, as well as some other desert plants that I have observed, has two distinct root systems—one spreading laterally in every direction from the tree and evidently availing itself of the occasional supplies of moisture coming from heavy penetrating rains, and the other striking straight down to great depths and, presumably, feeding upon deep ground water supplies. I once, personally, dug up a lateral root running along a ditch, which at rare intervals carried flood water, a distance of exactly fifty feet from the trunk of the tree. This root was not as large as my

Indeed the roots are so great that at times they are very productive of firewood.

It is a mistaken localism to think that the mesquites are purely North American. Argentina has fifteen species of mesquite, while the United States has but six. (See pages 76-77.)

Dr. Walter S. Tower, geographer, late of the University of Chicago, reporting on his explorations in South America, says, "I have ridden all day through northern Patagonia with a temperature of 10° F. above zero, and have walked all the next day through continuous forests of algaroba. I think

little finger at its base and tapered out to a small filament at the end where I lost it."

Mr. Forbes sent me the following item February 23, 1914:

"W. M. Riggs says that in boring a well in the San Simon Valley, using a drop auger that brought up a core, they found fresh living roots at a depth of eighty feet. There were growing at that point greasewood, sagebrush, and scrubby mesquite. The roots must have been mesquite. There was an earthquake crack near by which may have facilitated the penetration of the roots. Earthquake, 1886. Well bored, 1909."

The American Naturalist, Vol. XVIII, May, 1884, "The Mesquite," by Dr. V. Havard, U. S. Army: "Sometimes in the Southwest tents are pitched on claims where no timber or fuel of any sort is visible. It is then that the frontiersman, armed with spade and ax, goes 'digging for wood.' He notices a low mound on whose summit lie a few dead mesquite twigs; within it, he finds large, creeping roots, which afford an ample supply of excellent fuel. These roots can be pulled out in pieces fifteen or twenty feet long with a yoke of oxen, as practiced by the natives in the sandy deserts of New Mexico and Arizona, where no other fuel can be had.

"Of the vertical roots, the taproot is often the only large and conspicuous one. It plunges down to a prodigious depth, varying with that at which moisture is obtainable. On the sides of the gulches one can track these roots down thirty or forty feet. They branch off and decrease in size if water is near by; otherwise they, even at that depth, retain about the same diameter, giving off but few important filaments. How much farther they sink can only be conjectured.

"Between these heaps of shifting sand are sometimes found large, vigorous mesquite shrubs, the only aborescent vegetation there. The inference would be that water, although too deep for the ordinary shrubs of the country, is accessible to the mesquite and should be reached at a depth of about sixty feet, a conclusion practically verified by the digging of wells along the Texas-Pacific Railroad.

"Mesquite posts, much used in fencing, are said to be indestructible whether under or above ground.

"As fuel, the wood from both root and stem is unsurpassed. It is the most commonly used from San Antonio, Texas, to San Diego, California."

their species would grow in our own arid wastes of the Southwest because I found with it identical species of cactus growing in New Mexico and Arizona."

Dr. Tower further writes, "As I recall conditions, the algaroba grows pretty generally in the dry fringe along the western and southern margins of the Pampas.

"To the best of my recollection, the algaroba is common at least as far south as latitude 40°, and at least as far north as latitude 30°.

"The trees are small; as I recall them, few were more than ten or twelve feet high, rather bushy, and pretty well protected with long sharp thorns. In the more northerly sections of its distribution, I think the size of the trees was rather larger than toward the south, where the growth was more in the nature of scrub than of what one commonly thinks of as real trees." [11]

[11] Speaking of the Pampas of northern Patagonia, Baily Willis says, *Northern Patagonia,* p. 109: "The shrubs which are present in the flora throughout the entire range of the bushes are the algorrobo or algorrobilla (prosopis juliflora) and the jarilla (larrea divaricata). The algorrobilla is an acacia, a bush of strong growth, characterized by the delicate foliage, strong brown thorns, and large beanpods of the family. Sheep and cattle eat the beans when ripe, and the large roots are dug for firewood."

This was in an area (latitude 40° 45' S. and longitude 65° W. and on to westward) entirely too dry for agriculture without irrigation and having had recently observed temperatures of 106° F. and 12° F.

Through the kindness of Mr. Tracy Lay, American Consul at Buenos Aires, I have received communication from the Argentinian Minister of Agriculture quoting from the book entitled *Contribution al Conocimiento de los Arboles de la Argentina (Contribution to the Knowledge of Trees in Argentina)* by Miguel Lillo, to the effect that Argentina has eleven species of prosopis, that one of these, the juliflora, exists in eleven provinces, including Buenos Ayres and Corrientes on the extreme east and all the western arid provinces from Patagonia in the south to Salta and Tucuman in the north; in fact, almost the whole of that vast country. The Minister further reports that the beans are very valuable for live stock, especially horses and mules, in place of green grass in times of drought.

The Minister of Agriculture further reports that one species, prosopis alba, called in translation the white carob, analyzes twenty-five per cent. sugar, sixteen per cent. starch, and ten per cent. protein. This species was reported growing in nine provinces.

According to the Argentinian Minister of Agriculture the mesquites grow in nearly all parts of Argentina.

Dr. Clarence F. Jones of Clark University reports bean-bearing mesquites in the dry parts of Ecuador, Peru, Bolivia, and Paraguay.

Some of these beans were valuable and used for *tannin* and others for *dye stuffs*.[12]

THE ASTONISHING POSSIBILITIES OF THE MESQUITE GROUP OF SHRUBS AND TREES

This group of bean-bearers holds out interesting possibilities of increased productivity for the arid lands of our Southwest, of Mexico, and of similar lands in each of the other five continents.

The possibility of further and useful adaptation to particular places and needs lies pregnantly in the statement that the tropically tender keawe of Hawaii is of the same species

[12] "The algaroba or mesquite tree (prosopis juliflora) is found in a number of places in South America:

"1. In scattered patches in the dry coast of northern Colombia.

"2. In the dry section of western Ecuador.

"3. Along stream courses on the western flank of the Andes in Peru and Chile.

"4. In the eastern lowlands and savannas of Bolivia.

"5. In the Chaco of northern Argentina and Paraguay. A closely related tree, hymenaea courbaril—known also as algaroba—is found near northern Uruguay."

"It bears numerous straight or sickle-shaped pods about six inches long. . . . In Ecuador, the Chaco, and the savannas of Bolivia it is prized as an article of food, being prepared in a number of ways. The leaves and tender shoots are grazed by cattle."

"The pods, which are very saccharine, are greedily eaten by cattle. In the coastal desert of Peru both pods and beans may be gathered and fed to cattle, especially in years of scant pasturage. In northern Colombia, in Ecuador, and in Peru the beans, being rich in tannin (sometimes containing 45 per cent.), are gathered and made into tanning materials for domestic use; also there is quite a trade developing in the beans for the manufacture of tannin."

"Algaroba beans are also used in the manufacture of dye stuffs and coloring materials." (Extracts from letter, Clarence F. Jones, Clark University, Worcester, Massachusetts, February 6, 1928.) -

(prosopis juliflora) as many frost-resistant strains that are scattered from Texas to Patagonia.[13]

According to F. V. Coville, Botanist, U. S. Department of Agriculture, letter, August 17, 1927:

"The range of each of the American species of mesquite and screw bean covers a wide area in our Southwest.[14] All

[13] *A Chemical and Structural Study of Mesquite, Carob, and Honey Locust Beans,* by G. P. Walton, Assistant Chemist, Cattle Food and Grain Investigation Laboratory, Bureau of Chemistry, U. S. Department of Agriculture, Department Bulletin No. 1194.

"Mesquite grows over a wide range of territory and will flourish where the more valuable carob can not exist. It is common in Hawaii, where it was introduced in 1828 and is known as the algaroba or keawe bean [E. C. Shorey, in *The Composition of Some Hawaiian Feeding Stuffs,* Hawaii Agricultural Experiment Station Bulletin 13, published in 1906, says on pp. 12-13 that algeroba is the usual Hawaiian way of spelling and that this plant is not the true algaroba], and in Jamaica, where it has been called 'cashaw.' [Abrahams, C. R., 'Cashaw Poisoning,' in *Journal* of Jamaica Agricultural Society, 1897, Vol. I, pp. 319-21.] It is found also from the southern boundary of Utah and Colorado to Chile, and has been introduced into India and South Africa, where it is attracting favorable attention. [Brown, W. R., 'The Mesquite (Prosopis Juliflora), a Famine Fodder for the Karroo.' In *Journal* of the Department of Agriculture (Union of South Africa, 1923), Vol. VI, pp. 62-67.]"

According to C. V. Piper (letter, May, 1923) : "The mesquites belong to the botanical genus prosopis, in which there are about 30 valid species, although many more than this have been proposed. One species occurs in Persia and India, one in the eastern Mediterranean region, two in Africa, and the rest in America. Argentina is richest in species, 15 occurring in that country. In one group of species, the pods are coiled and hence called screw beans. According to some botanists these constitute a distinct genus, strombocarpa. Two species of screw beans occur in the United States and four in Argentina. . . . P. juliflora is apparently the same as the older p. chilensis, which ranges from Patagonia to Texas. The species so abundantly introduced into the Hawaiian Islands is p. chilensis and is there known as kiawe or algaroba. The common species in the United States (p. glandulosa torr.) occurs from southern California to Texas and Oklahoma. In modern times it has spread greatly and now occupies extensive areas formerly prairie. This is probably due to the seeds being carried by horses and cattle and not being injured in passing through the intestinal tract."

[14] *Strombocarpa pubescens* (Benth.) A. Gray, ranges from western Texas to California and northern Mexico.

Strombocarpa cinerascens A. Gray, ranges from southwestern Texas to Nuevo Leon, Mexico.

Prosopis glandulosa torr.

Prosopis juliflora glandulosa (torr.) Cockerell. The range of this species is given as "Louisiana to southern California" and Mexico.

the species are tropical or sub-tropical. Within our borders, they grow in the creosote-bush belt of our southwestern desert region. Standley, in *The Shrubs and Trees oj Mexico,* refers all the species of strombocarpa to the genus prosopis."

THE PRODUCTIVITY OF THE MESQUITE

Mr. J. J. Thornber, Botanist, Arizona Agricultural Experiment Station, Tucson, Arizona, says [15] he has seen the beans so abundant under the tree "as to cover the ground everywhere for a considerable area as much as one inch or two inches in depth," and that a good-sized tree yields anywhere from fifty to one hundred pounds of beans. A space ten feet square would hold thirteen bushels or more than two hundred and fifty pounds if the beans were two inches deep.

Mr. Robert C. Forbes, Director of this same station, wrote a bulletin (No. 13) urging the use of mesquite as a crop because of the two qualities of good food and value of productivity of the tree.[10]

Prosopis velutina (Wooten.)
Prosopis juliflora velutina (Wooten) Sarg. Ranges from Arizona to Lower California and Michoacan, Mexico.
Prosopis palmeri S. Wats. Lower California.
Prosopis juliflora (Swartz) DC. West Indies and Central America, including Mexico.

[15] "I will state that the yield of the mesquite tree ranges anywhere from fifty to one hundred pounds per tree of good size. This is in deep rich soil of our valleys with, of course, the rainfall and no irrigation. These trees are anywhere from twelve to eighteen inches in diameter and perhaps fifty years old. Some of them stand as tall as forty feet. They are not a tall-growing tree, but they have very wide-spreading branches so that a single tree may cover a diameter of fifty to seventy feet. Smaller trees will bear less in proportion. Such trees commonly grow anywhere from forty to one hundred feet apart over the ground under native conditions, and I have seen the crop of mesquite beans so abundant under them as to cover the ground everywhere over considerable area as much as one or two inches in depth." (Letter from Mr. J. J. Thornber, Arizona Agricultural Experiment Station, October 16, 1913.)

[16] "The mesquite tree in the South is very regularly a bearer and without having any definite information we are of the opinion that the total tonnage from an acre of mesquite trees would be quite large." (Letter from Bradford Knapp, Special Agent in charge, U. S. Department of Agriculture, Bureau of Plant Industry, Washington, D. C, May 23, 1913.)

"It is difficult to state the yield, more than that it is usually very abundant, often amounting to from one to several bushels on a small tree. It should also be noticed in this connection that the beans are quite bulky. One bushel weighs about twenty-one pounds."

Analyses show [17] the high content of sugar and other nutrients and explain why the animals are so fond of the beans.

Mr. G. P. Walton of the U. S. Department of Agriculture says, "After a favorable season the quantities of mesquite beans available over large areas of southwestern United States are limited only by the facilities for gathering the ripe fruit. Wilson[18] states that in southern New Mexico it is not uncommon to see a medium-sized bush, with a spread of not more than fourteen to eighteen feet, bearing from one to one and one-half bushels of beans. Although the process of gathering the fruit is tedious, during the 1917 season the beans could be secured for from twenty to thirty cents per one hundred pounds. A native worker at the New Mexico Agricultural Experiment Station gathered about one hundred and seventy-five pounds of dried beans in a day.[19] Since the pods weigh but twenty-one pounds to the bushel[20] however, the man gathered only eight and one-third bushels, not a very strenuous day's work. In a northwestern province of India, a good tree may yield more than two hundred pounds of ripe fruit a year.[21]

[17] See p. 302.

"The air-dry fruit, entire, was found to contain from 17.53 to 17.67 per cent. of cane sugar, all of which was in the pods. Further examination of another sample of pods showed them to contain 2.4 per cent. of grape sugar, and 21.5 per cent. of cane sugar, no starch or tannic acid being present." (Arizona Bulletin, No. 13, R. H. Forbes.)

[18] C. P. Wilson, "Value of Mesquite Beans for Pig Feeding," in New Mexico *Farm Courier,* 1917, Vol. 5, No. 5, pp. 7-8.

[19] "The Mesquite Bean As a War Crop," in New Mexico *Farm Courier* (1917), Vol. 5, No. 9, pp. 9-10.

[20] Foster, L., "Feeding Value of Mesquite Beans," in New Mexico *Farm Courier* (1916), Vol. 4, No. 9, pp. 4-5.

[21] Brown, W. R., "The Mesquite (Prosopis Juliflora) a Famine Fodder for the Karroo," in *Journal of the Department Agriculture* (Union of South Africa) (1923), Vol. 6, pp. 62-67.

"In 1917 mesquite beans were gathered and shipped by the carload in Texas.[22]

"The yield of fruit, of course, varies with the type and size of the tree or bush. It has been stated that one acre of land well covered with the trees may produce one hundred bushels of fruit per year.[23] [24] Two crops a year have been produced in Arizona[25] and in Texas, the early crop ripening during the first half of July and the second during the first half of September."

As to the value of the beans, Professor Robert C. Forbes (Bulletin 13, Arizona Experiment Station) says that according to analyses the entire beans, weight for weight, compare favorably with alfalfa hay, are of slightly less value than wheat bran, and contain more protein, but less fat and carbohydrate, than shelled corn. It must be remembered, however, that these ingredients are partly contained in the hard kernels.

THE SCREW BEANS

Mesquite has a kind of first cousin in the screw bean[26] (strombocarpa) or tornillo, which is so greatly like it in both

[22] "The Mesquite Bean as a War Crop," in New Mexico *Farm Courier* (1917), Vol. S, No. 9, pp. 9-10.

[23] Bentley, H. L., "A Report Upon the Grasses and Forage Plants of Central Texas." U. S. Department of Agriculture, Division Agrostology Bulletin 10 (1898), p. 36.

[24] Smith, Jared G., "Fodder and Forage Plants (exclusive of the grasses)." U. S. Department of Agriculture, Division Agrostology Bulletin 2, rev. (1900), pp. 31, 56.

[25] Thornber, J. J., "The Grazing Ranges of Arizona." Arizona Agricultural Experiment Station Bulletin 65 (1910), pp. 270-271, 297.

[28] "The tornillo grows extensively at lower levels in the southern part of New Mexico on the flood plains, as a rule. The trees grow from fifteen to twenty feet high. Posts from the larger trees are very durable. The stems and roots make excellent fire wood. The crop of "screw beans" is usually very prolific, though badly infested with bruchids. These beans have a large amount of sugar in the substance surrounding the seeds, and are, for this reason, eagerly eaten by stock. I have no particular data on the productivity, except that last fall one tree fifteen feet high on the campus here yielded one bushel and one-half of the beans measured." (D. E. Merrill, Biologist, Agricultural Experiment Station, New Mexico College of Agriculture and Mechanic Arts, State College, New Mexico, letter, September 8, 1916.)

botanical and economic aspects that they commonly are and should be classed together.[27]

Perhaps adequate testing will show that both mesquite and screw bean have their places in a reasonably scientific agriculture for the semi-arid lands.

THE NEED FOR SCIENTIFIC WORK

This combination of the above-mentioned qualities, productivity of trees, ability to stand drought and frost, and good analysis of beans and their appetizing quality, certainly makes reasonable the statements of the scientists[28] and ranchmen of the southwestern plateaus that the mesquites are worthy of experimentation and gives reason for Mr. Forbes' belief that gathering beans on a commercial scale "seems to be practicable in some parts of the country." In considering all these statements it should be remembered these are wild plants, quite unimproved either by propagation of the best strains or by breeding.

[27] See table of analyses, page 302.

[28] "In the western and southwestern sections of the state the mesquite bean affords during some years a large proportion of the feed supply of the horses and cattle of those sections. As far as I am aware no investigations have been made in regard to the actual feeding values of these products. Neither has anything been done towards the development of more productive strains of trees. It seems to me that the field offers considerable opportunity for investigation." (Letter from John C. Burns, Professor of Animal Husbandry, Department of Animal Husbandry, Agricultural and Mechanical College of Texas, College Station, Texas, June 6, 1913)

CHAPTER IX

THE REAL SUGAR TREE

Several generations of Caucasian Americans have called the sugar maple the "sugar tree." It had been done before by countless generations of American Indians. Rare indeed is the person who will not say that maple syrup and maple sugar are delicious.

The sugar maple is a fine tree. Its spring sap has from 3 to 6 per cent. of sugar. It grows over a wide area of cold, rough, upland country with a poor agricultural surface and in some cases a poorer agricultural climate. Possibly plant breeding could do with the maple wonders similar to those it has already done with the sugar beet—namely raise its sugar content several fold in a century and a quarter.

But why wait? Behold the honey locust! Look at Figs. 34 and 36! There is a wild tree, native, hardy, prolific, and yielding beans more than a foot long.

The beans from some of these unimproved and unappreciated wildlings carry 29 per cent. of sugar. This is equal to the best sugar beets and more than the yield of the richest crops of sugar cane. This, too, after man has been struggling with the sugar cane for centuries.

And Mr. Secretary of Agriculture Jardine tells me that his department has no time for such new things as honey locusts, that they are busy with the bugs and bites and blights of crops already established. Such is the scientific side of this democracy!

Who will apply science and horse sense to this wonderful bean tree, which may hold a hundred thousand gullying hills with its roots while its tops manufacture the world's sugar without the arduous toil of women and children on hands and knees pulling weeds from among the pesky little beets?

Consider the history of the sugar beet, and it seems perfectly reasonable to picture, fifty years hence, a thousand mountain farm wagons hauling locust beans down to the sugar factory in some Carolina valley.

This sugar factory should also sell thousands of tons of cow feed, rich in protein and having enough molasses left in it to make the cows fight for it.

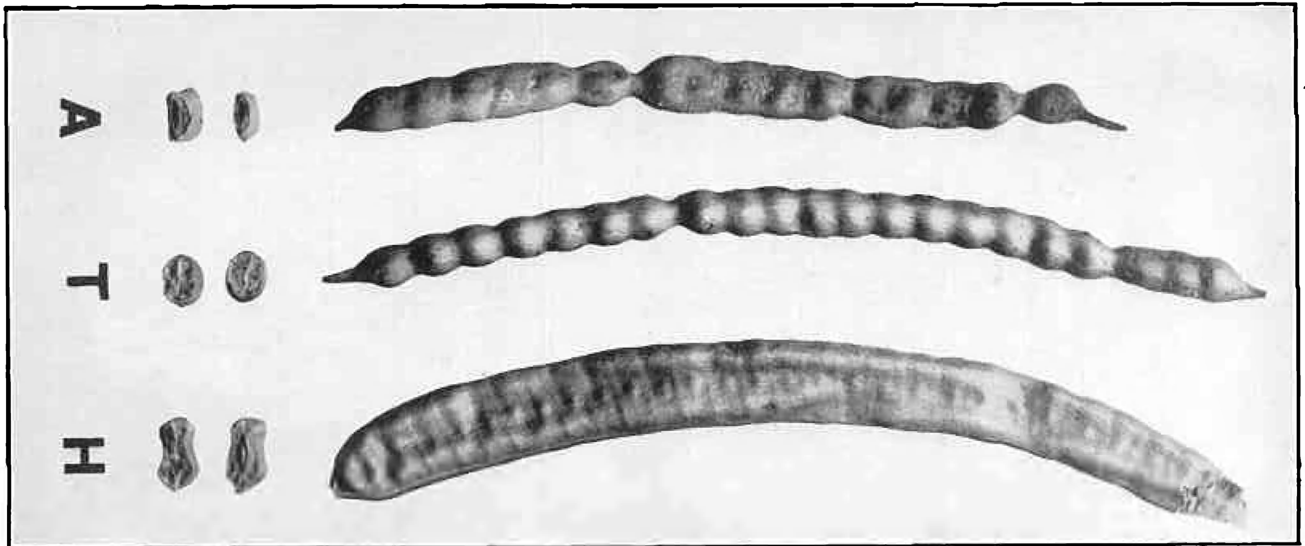


Photo E. R. Deats

FIG. 38. Mesquite beans, cross section, reduced two-sevenths in diameter. *H* is from Hawaii (courtesy J. M. Westgate). *T* is from Texas (courtesy H. Ness). *A* is from Arizona (courtesy J. J. Thornber). Mr. Thornber says: "I am somewhat in doubt about the species. The pods are very similar to Prosopis Velutina but the tree resembles quite closely that of Prosopis Glandulosa except the leaves are scarcely Glandulosa and the tree grows to a considerable height. We have never determined definitely what species this mesquite is." That quotation reflects the glorious battle that has raged and still rages among the botanists as to how many species there are of mesquite. Note the fatness of the beans.

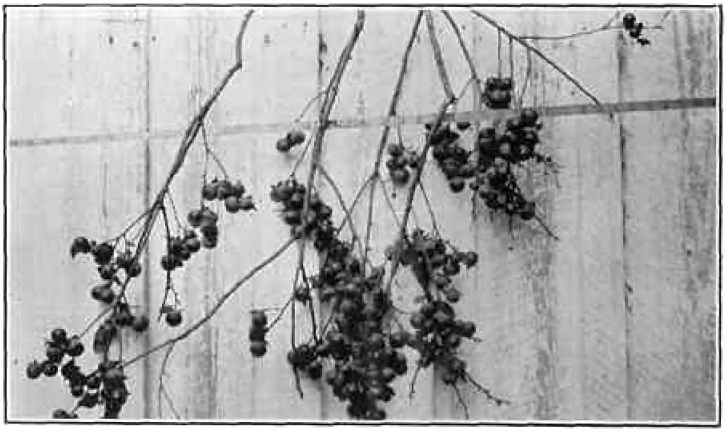


FIG. 39. *Top*. A systematic orchard of mulberries for hog pasture near Raleigh, N. C. The man stands on top of a mangum terrace.—FIG. 40. *Center*. Hogs in a mulberry orchard planted for them near Fayetteville, N. C.—FIG. 41. *Bottom*. Characteristic burden of fruit produced by the wild American persimmon tree. Fruits nearly an inch in diameter, Augusta, Ga. (Photos J. Russell Smith.)

CHAPTER X

A SUMMER PASTURE TREE FOR SWINE AND POULTRY—THE MULBERRY

For a large section of the United States the mulberry is easily the king of tree crops when considered from the standpoint of this book; namely, the establishment of new crops which are easily and quickly grown and reasonably certain to produce crops for which there is a secure and steady market for a large and increasing output.

A KING (OF CROPS) WITHOUT A THRONE

The mulberry is excellent food for pigs. To harvest mulberries costs nothing because the pigs gladly pick up the fruit themselves. Therefore, mulberries fit especially well into American farm economics because labor cost is high.

The mulberry tree is no new wildling just in from the woods and strange to the ways of man. It is one of the old cultivated plants. It has resisted centuries of abuse. It has been tried and found to be good and enduring.

It can perhaps be called the potential king of tree crops for the Cotton Belt[1] and part of the Corn Belt. The honey locust, oak, and chestnut probably have greater promise, because their crop can be stored; but the mulberry has already arrived and has proved its adaptability and its worth.

The mulberry is a tree with good varieties already established and waiting to be used.

[1] In actual production today the pecan is far ahead of the mulberry, but the potential market for mulberries is far ahead of that of pecans.

THE ADVANTAGES OF THE MULBERRY TREE

(1) The trees are cheap because they are so easy of propagation.[2]

(2) The tree is very easy to transplant.

(3) It grows rapidly.

(4) It bears as early as any other fruiting tree now grown in the United States, perhaps earliest of all.[3]

(5) The fruit is nutritious and may be harvested without cost.

(6) The tree bears with great regularity as far north as the Middle Atlantic States and New England, also through the Cotton Belt and much of the Corn Belt, and even beyond it into the drier lands.

(7) It has a long fruiting season.

(8) It bears fruit in the shady parts of the tree as well as in the sunshine, and thus has unusual fruiting powers.

(9) It has the unusual power of recovery from frost to the extent of making a partial crop the same season that one crop is destroyed.[4]

(10) The fruit has a ready and stable market since swine and other animals turn it into meat, a product for which there is no prospect of a really glutted market, such as haunts the growers of so many crops.

(11) The trunk of the tree is excellent for posts, and the branches make fair firewood for the farm stove. It is doubtless worth growing in many sections for wood alone.

(12) While attacked to some extent by caterpillars, it prospers at present in most parts of its area without spraying, and seems to have fewer enemies than most other valuable trees.[5]

[2] In 1913 trees of everbearing varieties could be bought for $2.00 per hundred at Green's Nursery, Garner, North Carolina.

[3] They even bear in the nursery row.

[4] This results from the remarkable habit of putting forth secondary buds and producing some fruit after a frost kills the first set of buds.

[5] Unfortunately, according to a letter from the Fruitland Nursery, Augusta, Georgia (1927), the San José and India scale in that locality require

(13) Growth of the mulberry for forage has gone forward in the United States so that for a large area the experimental stage for the *tree* is past (but not for the crop). In localities where the mulberry is not well established experiments are aided by the incomparable boons of low-cost trees, rapid growth, and ease of transplanting.

THE MULBERRY CROP IN THE UNITED STATES

Every claim that I have made for the mulberry has been backed up by correspondence with persons interested in mulberries or with interviews that I have had. In most cases my information comes from the statements of people who grow mulberries or are closely associated with those who did.

Mr. G. Harold Hume of the Glen Saint Mary Nurseries Company, Glen Saint Mary, Florida, wrote April 12, 1913, "All through the Southern States, mulberries are commonly used as feed for pigs and poultry. In North and South Carolina and Georgia nearly every pig lot is planted with these trees, and the mulberries form a very important addition to the pig's diet.[6] There is one variety, Hicks, which will give fruit for about sixty days, in some seasons even for longer.

one good dormant spray per year to keep the tree in good health. This, however, is not a serious burden, especially as it is a winter job.

As the mulberry tree has been cultivated for ages over a wide region, this comparative pest-immunity is probably more dependable than it would be on a tree that has just come in from the forest and has not been subjected to the crowded conditions of artificial plantings. It is also probably a much safer tree than some fresh importation would be.

[6] "In eastern North Carolina it is the common practice to plant orchards of mulberry trees for hogs to run in." (W. F. Massey, Associate Editor, *The Progressive Farmer,* Raleigh, N. C, letter, March 11, 1913.)

"The everbearing mulberry in this country is so common as to occasion very little comment; in fact, they become unpopular on account of their profuse bearing, especially if there are not pigs and chickens enough to pick them up." (Letter, John S. Kerr, Texas Nursery Company, Sherman, Texas, November 19, 1913.)

"The mulberry grows to perfection, fruits abundantly, and is used both for hogs and for poultry." (Professor C. C. Newman, Clemson College, South Carolina.)

With a proper selection of varieties, this season might be extended.

In 1927 Mr. Hume, who is an ex-professor in horticulture, reported that there was little change in the situation.

I find a very general belief in the Cotton Belt that one "everbearing" mulberry tree is enough to support one pig (presumably a spring pig) during the fruiting season of two months or more. Professor J. C. C. Price, Horticulturist, Agricultural and Mechanical College, Mississippi, says,[7] "The everbearing varieties will continue to bear from early May to late July, a period of nearly three months. I believe that a single tree would support two hogs weighing 100 pounds each and keep them in a thrifty condition for the time that they are producing fruit. They could be planted about 35 trees to the acre."

Mr. F. A. Cochran, breeder of Berkshire swine at Derita, North Carolina, said,[8] "I only have a few trees, but they are large ones, 100 feet apart. . . . I would not take $25 per tree for the old trees. I have three hogs to the tree. They are doing fine, in good flesh. . . . I have not weighed any hogs that were fed on mulberries, but estimate that they gained one pound and over per day. My hogs have a feed of two small ears of corn twice a day."

Mr. James C. Moore, farmer of Auburn, Alabama, writes, "I never weighed my pigs at the beginning and close of the mulberry season, but think I can safely say that a pig weighing 100 pounds at the start would weigh 200 pounds at the close. . . . Three-fourths to the mulberries is safe calculation of the gain. I have had the patch about 18 years bearing. I planted my trees just 32 feet apart, and now the branches are meeting, and I have about 40 trees. I have carried 30 head of hogs through from May 1 to August 1, with no food but the gleanings of the barn and what slops came from the kitchen of a small family."

[7] Letter, September 2, 1927.
[8] Letter, July 21, 1913.

Mr. J. C. Calhoun, farmer of Ruston, Louisiana, says, "The variety is the 'Hicks.' I set them out 30x30 feet apart. I have 50 trees. They were mere switches when I set them out about three feet high. They began bearing the second year and made rapid growth. The fourth year after putting them out the trees would nearly touch, and they are abundant bearers—ripening from the last of April to the last of July. There is nothing that a hog seems to enjoy better than mulberries. I always feed my hogs at least once a day, but I find that it takes considerable less feed for them to thrive and do well during mulberry season." (Letter, March 7, 1913.)

In the course of much correspondence and a long journey through the Cotton Belt in 1913 I met many such enthusiastic statements.[8]

In that east-central part of North Carolina where the mulberry orchard is a very common part of farm equipment, a veteran of the Civil War (a captain) declared, "When I lived

[9] "We have talked this matter over thoroughly here in the office and believe that one mulberry tree 10 years old ought to support a pig 4 to 6 months old during the tree's fruit season. As the tree gets older, 15 to 20 years old, if it has had good attention and has grown well, then it ought to support two or three pigs at the same age as mentioned above." (O. J. Howard, J. Van Lindley Nursery Company, Pomona, North Carolina, August 11, 1912.)

"The large mulberry tree of which I spoke is in the south part of Wake County, North Carolina. I stopped at the place to get some water and spoke of the large mulberry trees and made the remark that it was wisely said that one tree fed one pig during fruiting season. The owner said it certainly would, for this tree was feeding fifteen hogs at that time and was probably one hundred years old. The place is near Fuquay Spring, North Carolina." (J. W. Green, Green Nursery Company, Garner, North Carolina.)

It may properly be objected that these men are partisans, being nurserymen with trees to sell, but many farmers without any axes to grind are of the same opinion.

Mr. R. H. Ricks, a farmer specializing in cottonseed at Rocky Mount, North Carolina, gives the following testimony: "I planted two hundred mulberry trees of the everbearing variety thirty-three years ago on what I regarded as waste land. They commenced having some fruit at once, but they did not have profitable crops until the fifth year. I have since planted another orchard of fifty trees. I carry fifty to sixty hogs on the fruit ten to thirteen weeks every year for the last twenty-seven years without other ovah the rivah we had a lot of mulberry trees—300 to 400 mammoth big ones. We had fully 200 hawgs, but we had to send fer the neighbors' hawgs to help out and to keep the mulberries from smellin'."

Where the captain then lived he had a bunch of thirty-five hogs of various sizes running in mulberry and persimmon pasture, all of which I saw. He estimated that one-third of their weight, or one thousand pounds of pork, live weight, was due to the mulberries from eighty trees set twenty-four by thirty-three feet. That runs out about six hundred and twenty-five pounds of pork, live weight, to an acre of rather thin, sandy land with little care and no cultivation. A big yarn, you say? I'll willingly take it back just as soon as any experiment station makes a real test and disproves it.

The trouble is that no station, so far as I can find out, is in a position to disprove it,[10] because none of them has any

food, and in the main bearing season the two hundred and fifty trees would carry twice the number of hogs. Nearly every farmer has a small orchard in this section, eastern Carolina. I regard the mulberry for hog food with much favor."

"I wouldn't take a pretty for my mulberry orchard," said one of these Carolinians. "It's funny to me to see how soon a hawg kin learn that wind blows down the mulberries. Soon as the wind starts up, Mr. Hawg strikes a trot out of the woods fer the mulberry grove. Turn yer pigs into mulberries, and they shed off and slick up nice. It puts 'em in fine shape—conditions 'em like turnin' 'em in on wheat. They eats mulberries and goes down to the branch and cools off, and comes back and eats more—don't need any grain in mulberry time."

"They begin to beah right away," one Carolina farmer declared. "Why, I've seen 'em beah in the nursery row, and they begin to beah some as soon as they get any growth at all."

I have myself seen wild ones bearing in the Virginia woods when only five feet high. As to their hardiness, another Carolina mulberry grower testified as follows: "Yeh can't kill the things. Yeh kin plant yeh mulberries jest like yeh would cane—cut it off in joints and graft from the one yeh want to. I moved a tree last yeah. Jest put a man cuttin' roots off—and he cut 'em scandalous—and I hooked two mules to it and hauled it ovah heah. I didn't 'spect it would live, but it did." ("A Georgia Tree Farmer," J. Russell Smith, *The Country Gentleman,* December 4, 1915, pp. 1921-22.)

[10] The attempt to secure scientifically determined facts from southern stations brought nothing but much favorable opinion and a suggestion that something might have been done at Tuskegee Institute. Dr. G. W. Carver,

facts. This is a reproach to station staffs and also a really interesting piece of human psychology. The mulberry tree warrants careful testing.

THE NEED OF SCIENTIFIC TESTING AND EXPERIMENT

As nearly as I can learn through trusted correspondents in several southern states, there has been little change in the mulberry situation between 1913 and 1927. The neglect of the mulberry as a crop in the face of such evidence seems to require some explanation. However, this psychological and economic phenomenon becomes easier to understand when one recalls the slavish dependence of the southern farmer on the one crop of cotton. By tens of thousands they have resisted the temptations of clover and cowpeas and soy beans and vetch. They still buy hay for the mule. Nor have they planted pecan trees in their door yards. They grow no fruit, and some do not even have anything worth the name of garden.[11] So the mulberry is after all in good company with the things they haven't done. Occasionally one finds a man who has tried mulberries and does not like them because of caterpillars, but in the main I have found enthusiasm among those pioneer farmers who were trying out the crop.

Director of Research and Experiment Station at Tuskegee Institute, Tuskegee, Alabama, wrote (November 2, 1927), "The small amount of analytical data that I have been able to find on the mulberry shows it to be higher in carbohydrates than pumpkins, being fourteen per cent. carbohydrates, a rather convincing evidence that it is really worth while as a fattening food." He also told of their own use of it in growing their own pork supply.

[11] "It is still true that in the principal cotton sections, particularly the black belts, anything that can really be called a garden is quite scarce.

"You are also undoubtedly correct in saying that there are still not only thousands but tens of thousands of cotton farms which make practically no hay and depend almost entirely upon buying hay if any is used, and this in spite of the fact that there has been a tremendous increase in the acreage in alfalfa, soy bean, cowpea, and other hays in the past few years. You could even go further and say that thousands of such farms have no milch cows, practically no poultry and no hogs.

"A real home orchard is yet a comparative scarcity in the Cotton Belt." (Letter from J. A. Evans, Assistant Chief, Office of Coöperative Extension Work, U. S. Department of Agriculture. Sent. 7, 1927.)

THE POSSIBLE RANGE OF THE MULBERRY IN THE UNITED STATES

As with any other little-used crop, the exact range over which the mulberry can eventually spread is today unknown. For example: Kansas seems to have some mulberry territory and some that is not mulberry territory.[12] But there is every reason to expect that breeding can extend this crop.

There is little doubt that at least a million square miles of the United States, and in the most populated parts of the country, are now capable of producing crops of fruit from the everbearing strains of this remarkable tree. Fortunately two of the commoner varieties, the Downing and the New American, originated in New York.[13]

STABLE PRICE AND EASY EXPERIMENT

The price stability of the mulberry should be emphasized in a country where so many commodities find markets that are

[12] State Forester Albert C. Dickens makes the following interesting observations in Kansas Bulletin 165, pp. 324-26. It should be remembered that as a forester he naturally is dealing primarily with wood trees rather than fruit trees, and that therefore his fruit statements might tend to be weak rather than strong.

"The success of the Russian mulberry has been quite varied. In northern Kansas it has been injured very frequently in severe winters.

"In the southern counties of the state Russian mulberry seems much less liable to winter injury. At the fair grounds at Anthony, Kansas, the rate of growth has been especially good, trees set four years ago having attained a height of fourteen feet and a diameter of four inches.

"The fruit is not of high quality, but is often used when other fruits are scarce; and as it ripens with the cherries and raspberries, it seems to attract many birds from the more valuable fruits, and it is frequently planted in the windbreaks about fruit plantations with this end in view. The fruiting season lasts a month or more. The need of some careful selection and breeding of this species is clearly indicated. The species is quite readily grown from cuttings and the better individuals may be propagated and the uncertainty which attends the planting of seedlings be avoided."

[13] "With chickens, ducks, birds, and pigs clamoring for the fruit, the everbearing mulberry is certainly a candidate for experiment in your poultry yard or pig lot; but if you live north of Mason and Dixon's line, make some investigation as to the hardiness of varieties that are offered you." ("A Georgia Tree Farmer," J. Russell Smith, *The Country Gentleman,* December 4, 1915, p. 1822.)

often glutted. Sometimes peaches are not worth the picking. Apples and oranges occasionally rot on the ground, as do beans, peas, and all the truck crops. In contrast to this the mulberry is in the class with corn. We have not had much trouble in the past twenty years about a glut in the corn market, or in that of meat, its great derivative. A stable market is a fact of great importance in considering any crop. The fact that the mulberry has no harvesting costs and needs no special machinery minimizes the risk in experimenting. We need to get the facts on the feeding value of the mulberry from state experiment stations. However, any landowner can try it now. Commercial nurseries have the trees ready.

For the actual use of the mulberry as a farm crop see Chapter XXIII.

The farm yard, the rocky slope, the gullied hill, the sandy waste invite you to try this automatic crop for which there is a world market at a stable price, and probably a very good price when one considers cost of production.

OLD WORLD EXPERIENCE WITH THE MULBERRY

Perhaps some one thinks that I should mention the silk worm. That classic, domesticated insect makes the mulberry leaf worth its hundreds of millions of dollars yearly and thus renders its great service to humanity by enabling hundreds of thousands of hard-worked orientals to eke out a hungry existence. We have the climatic and soil resources for the mulberry trees, but the silk crop is not for us—not in this next hundred years. It requires labor, human labor, lots of it, and in this we have no present prospect of competing with China, Japan, and other very populous countries.[14]

Nor is there much likelihood that in this century we shall put on a tariff that would drive us to such a crop. But if we do ever want to feed silk worms, we have the resources, be-

[14] See Smith, J. Russell, *Industrial and Commercial Geography,* Henry Holt and Company.

cause the humid summer of our Corn and Cotton Belts keeps the trees growing and producing leaves.

The mulberry has another great use among the Asiatics. It is a food of value for a dense population pressing upon resources more heavily than we do. This fruit has long been an important food in many parts of Western Asia.

"Dried white mulberries, practically, but not quite, seedless and extremely palatable, form almost the exclusive food of hundreds of thousands of Afghans for many months of the year. This use of dried mulberries suggests a new tree food crop.[15] Analysis of these dried mulberries (page 93) shows them to have about the food value of dried figs, and the fig is one of the great nutritive fruits. (See table, page 303.)

Ellsworth Huntington of Yale, geographer and explorer, says that in Syria the troubles of the beggar and the dog are over for a time when mulberries are ripe, for both of these mendicants move under the mulberry tree and pick up their living. "Not only do the people eat large quantities of the fruit, but they also dry it and make a flour out of which a sort of sweetmeat is made."[16]

But I am not urging diet reform for people—only for pigs. They are much more amenable to reason, much more easily pressed by necessity. But, nevertheless, this Afghan dried mulberry[17] seems to be a remarkable food according to the ex-

[15] This particular variety, if needed in America, should be expected to thrive in the irrigated lands of our West and Southwest where dry summers and frosty winters somewhat like those of Afghanistan are found.

[16] Personal letter.

[17] "The dried mulberries form the principal food of the poor people of the mountain districts or 'Koistan.' In the valleys of Koistan and around Kabul there are extensive orchards of this mulberry, all irrigated, and the yield seems to be heavy. There is a howl if you have cut down a mulberry tree. When the mulberries are ripe, they sweep under the trees and let the fruit fall down and dry them just as they do the plums in California. For eight months the people live entirely on these mulberries. They grind them and make a flour and mix it with ground almonds. The men come month after month with their shirts filled with them. They can carry in their shirt enough of these dried mulberries for five days' rations. These men are

plorer's record of its use in that country, where it is more important than bread is to the people of the United States.

commandeered and they bring their food with them. They get no other food whatever, mulberries and water are the whole diet. They sit down on the rocks and lunch and dine on nothing but these dried mulberries (Jewett). Here is the analysis of the dried mulberry, thirteen ounces in pulp, from Afghanistan made by F. T. Anderson of this Bureau." (Courtesy of Mr. Peter Bissett.)

Total solids	94.81
Ash	2.75%
Alkalinity of ash as K_2CO_3	.414%
Ether extract	1.60%
Protein (N x 6.25)	2.59%
Acid as malic	.30
Sucrose	1.20%
Invert sugar	70.01%
Starch	Absent
Crude fiber	2.65%

(From records of Division of Seed and Plant Introduction, United States Department of Agriculture. Copy of Inventory Card. 40215 [F. H. B. No. 3445] Morus alba. Mulberry. From Afghanistan. Presented by his Majesty Habibulah Khan, Amir of Afghanistan, Kabul, through Mr. A. C. Jewett. Received February 23, 1915. See Plant Immigrants, 1916, Bureau Plant Industry, U. S. Department of Agriculture, 1916.)

CHAPTER XI

THE PERSIMMON: A PASTURE TREE FOR THE BEASTS AND A KINGLY FRUIT FOR MAN

A CASE OF STRANGE NEGLECT

One of the remarkable things about the human mind is its power of resistance to new ideas. By way of illustration consider the present status of the persimmon in American agriculture. The persimmon has been praised, and its bright future has been predicted by the earliest explorers[1] and the latest horticulturists.[2] Captain John Smith, first explorer of Virginia, declared that the persimmon was as delicious as an "apricock."

Persons interested in the persimmon as human food should know that the well-known puckering astringency can sometimes be removed by simple processes.[3]

Ten generations of Americans have spent some thrilling autumn nights pulling fat opossums out of the persimmon trees, where they so love to feed. Every animal on the American

[1] "Plumbs there be of three sorts. The red and white are like our hedge plumbs; but the other which they call Putchamins, grow as high as a Palmeta; the fruit is like a medlar; it is first green, then yellow, and red when it is ripe; if it be not ripe it will draw a man's mouth awrie with much torment; but when it is ripe it is as delicious as an apricock." *(The Industrialist,* Manhattan, Kansas, March 4, 1904, Vol. XXX, No. 20, "Persimmons.")

[2] "I am convinced that the persimmon is destined to be one of the most important fruits grown in the United States." (Walter T. Swingle, Physiologist in charge, United States Department of Agriculture, letter, August 25, 1927-)

"The persimmon is gradually being recognized as an important food for hogs." (C. C. Newman, Horticulturist, Clemson College, South Carolina, letter, May 27, 1913.)

[8] See U. S. Department of Agriculture, Bureau of Chemistry, Bulletin 141 and Bulletin 155.

Courtesy John H. Tarbell

FIG. 42. These people do not go to the movies for a thrill. They go 'possum hunting, instead. One of the surest ways to find Br'er 'Possum south of the Mason and Dixon line is to look up a persimmon tree at night. Even a dark night will show his profile against the sky. This weakness of the opossum for the nutritious fruit of the persimmon simplifies the harvest of the opossum crop and furnishes to the Afro-Americans millions of greasy meals.

Courtesy U. S. Deft. Agr.

FIG. 43. Life-size picture of one of the medium Chinese persimmons. Fruits nearly twice this size are common. In many parts of China th?y are to be had fresh as late as March. I have eaten them in Korea early in October. I want one now.

farm eats persimmons greedily. Millions of our people eat [4] them occasionally with relish. Nevertheless, the persimmon has not become an important crop in America.

It grows on a million square miles of the southeastern part of our country. It bears fruit profusely,[5] often as much as the tree can physically support, and many trees bear with great regularity. Yet the persimmon as a crop in American agriculture has not arrived despite its two great chances, one as a forage crop and one as human food.

THE ORIENTAL PERSIMMON INDUSTRY

Our failure to appreciate the persimmon becomes the more conspicuous because persimmons have been a major fruit crop and a standard food in the Orient for many centuries. I am one of many thousands of American erstwhile travelers who hunger for the persimmons of East Asia. How I would like to chew the firm flesh of the persimmons such as I had in Korea, and still more do I crave the soft, luscious golden saucer-full such as I ate week after week through the autumn in Peking.

The *Yearbook* of the United States Department of Agriculture [6] quotes plant explorer Meyer, who had spent years in China, "The fruit of this particular variety (now called in America the tamopan) has a bright orange-red color, grows to a large size, measuring three to five inches in diameter, and sometimes weighs more than a pound. It is perfectly seedless, is not astringent, and can be eaten even when green and hard. It stands shipping remarkably well."

[4] "Throughout the region where persimmons are found in abundance the fruit is considered as being 'good for dogs, hogs, and 'possums.' Occasionally a family is mentioned as having lived for several months upon the fruit from a single large tree." (United States Department of Agriculture, Farmers' Bulletin 685. *The Native Persimmon,* by W. F. Fletcher.)

[5] "Certain types of persimmons and mulberries in this section have produced tremendous yields." (Professor C. D. Matthews, Department of Horticulture, North Carolina State College of Agriculture and Engineering, Raleigh, North Carolina, letter, September 21, 1927.)

[6] 1910, p. 435.

The persimmon is a fruit of great climatic range. It is the major autumn fruit of both North and South China. I have seen the rich orchards bending down with the big fruits in the shadow of the mountain range north of Peking that bears the Great Wall, northern boundary of China. Peking has the latitude of Philadelphia and the climate of Omaha (almost precisely), save possibly some spring changes from hot to cold. I have also seen the Chinese persimmon trees growing abundantly and rendering important food service in the hills of Fukien back of Foochow in the latitude of Palm Beach, Florida.

In certain localities of China the valleys[7] are entirely given over to the cultivation of persimmon. "Hundreds of varieties exist there, and the trade in dried as well as fresh persimmons compares in importance with our trade in peaches."

The fruit is eaten raw, kept through most of the winter in a fresh condition. It is also extensively used over wide areas dried as we use figs and prunes.[8]

[7] Bureau of Plant Industry Bulletin No. 4, *Agricultural Exploration in the Fruit and Nut Orchards of China*. (Frank L. Meyer, Agricultural Explorer, March, 1911 and *Yearbook* United States Department of Agriculture, 1915, pp. 212-14.)

[8] *Yearbook* of the Department of Agriculture, 1915, pp. 212-14. "In certain sections of the provinces of Shantung, Shansi, Honan, Shensi, and Kansu one finds that strains of persimmons are being grown for drying purposes only. These strains are quite different—not as juicy as those which have been so far cultivated in this country.

"A dried persimmon in looks and taste resembles a dried fig, with the exception that it is devoid of small seeds and is coated with a heavy layer of fine grape sugar.

"Dried persimmons of different varieties differ both in taste and in appearance. This difference is not due to the variety alone, but to the greater or less care employed in their preparation. The coarser sorts, upon the preparation of which little care has been bestowed, taste very much like cooked pumpkin, but those of finer quality are as fine as dried figs, being even juicier and more palatable because of the absence of objectionable small seeds.

"I noticed that the Chinese used a stock which was entirely different from the American persimmon and also was not merely a seedling stock.

"At last, in a valley north of Peking, near the Nanku Pass, I was shown wild trees of this stock. I recognized it at once as a species of persimmon (diospyros lotus) which is also found in northern India, Persia, the

THE PERSIMMON AS HUMAN FOOD IN AMERICA

It would appear to be a simple process to establish the persimmon in America as a commercial orchard industry sending its products to city markets for human consumption in large quantities. It bears close analogy to the peach industry—the transfer across the ocean of the improved strains of a productive species. There are already available and growing here and there in the United States a few of the hundreds of varieties of the Chinese, Japanese, and Korean persimmons [9] which have resulted from centuries of plant improvement by the patient orientals. As the peach came across the eastern ocean to be a staple food, so might the persimmon come across the western ocean. At present it is merely a food novelty in a few of the larger city markets.[10]

Crimea and the Caucasus. In the last-mentioned country it is known by the Turkish name of 'ghoorma.'

"This ghoorma when found in its native haunts seems to be able to withstand drought and neglect to a remarkable degree, and it is for that reason, no doubt, that the Chinese have selected it as a stock. It has already proved to be better adapted to our American semi-arid Southwest than our native persimmon (diospyros virginiana), which has been the only one heretofore used. These varieties for drying purposes budded upon the ghoorma as a stock will probably be very well adapted to large areas of land in the Southwest. Americans heretofore have never realized what an important food product the oriental persimmon is in its native country."

I wish to call attention to the wide area over which this fruit grows. If it is the same wild persimmon that I ate at the same place, Nanku (Nankow) Pass, its fruit, less than an inch in diameter, is delicious, and some trees are growing in Pennsylvania from seed of my importation.

[9] It is an interesting contrast to see near the Ming tombs north of Peking native wild persimmons three-fourths of an inch in diameter standing near orchards with fruit four inches in diameter.

[10] The trees of a number of varieties of oriental persimmon are on sale at Glen Saint Mary Nurseries (10 varieties) at Glen Saint Mary, Florida, and elsewhere. Florida and California send small shipments to market. Some of the fruit is as large as large peaches, but the demand is so light that they cannot yet move in full carloads. Therefore, they sell at exotic prices—fifteen to thirty cents each. They must move in carload lots before they can be sold at prices within the reach of large numbers of people. Thus the industry is in a kind of impasse. I am importing with much enthusiasm the hardiest varieties that I could find near Peking and Taiynan Fu in China. I want them to eat, but that does not start an industry, not quite.

In addition to all this oriental success the excellence of the native persimmon is widely recognized, and in the year 1915 our Department of Agriculture published a bulletin.[11]

After all, when the persimmon, native or oriental, comes to the American market for human food, it finds two great drawbacks; first the American stomach is already full, and the markets are overloaded with our old familiar fruits. Introducing a new food is usually a process of slow and expensive education. Who is going to pay for the introduction of the persimmon as human food? If a corporation like the United Fruit Company, which is back of bananas and has most of them to sell, could handle the persimmon, it would have a good chance. As it is the whole thing stands awaiting an educational or marketing program; [12] or perhaps it would be better to say the development of a need for more food.

[11] Farmers' Bulletin No. 68s tells about thirteen named varieties of native persimmons and gives fourteen recipes for the use of persimmons as food, including recipes for bread and fudge.

[12] "The latest statistics show a total acreage in this state (California) of 2,274 acres, of which only 582 are classed as bearing. The present production is approximately 50 cars.

"Persimmons have been grown in this State for many years but it was not until four or five years ago that the industry began to expand. It now looks like it might grow rather rapidly during the next decade. Thus far most of the fruit has been consumed locally, Los Angeles being by far the greatest persimmon-consuming center in the country. Some shipments have been made to the eastern markets for years, mainly Chicago, New York, and Boston, but so far as I know the first car-lot shipments were made this past season by a recently organized coöperative marketing agency with headquarters in Santa Ana, Orange County. I am told that 30 years ago or more several carloads of persimmons were shipped from Santa Barbara but the price received was such as to discourage any further shipments.

"The cost of production of persimmons is much lower than in the case of the citrus fruits and eventually the fruit will undoubtedly sell for much lower prices than have been obtained up to the present. I am quite certain that persimmon growers can make good money at prices of two or three cents per pound for the best grades. (Letter, Jan. 4, 1928, Robert W. Hodgson, Associate Professor of Sub-tropical Horticulture, University of California.)

THE PERSIMMON AS A CROP TREE

Meanwhile the opportunity, the real opening, and the great need for the persimmon is for forage. Here and there a negro mammy sits over a few native persimmons in some town or city market, and a few men in the Middle West have grown and sold a few bushels of named varieties of natives, but forage—pig feed—is the big outlet for the native American persimmon.[13] Let the pigs pick up persimmons as they do mulberries.

The persimmon tree has magnificent natural qualities of great aid as a crop-maker.

(1) Its extreme catholicity as to soil. It thrives in the white sand of the coastal plain, in the clay of the Piedmont hills and the Blue Ridge, in the muck of the Mississippi alluvium, and on the cherty[14] hills of the Ozarks.

(2) Another soil aspect needs to be emphasized—the ability of the American persimmon to grow in poor soil. I have

[13] Letter from A. D. McNari, Agriculturist, Box 316, Little Rock, Arkansas, March 24, 1913, says:

"In this connection I will state that Mr. S. A. Jackson, of Monticello, Arkansas, has some very poor land on which persimmon trees are growing and which he thinks furnish more hog feed than if the same land were planted to cultivated crops. These are wild persimmons, but there is a great difference among the trees in the time of ripening the fruit. Some are ready for hogs to eat in September, while others are fit only after frost or as late as November."

Letter from University of Tennessee Experiment Station, Department of Horticulture and Forestry, Knoxville, Tennessee, May 26, 1913, says:

"Everybody in Tennessee considers the persimmon a good pig feed, but nobody so far as I know has attempted to grow persimmons specifically for this purpose, nor has any attempt been made in the improvement of fruits of forest trees as a forage for domestic animals." (Charles A. Keffer, Acting Director.)

Letter from Joseph H. Kastle, Director of Kentucky Agricultural Experiment Station, State University, Lexington, Kentucky, September 27, 1913, says:

"P.S. I have also heard it stated many times that hogs fatten rapidly on persimmons."

[14] This chert is a covering of flints which remain when certain limestones dissolve and pass away. In some cases it covers the Ozark hills for several inches in depth, making tillage almost impossible but permitting full growth for forest or crop trees.

seen them grow and produce fruit in the raw subsoil clay of Carolina roadsides and in the bald places in the hilly cotton fields where all the top soil had been washed away and there was neither crop nor weeds——save the persimmon, which is one of the great weeds of the South.

(3) The persimmon is remarkable in the length of its fruiting season. With the persimmon nature unaided has rivaled the careful results of man with the peach and apple, for the wild persimmons ripen often in the same locality continuously from August or September until February,[15] dropping their fruit where animals can go and pick it up through this long season of automatic feeding. In this respect it is ahead of the mulberry. Furthermore, it should be pointed out at once that this long season combines the added virtue, the great virtue, of (4) automatic storage. It is true that nearly half of the season of persimmon-dropping occurs after frost has stopped all growth, and farm beasts are usually eating food stored in barns. Truly these are two great virtues for a crop tree.

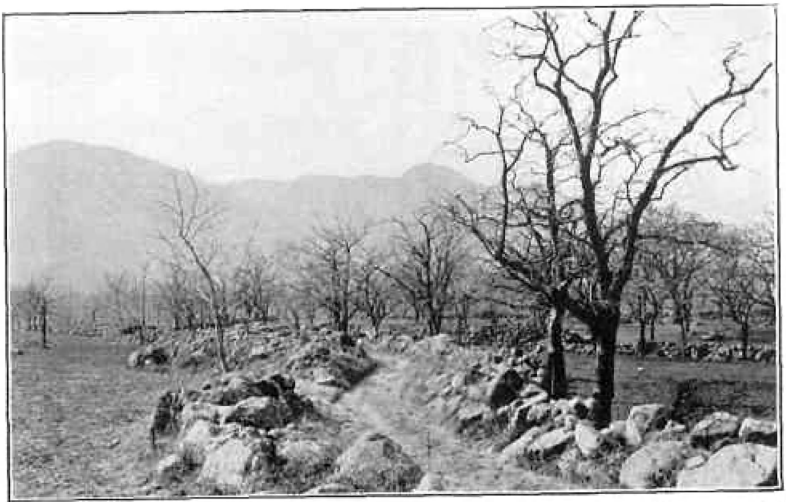
(5) The fruit of the persimmon is very nutritious. It is said to be the most nutritious fruit (analysis, page 303) grown in the eastern United States.

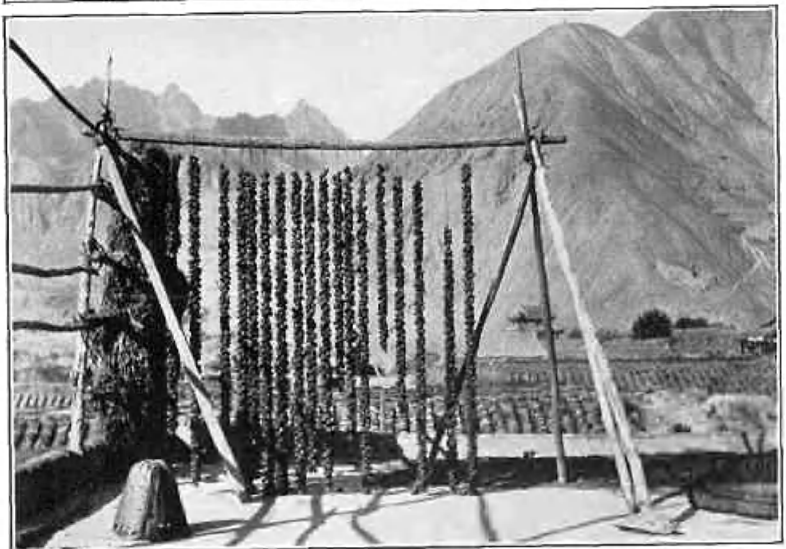
It is too much to expect the persimmon tree to have the complete and amazing collection of virtues cited for the mulberry. Compared to the mulberry the persimmon (a deep rooter) is not easy to transplant. Therefore it is produced in the nursery at greater expense. It does not grow so rapidly as the mulberry. It does not even grow quite so rapidly as the apple.[16]

[15] Dr. John E. Cannaday of Charleston, West Virginia, reports one tree in his neighborhood (letter, September 27, 1924) that ripened its fruit in July.

[16] "A persimmon, stem-grafted in a two-year-old and vigorous stock, may make anywhere from one to four feet the first and second years, but later the new growth will be shorter, especially in years of heavy fruiting.

" 'Early Golden' should have a 'gallon to the tree' in three or four years after planting. 'Kawakami' always bears very sparingly, yet it is a very vig-





Courtesy F. N. Meyer, U. S. Dept. Agr.

FIG. 44. *Top*. Grove of persimmon trees, Diostyros Kaki grafted on Diospyros Lotus. These are dry-meated varieties grown for drying, near Sian Fu, Shensi Province, China. Note the common Chinese method of growing them along the edges of fields.—FIG. 45. *Bottom*. Long strings of peeled persimmons hanging from a pole set up on the mud roof of a house at Siku Kansu near Tibetan border of West China. This fruit is dried prune and dried fig for the Chinese. Generally relished by foreigners.

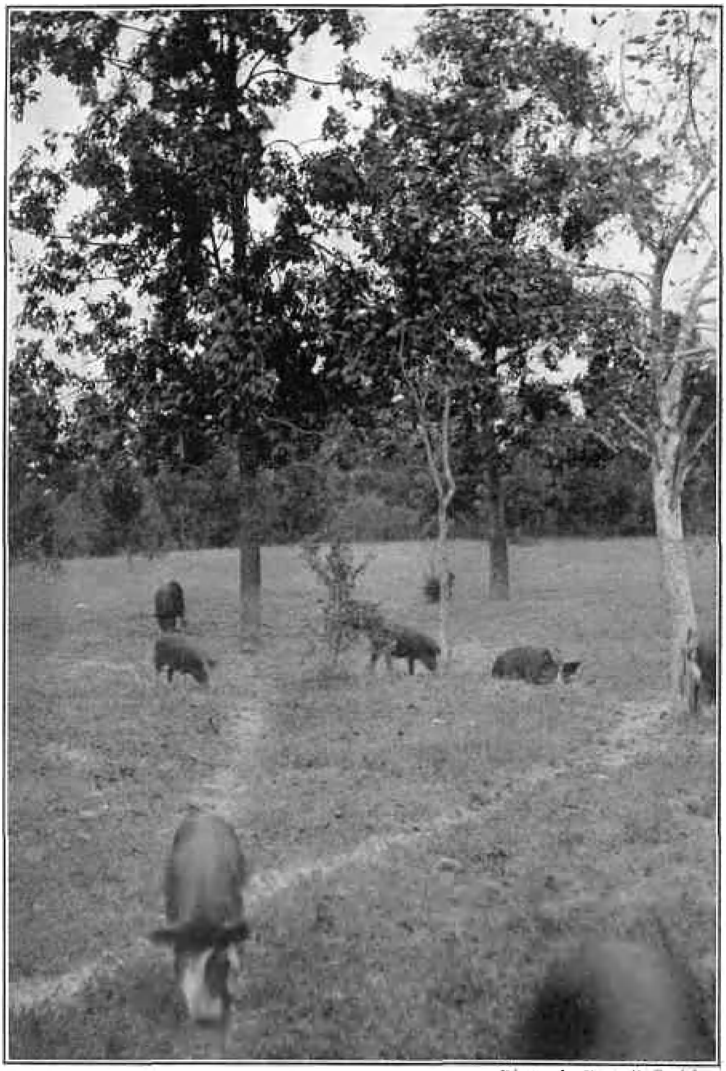


Photo J. Russell Smith

FIG 46 Cross roads in North Carolina pasture. At the right is a poor mulberry tree, one of many connected by paths worn in July as the pigs made their mulberry-gathering rounds. Other paths develop in September as the pigs pass from persimmon tree to persimmon tree in the same enclosure. Pigs in background gathering persimmons.

However, it is a much more common tree in American than the mulberry, growing wild in much greater abundance. This is partly due to the fact that the leaves are shunned by most pasturing animals, including the sheep and goat. I have proved this in my own experience. This is a point of great importance because seeds can be planted in pasture fields, pasturing can continue without interruption, and the trees can be grafted to better varieties when they reach a suitable size.

(6) Native persimmons in my native locality, northern Virginia, bloom late in June, when wheat is ripe. This almost sure escape from frost injury seems to be a great advantage.

THE PERSIMMON AS A FORAGE CROP IN AMERICA

While making a journey of investigation through the South, I found that Dr. Lamartine Hardman of Commerce, Georgia, now governor of that state and owner of sixty farms, is one of the most enthusiastic tree farmers and persimmon growers anywhere to be found.

"Cows keep the persimmons picked up clean," he said.

orous grower." (Letter from Benjamin Buckman, Farmingdale, Illinois, Sept. 12, 1916.)

"I budded about forty to fifty trees in four-foot rows—only a small part of an acre—three years ago last March. They are now bending with their third crop.

"I happened to bring in a leaf this morning of Shingler 10 x 5¾ inches on a thrifty graft." (Letter from F. T. Ramsey, The Austin Nursery, Austin, Texas, July 19, 1913.)

"The seedling persimmons we have grown here have in the fifteen years they have been growing attained a height of from twenty-five to thirty feet and a diameter averaging about six and a half inches. These trees have been growing in good ground and have been given good care, and I think their size is considerably less than that of standard varieties of apples would have been under similar conditions. We consider from four to five bushels a fairly good yield for these trees." (Albert Dickens, Horticulturist, Kansas State Agricultural College, Manhattan, Kansas, September 6, 1916.)

"Persimmon, not usually considered a timber tree, but the most valuable as food for stock of any forest tree that I know of, as it is a most profuse bearer, seldom failing to bear a crop and very nutritious." (Letter from E. A. Riehl, Alton, Illinois, July 16, 1913.)

"Hogs,[17] cattle, cows, and horses are fond of them. I couldn't tell which likes them better—and mule colts! Just turn them out and they go to the persimmon tree first thing. They just love persimmons better than anything. Yes, sir!"

Then telling of his farm practice he continued:

"I found that I had a lot of land; it was just washing away, and here was natural produce in these good persimmons. I just put my men to looking for the best persimmon they could find, and we planted the seed."

To my question about the time of bearing, Dr. Hardman replied, "The trees are full before they get as high as your head.[18] Another thing is, they do not seem to need any rich land, but just grow right out of the side of a gully. They don't seem to have any disease except a girdler, and he doesn't hurt them much—they live on. Crops grow right up to a persimmon tree."

The facts which caused Dr. Hardman to plant persimmon seed in his fields seem to be widely known throughout the South and parts of the Ohio Valley. However, this knowledge appears to have produced little result other than fairly common practice[19] of leaving the wild persimmon standing in pastures when clearing the woods and thickets.

[17] "In North Carolina I have seen boys getting persimmons from the trees where the hogs were pasturing, and it required three boys to get the persimmons—one to keep the hogs back, one to knock the fruit from the tree, and one to pick it up. And the boys had to be quick if the hogs did not get a share." (D. S. Harris, of Roseland, Capital Landing Road, Williamsburg, Pennsylvania, in a letter to H. P. Gould, Pomologist in charge, Fruit District Investigations, Washington, D. C, March 26, 1913.)

[18] My own observation of many wild persimmons in Virginia confirms this.

[19] This situation is fairly well proved and described by the following excerpts from some letters kindly secured for me by Messrs. W. A. Taylor and H. P. Gould of the United States Department of Agriculture:

"In regard to the use of the native persimmon as a hog crop, will say '.hat I do not know of any parties in the state who have planted the persimmon with this idea in view, yet it is very common in the making of hog pastures to retain any native persimmons that may be growing there with the idea of the hogs gathering the fruit. I believe that this is a most valuable fruit for hogs, and I have been collecting a number of our native persim-

I have found one other farmer, the late R. 0. Lombard, of Augusta, Georgia, who was enthusiastically grafting the native persimmons that stood in his fields. He did this to get hog feed as one of the crops in his systematic series of tree-crops-for-hogs-forage system. I saw the trees standing in the white

mons that ripen their fruit at different stages with the idea of having them come on in succession from early fall until midwinter. (C. C. Newman, Horticulturist, Agricultural Experiment Station, Clemson College, South Carolina.)

"A number of native persimmon trees are found in almost every pasture in this section of the state, and the hogs consume the fruit freely; however, very little attention is paid to the trees." (Letter, April 10, 1913, H. P. Stuckey, Horticulturist, Georgia Experiment Station, Experiment, Georgia.)

"I have noticed this, that hogs seem to like them very much and make paths through the woods and fields going to the trees to pick them up as fast as they fall and seem to relish them very much, and they are generally in fine condition during persimmon season, though the acorn and other nut crops generally come off at the same time. Owing to the fact that the persimmon is very full of sugar, I think it very fattening and would be a fine thing to enclose in hog pastures following the everbearing mulberry which lasts through the summer." (Letter, April 22, 1913, John F. Sneed, proprietor, The Sneed Wholesale and Retail Nurseries, Tyler, Texas.)

"As a matter of fact a great many hog lots have persimmon trees in them, some of which may have been left because of the liking of the hogs for the fruit of the trees. Only one man of whom I know has any considerable quantity of the persimmon trees in his hog lot. It seems that he has chosen this lot in part because of the presence of the trees. He also has mulberries growing in the same area for the same purpose. I refer to Mr. Sam Wilder, proprietor of the Trinity Dairy, whose postoffice address is Cary, North Carolina." (Letter, April 29, 1913, J. P. Pillsbury, Agricultural Experiment Station, West Raleigh, North Carolina.)

"Here in southern Indiana where native persimmons abound, nearly every one appreciates the value of persimmons for hogs. I had a hog pasture on one of my farms in a native persimmon orchard, and their value is almost equal to corn, after they get ripe, but cannot be utilized at any stage of growth like corn. But after they begin to ripen and lose their astringency, they turn rapidly to sugar that has a decided fattening property. I had a lot of hogs in a pen that contained two wild or native persimmon trees; as I was fattening these hogs I kept plenty of corn by them, but it was very interesting to watch these porkers ever on the alert for the familiar sound of persimmons, following and vieing with each other in trying to be first to reach the fruit, leaving any kind of feed. I know a party near me who planted a considerable orchard of Golden Gem persimmons on purpose for hogs and paid (I think) $1.00 each for the trees." (Letter, March 25, 1913, Alvia G. Gray, Salem, Indiana, R. No. 4.)

sand of his coast plain cowpea fields and bending down with fruit (page 257).

It should be a nice element of farm management to let the pigs that picked up their own living on mulberries in June and July continue the process with persimmons from September until Christmas or snowfall.

CREATIVE WORK WITH PERSIMMONS

All this promise in the American fields and woods comes from one species (diospyrus virginiana). Its range is at least a million square miles of area.

In this wide variety of climates, soils, elevations, and exposures, nature has made this species into an almost infinite variety of forms. These offer great promise alike to the searcher for trees fit to propagate and for the plant breeder. Mr. Fletcher of the United States Department of Agriculture, who has spent much time studying persimmons, states it thus: "The wide variations shown by the fruit in size, color, season of maturity and tendency to seedlessness, and by the trees in size, shape, and vegetative vigor, indicate the possibility of greatly improving the native persimmon."[20] Analyses[21] of persimmon pulp expressed in per cent. pulp show one specimen of diospyros virginiana to have 29 per cent, solids while another had 48 per cent. solids. The low one had 26.30 per cent. nitrogen free extract, the other 43.88—suggestive variations.

Now here is the stupendous fact. There are two hundred *species* of persimmons scattered about the world.[22] A veritable gold mine, first for the plant hunter, and then for the plant breeder.

[20] United States Department of Agriculture, Farmers' Bulletin 685, *The Native Persimmon,* by W. F. Fletcher.

[21] *Journal of American Chemical Society,* Vol. XXVIII, No. 6, June, 1906, "Growth and Ripening of Persimmons," by W. D. Bigelow, H. C. Gore, and B. J. Howard, pp. 688-703.

[22] *Yearbook,* United States Department of Agriculture, 1911, p. 416.

There should be a corps of men at work right now upon the persimmon. Think of the work involved in finding the dozen best wild parent persimmon trees suited to make a crop series for East Texas, the Ozarks, southern Indiana, central Tennessee, north Florida, central Georgia, eastern North Carolina, western North Carolina, central Virginia, southeastern Pennsylvania, Connecticut and Rhode Island, and for extending the range to places where it does not now grow.[23]

Here alone is a heavy task—the adequate search of American fence rows, fields, and woods for parent trees. It is a work of years. Testing these trees is another work of years. Breeding better ones is yet another work of years. And no one is doing it. And then there are the one hundred and ninety-eight foreign species, of which one, diospyrus kaki, has been made into the glorious golden fruit known to the Peking travelers and important to the Chinese in so many forms.

"There are at least six species of diospyros (temperate and sub-tropical) d. virginiana, U. S. A.; d. kaki, China; d. chinensis, China; d. conazotti, Mexico; d. sonorae, Mexico;

[23] Concerning one of the few American experiment station plantings, Professor Albert Dickens, of Manhattan, Kansas, writes (September 2, 1927), "Our planting of persimmons has been very satisfactory, but the named varieties are not much more desirable than a number of our seedlings. As a matter of fact, I think that two of the best we have are seedlings.

"In spite of the fact that they are particularly tempting to the student body, we have harvested considerable quantities and have had a fairly ready sale for them when marketed in strawberry boxes or small baskets."

"The trees that have borne five bushels of fruit were seedlings of the 1901 crop, being now twenty-six years old. They are about thirty-five feet in height and six to eight inches in diameter at breast height. They are almost as large as an apple tree of that age. For fruit production, I think the trees should not be spaced closer than thirty feet." (Letter from Professor Albert Dickens, Department of Horticulture, Kansas State Agricultural College.)

Professor James Neilson, Horticulturist at Port Hope Station, Ontario, reports a seedling persimmon from southern Missouri stock bearing fruit on the farm of Lloyd Vanderburg, Simcoe, Ontario, ninety miles from Niagara Falls and seven miles from Lake Erie. This place is somewhat protected from spring frosts by the lake, but the late-sleeping persimmon is not supposed to be a spring frost victim.

d. rosei, Mexico, and probably more that yield edible fruits and are hardy enough to be grown in the limits of the United States. I think a careful study of the species of this very large genus would bring to light two or three times this many. They should be studied exhaustively.

"At least four species are now used for stocks: D. lotus, D. kaki, D. sinensis, D. chinensis, and D. virginiana. Many more should be tested and probably some would be valuable." (Letter dated August 25, 1927, from Mr. Walter T. Swingle, Physiologist in charge, Bureau of Plant Industry, United States Department of Agriculture.)

The persimmon alone could occupy profitably for many decades the time and resources of an institution with a staff of twenty to forty persons. They could probably produce crops that would rival corn, as well as the apple and the orange.

CHAPTER XII

A CORN TREE—THE CHESTNUT

THE CHESTNUT SYSTEM OF EUROPEAN MOUNTAIN FARMS

Three men sat chatting at leisure under a chestnut tree on the little common of a Corsican village. It was a beautiful day in June. As the chestnut trees were only now blooming, it would be two full months before these men, one-crop farmers and owners of chestnut orchards, would have to go to work.

For miles I had ridden along a good stone road that wound in and out along the face of the mountainside, a mountainside that was much like my own Blue Ridge in Virginia, with one chief difference—this mountainside was higher and more prosperous than its Virginia prototype. The road at about two thousand feet above sea level went for miles along the mountain through a zone of chestnut orchards. In and out it went, in and out through coves and around headlands. Down near the sea level it was too dry for the chestnut, for Corsica is a land of Mediterranean climate, with little summer rain at low altitudes. Up near the top of the mountain it was too cool for the chestnut; but throughout a middle zone one thousand feet or more in elevation, the chestnut was at home. I think that in fifteen miles I had not been more than one hundred yards from a chestnut tree. If I was correctly informed, every chestnut tree in the wide area that stretched up the slope and down the slope was a grafted tree. At frequent intervals I had passed substantial, comfortable-looking stone villages, villages that looked older than the gnarly chestnut trees that shaded them.

I wanted to learn the system by which these trees made a living for the village folk, so I joined the three men who sat chatting on the little common. It was a simple story that they told me. The men of the village were farmers. Their chief estate and sustenance were tracts of the grafted chestnut orchards that surrounded the village in all directions. In addition they owned little terraced vegetable gardens and alfalfa patches near the village. Every morning a flock of milch goats, attended by some member of the family, and perhaps accompanied by a donkey or two, or by a mule, went out to browse beneath the trees. Goat's milk, goat's-milk cheese, and goat flesh were important articles of diet in the village. I found that a meal of goat's-milk cheese and cakes made of chestnut flour was good food.

The men told me that the year's work begins in August or September. A few weeks before chestnuts are ripe, the orchards are scythed to remove the things that goats and mules can not eat. Then in September comes the chestnut harvest. At that season there is no school. Even the children help the men and women to pick up chestnuts. The nuts are carried upon the backs of donkeys and mules to the village. After harvest, pigs are loosed to turn over the leaves and find the nuts that have escaped the human eye.[1]

Some of the nuts are shipped fresh to market, but the main crop is dried for local use. Upon the slatted floor of a stone-dry house, the nuts are spread to a depth of two or three feet. From a slow fire in the basement smoke and heat arise through

[1] Paris restaurateurs and butchers say that chestnut-fed pork is as good as any pork and is usually considered to be of superior quality. (Letter from American Vice-consul General, Paris, August 12, 1913.)

"Smoked pork coming from pigs raised in a chestnut district is regarded as a great specialty, and its superiority to ordinary pork is so marked that the pigs are fed almost exclusively on chestnuts from October to the end of March." (Letter, Wesley Frost, American Consul-General in charge, Marseilles, August 4, 1927.)

The American Consul at Seville, Spain, wrote, September 29, 1914:

"Frequently the chestnut crop in the northern part of this district is sufficiently plentiful to go far toward fattening the famous Extremaduran hams."

the slatted floor to dry the nuts that are spread upon it. This kills all worms and cures the nuts so that they will keep as well as any other grain. The air space between the shell and the shrunken meats makes good ventilating space.

The chestnut is to the Corsican mountaineer[2] what corn is to the Appalachian mountaineer in the fastnesses of Carolina, Kentucky, or Tennessee, except that Corsica grows more of chestnuts than Appalachia does of corn.[3] In the place of the Appalachian corn bread, the Corsican has chestnut bread; in the place of corn to feed the animals, the Corsican uses dried chestnuts. One of my informants—the mayor of the village—took me around to the barn and showed me how his horse relished a feed of dried chestnuts. She crunched them, shells and all, exactly as my horses crunched corn.

While my new-found friends were telling me about their system of agriculture, a woman and a little girl came out to show me cakes made of chestnut meal. The cakes were to be used at a feast in honor of the marriage of the priest's sister. For these festive cakes the chestnut meal was wrapped in chestnut leaves for baking.[4]

[2] The Corsican crop of 1925 was 95,000 metric tons, worth $1,650,000. (Letter, September 23, 1927, from Lucien Memminger, American Consul, Bordeaux.) The production of chestnuts that year in Corsica per square mile was more than that of wheat in Kansas (28 tons to 25). The next year Kansas doubled its wheat crop. Consul Memminger states that the Corsican crop was reported to be 90,000 tons in 1924 and 95,000 in 1927.

[3] In 1925 Corsica grew 28 metric tons of chestnuts per square mile. The corresponding figures for corn for 1924 were as follows: Bledsoe County, Tennessee, 29 tons; Yancy County, North Carolina, 21 tons; Buncombe County, North Carolina, 17 tons; Mitchell County, North Carolina, 15 tons; Harlan County, Kentucky, 5 tons; Bell County, Kentucky, 8 tons. On the per capita basis, the figures were Corsica, chestnuts 740 lbs. and of corn for the American counties, Bledsoe County, Tennessee, 2,040; Yancy County, North Carolina, 1,630 pounds; Buncombe County, North Carolina, 400 lbs.; Mitchell County, North Carolina, 800 pounds; Harlan County, Kentucky, 200 pounds; Bell County, Kentucky, 300 pounds. (Information from office Farm Management, United States Department of Agriculture and Consul Memminger, Bordeaux, letter September 23, 1927.)

[4] In Palmero, Sicily, I was told that a laborer's breakfast often consisted of leaf greens, bread, and chestnuts.

The leaves from chestnut trees also furnished bedding for the animals in lieu of the American straw; dead branches from the trees furnish firewood. They had a regular system of selling the old trees to the factories that manufacture tannin from chestnut wood. The trees stood about irregularly almost as Nature would place them, as she had doubtless placed the first trees at the beginning of chestnut orcharding some centuries ago. As a tree approached old age, a young tree was planted as near to the old tree as possible. The younger tree lived for ten, fifteen, perhaps for twenty years a stunted and suppressed life, but it grew a little and got its roots well established.

The moment the big tree was taken away, sunshine, light, and free fertility made the erstwhile starveling grow rapidly to fill the place of the old giant that had made its final grand cash contribution. This regular system of retirements and replacements [5] kept these orchards continually replenished tree by tree—generation after generation—century after century.

I asked one of my Corsican informants how long these orchards had been established. This man happened to be a government official from the nearby city who spent his summers in the chestnut village of his nativity.

"Oh," said he, "a hundred years, five hundred years, a thousand years,—always!"

In English phrase he might have said, "The memory of man runneth not to the contrary." It seems to be a matter of record that the chestnut was introduced into Corsica by the soldiers of the Roman occupation, and the gentleman was right in

[5] "To encourage heavy crops of nuts the trees are kept far enough apart for the light of the sky fully to reach the ends of all branches.

"The annual increase of wood in the chestnut orchards of Italy is reported to be very low because the situation is somewhat akin to the production of wood in an apple orchard. The chestnut trees are kept for their nuts long after they have passed the maximum of wood making. It is another way to say that the nuts are more valuable than the wood." (Raphael Zon, United States Bureau of Forestry, letter, March 23, 1923.)

maintaining that the chestnut business of his mountainside had been going on uninterruptedly for many centuries.[6]

This Corsican chestnut farming is typical of that which covers many thousands of steep and rocky acres in central France, some of the slopes of the Alps, of the mountains of Spain and Italy, and of parts of the Balkans. Especially do I recall when crossing the Apennines from Bologna to Florence the marked and sudden increase of population that occurred at about two thousand feet elevation. The slopes below two thousand feet were treeless and on them are few evidences of people. At two thousand feet where the chestnut forests begin, the villages were numerous, large, and substantial.

Compare this age-old and permanent European mountain farming with the perishing corn farms of our own Appalachian mountains. The farmer of Carolina, Tennessee, or Kentucky mountains has the cornfield as his main standby. He has a garden, perhaps in the woods some pigs—largely acorn-fed, some cows and sheep which range the glades and hills and pick such living as they can. The corn crop is the main standby. Corn bread is the chief food of the family. If there be enough the pig or sheep or cow may get a little, or again they may not. The part that corn whiskey has played in the history of this region need not be expanded here.

The economic contrast between the Corsican and Appalachian mountaineers is striking. In Corsica the stone house in contrast to the log cabin of Appalachia; in Corsica the good stone road going on a horizontal plane along the mountainside in contrast to the miserable trails running up and down the American mountain; the Corsican mountain covered with majestic trees whose roots hold the soil in place, in contrast to the American mountainside deforested, gashed with

[6] "The date of the earliest grafting on chestnut trees cannot be determined, but there are in existence trees over one thousand years old which have been grafted." (Wesley Frost, American Consul General in charge, Marseilles, letter, August 4, 1927.)

gullies, gutted, and soon abandoned. When the Corsican starts a crop, he does it by planting beautiful trees whose crops he and his children and his children's children will later pick up from year to year. When the American mountaineer wants to sow a crop, he must fight for it, a fight without quarter, a fight to the death of the mountain. First he cuts and burns forests, then he must struggle with the roots and stones in the rough ground of a new field. The sprouting shoots of the trees and tree roots must be cut with a hoe. This is the most expensive form of cultivation, but often the steep and stony ground can be tilled in no other way. In a few seasons the mountainside cornfield is gullied to ruin, and the mountaineer—the raper of the mountain—must laboriously make another field. No race of savages, past or present, has been so destructive of soil as have been the farmers of the southeastern part of the United States during the past century.

There is one argument for corn. It is a great and destructive argument. The plant is annual. The labor of the husbandman is quickly rewarded. The ruin of his farm comes later.

As between corn and chestnuts as types of mountain agriculture, the labor cost appears to be plainly in favor of the chestnut.

The chestnut also seems to be more productive than corn. Much sifting of facts among the chestnut growers of Corsica and France seems to show that the chestnut is a better yielder of food in the mountains of those countries than corn and oats are in the mountains of Carolina and Kentucky.[7] The

[7] An authoritative book on chestnut culture in France is *Le Chataignier,* by Jean-Baptiste Lavaille, Paris, Vigot Freres, 1906. This book says, "A good French chestnut orchard yields on the average thirty-two hectoliters per hectare," or about two thousand pounds per acre.

United States Daily Consular Report, July 20, 1912, p. 343, reports that "148,000 acres of chestnuts in the reporter's district in Spain yielded, 1910, 2534 pounds of chestnuts to the acre."

The average yield of corn in seven mountain counties of North Carolina, Tennessee, and Kentucky for 1919 was 1,124 pounds, for 1924 it was 1,145 pounds. For the same counties the yield of oats per acre was, 1919, 363 pounds; 1924, 524 pounds. Mr. Raphael Zon of the Bureau of Forestry yields are about the same in quantity, but the corn yield can be made only *occasionally* and for a short period of time before erosion destroys the field. In contrast to this the chestnut yields on and on and holds in place the ground it feeds on.

Mr. Pierri, a wealthy proprietor and merchant of the Corsican village of Stazzona, valued chestnut orchards in his vicinity at $230 per acre in 1913. For some orchards the price was more, for others it was less. At $230 per acre an orchard should have thirty-five to forty trees per acre, which would give a value of about six dollars per tree. A tree with a girth of one meter was worth six dollars, but a big tree was worth fifteen to twenty dollars because it bore more nuts. This land valuation was based upon an earning of sixteen dollars to twenty dollars per acre net at that time, 1913. This income in turn was based upon an average production of thirty-one hundred pounds per acre with fluctuations ranging between seventeen hundred and more than four thousand pounds per year.

I saw this land. It was as steep as a house roof and is shown in Figs. 9 and 10. Similar land without chestnuts had almost no value.

tells me that the 1,600,000 acres of chestnut orchards of Italy (good, bad, and indifferent) yield on the average about 1,000 pounds of nuts per acre. The American Consul at Marseilles, France, reported in 1912, for the 190,000 acres in his district, a yield of 1,320 pounds to the acre, worth 0.8 cent per pound or $10.46 per acre.

Professor Grand, Professor of Agriculture at Grenoble, said, 1913, that matured chestnut trees 70 years old, 25 to 30 meters apart, 12 to a hectare or 4 to an acre, would bear an average crop of 150 to 200 kilos per tree. This is 1,320 to 1,760 pounds per acre. He insisted on this as an average, and said that the yield at times would be 4,000 to 5,000 kilos of nuts per hectare in a year of big crop (3,520 to 4,400 pounds per acre).

A big tall tree near the village of Pedicroce in Corsica had a girth of 4.60 meters, a spread of 60 feet, stood on a terrace with nothing on three sides of it, and beside it was alfalfa on which its roots could feed. The owner stoutly held that it yielded 1,000 liters of nuts on the average, that the tree varied in production but little from year to year, and that he gathered nuts himself and therefore was sure of his facts.

THE CHESTNUT FIELD IN THE SYSTEMATIC FRENCH FARM

The chestnut is a regular crop on systematized farms in at least one section of south central France. I saw it near the towns of Jouillac and Pompadour in the department of Corrèze. Under this system the farmer plants about one-third of the farm land to grafted chestnut trees. The crop function is almost identical with that of corn on a farm in Pennsylvania, Kentucky, or Wisconsin. As the corn is used in these states for forage, so is the chestnut used in France. When the French farms are rented the agreements usually contain a provision similar to that found in many American leases with regard to corn, the French provision requiring that the chestnut shall be fed on the farm so that the land may benefit by the fertilizing value of the crop. Sometimes this land that is in chestnuts is good arable land, sometimes the trees are planted in rows and cultivated—true tree-corn indeed.[8]

I think that it is accurate to say that in this district covering many square miles of gently rolling country, one-third of the area is in trees, ninety-nine per cent. of the trees are chestnut, and virtually all the chestnuts are grafted. It is the regular rule of the country that one-third of a man's farm is in chestnut for nut crop with a by-product of wood; one-third of the farm is in tilled fields; one-third is in pasture and hay meadows.[9]

[8] The following interesting prices are reported from the chestnut-growing provinces Corrèze and Aveyron by American Consul Lucien Memminger, Bordeaux, letter, September 23, 1927:

	Per 100 kilos
Dry chestnuts	230 francs
Wheat	155 francs
Indian corn	170 francs

[9] I have seen other French localities in which the fields were small and every fence row or boundary was bordered by a solid row of great chestnut trees, which thus covered a substantial percentage of the area.

The area of cultivated chestnuts seems to be declining in most of the French districts, especially Corsica. The following reasons are cited:

CHESTNUTS IN JAPAN AND CHINA

Japan has a species of chestnuts different from those of America or Europe. They are larger than any of the American or European chestnuts, are less sweet, but like the sweet potato they are full of starch and nourishment. The chestnuts of Japan, like those of Europe, are used for both forage and human food. Japanese government bulletins recommend the use of chestnuts for hillside planting and grafting as it is done in Europe and as it was done in America. In one of the best-known chestnut localities in the Japanese mountains about forty miles northwest of Kyoto, the value of the poorest chest-

(1) Such a large income is to be derived from sending the trees to tannin factories, a comparatively new industry.

(2) The ravages of a disease called "maladie de l'encre" (blepharospora cambivora).

(3) A great increase in cost of gathering them which now amounts to fifty per cent. of their value. This is due to the increasing scarcity of hired labor.

A chestnut grove of say four hundred trees (about twenty-five acres) costs as follows to harvest:

Labor for 45 days to clear away shrubs, etc. ..	600 francs
40 loads of wood as fuel for drying.	250 francs
200 days' labor, mostly women and children, for the harvesting of the chestnuts.	2,000 francs
Total.	2,850 francs

The crop would amount to 1,200 decaliters (or 12,000 liters) of dried chestnuts, worth at four francs per decaliter, a total of 4,800 francs. (Letter, Wesley Frost, American Consul General in charge, Marseilles, August 4, 1927.)

These facts of decline should be considered in connection with the following facts. There has been recent decline of rural population in all the chestnut districts of France as well as in nearly all the other districts of France. This is accompanied by a decline of acreage of nearly all other crops in the chestnut localities and also the closing down of mines in Corsica. It should also be remembered that during the period 1920-26 there was a very sharp decline in rural population in nearly every American state, and many farms were abandoned, as much, for example, as five hundred thousand acres of land in the state of Ohio alone. (Information on chestnuts from Lucien Memminger, American Consul, Bordeaux, letter, September 23, 1927; and from Hugh H. Watson, American Consul, Lyons, France, letter, October 12, 1927.)

nut (30 to 35 yen per tan) was more than that of the poorest rice land, while the best (irrigated) rice land was twice as valuable as the best mountainside chestnut land above it.

Japan's mountain chestnut orchards do not differ greatly from those of Europe. As I observed the mountainsides of Japan, the conspicuous thing about them seemed to be the small area given to tree crops. This seems unfortunate when one considers the great proportion of Japanese land that is not tillable and the great need for food in that crowded land. Perhaps the chief reason for the small extension of hillside chestnut growing in Japan is to be found in the widespread practice of cutting grass and herbage from the hillsides annually and carrying it down to fertilize the rice fields in the flat lands. The mountainside cannot yield fertilizer and wood and also nuts. Orchards of either nuts or fruit are not common in China, but scattered trees for fruit and nuts are widespread in many hilly localities. The Chinese chestnuts are more like the American nut in flavor, and many are larger in size. Chinese chestnuts hold great promise as a basis for a future American crop.

THE AMERICAN CHESTNUT

The American chestnut is a fine tree for timber. It has the good timber qualities of swift growth and ability to throw up shoots or suckers from the stump. The value of this is seen by comparison with pine. Cut down a pine, and it dies; cut down a chestnut and at the end of the first year the stump will have twenty or fifty shoots, some of them six feet high. At the end of the second year the suckers may well be ten feet in height. In a very few years they will have attained a size sufficient to make them useful as poles. This quality of rapid growth of the suckers is a great advantage in the production of nuts. When the trees are cut for lumber, the resulting shoots can be grafted in a year. Fruit can be had as quickly as from the apple tree, or even more quickly in many varieties of chestnuts.

FIG. 47. *Top.* South Central France. Nearly all trees in landscape, grafted chestnuts. A part of farm system—corn substitute.—FIG. 48. *Center.* The Apennines near Florence, Italy. Terraced wheat fields, fore-. ground. Grafted chestnuts, background. Value of terrace and orchard same as Illinois cornland.—FIG. 49. *Bottom.* Corsican chestnut monarch. The man stands by its understudy and successor. (Photos J. Russell Smith.)

FIG. 50. *Top* Chestnut harvest from grafted trees (suckers) in Pennsylvania stump land, 1908. (Courtesy J. G. Reist.)—FIG 51. *Center*. Systematic planting of chestnuts on level land, Southern France, to grow forage—regular farm system. (Photo J. Russell Smith.)—FIG. 52. *Bottom*. Chestnut suckers grafted to paragon variety fifteen months before photographing. (Photo J. G. Reist.)

The native American chestnut has a delicious flavor. Very little use has been made of these nuts considering the fact that they once grew wild to the extent of millions of bushels on hundreds of thousands of square miles of the eastern United States. They were a source of income for the Appalachian mountaineer in many sections and for boys on farms along the fringes of the Appalachians. Looking for the beautiful brown nuts under the trees in the woods is a lure to the hunting instincts of man.

Only a few million pounds were sent to American markets. These nuts were eaten along the street, at Hallowe'en parties, and beside the open fire after supper; perhaps we should not omit their service in school to alleviate for country boys the tedium of lessons. American wild chestnuts were important to the Indian, the squirrel, the opossum, and the bear; but a century and a quarter after the Declaration of Independence, they rotted by the million bushels in the forests from Vermont to Alabama.

The great drawback of the American chestnut was its small size and the added disadvantage that many of them stuck fast in the bur and had to be removed by force. These disadvantages helped to make the Indian's corn preferable as the frontiersman's chief crop. For the same reason the large nuts of Europe appealed to the first experimenters with grafted chestnut trees and chestnut orchards.

Thomas Jefferson grafted some European varieties of chestnut on his Monticello estate in 1775, but an extensive introduction by Irenée Du Pont de Nemours of Wilmington, Delaware, about the beginning of the 19th century, seems to have been responsible for their rather wide distribution by the year 1900 over southeastern Pennsylvania and the adjacent parts of Delaware and New Jersey. As early as 1893 the late Edwin Satterthwaite at Jenkintown, ten miles north of Philadelphia, had the roadsides and fence rows of his truck farm lined with a great assortment of chestnut trees, many of which were grafted and produced nuts of many different sizes and-shapes,[10] some probably two inches or possibly two and one-quarter inches in their largest dimensions; these nuts were sold in Philadelphia markets. I suspect, although I cannot now prove it, that some of those nuts were better than the Paragon (I am sure that some were three or four times as heavy). The Paragon variety became the favorite of a young and promising American industry in the '90's of the last century. This Paragon favorite, originating in eastern Pennsylvania, was considered to be a cross between a European and a native American nut. It was very vigorous. I have seen grafts make six feet the first year. It was not uncommon for the grafts to yield good nuts the second year. Not unnaturally there was quite a boom for orchards of grafted chestnuts in the '90's. For example, Mr. John G. Reist of Mt. Joy, Pennsylvania, together with some associates, had eight hundred acres of hill land near the Susquehanna River in Lancaster County, Pennsylvania, stump-grafted to Paragons.[11]

Then came the chestnut blight. It came with an importation of some oriental plants. It spread concentrically from Brooklyn, where it first broke out[12] in 1904. In a few years all these commercial orchards were gone. Every tree is dead on my twenty-five acres save one little Japanese tree which sprang up from the seed of a Japanese variety.

[10] This rich collection of trees seems to have escaped the attention of professional horticulturists. I saw them only with the indiscriminating eyes of a schoolboy, but I am sure that they were of many sizes and shapes and mostly of European origin. Some, however, seemed to be natives of small size that ripened nearly a month before other natives in the same locality.

[11] In the year 1908 before this orchard was mature and after the blight had begun to kill trees it produced thirteen hundred bushels, which netted five and one-half cents per pound. The late C. K. Sober, of Lewisburg, Pennsylvania, had three hundred or four hundred acres on a nearby mountain ridge. I had twenty-five acres on the Blue Ridge Mountains of Virginia about fifteen miles southwest of Harpers Ferry, West Virginia. These are only a few of the plantings.

[12] Persons desiring to know the history and exact status of this calamity at any particular time can probably get information from the U. S. Department of Agriculture. It is now (1928) sweeping onward through the southern Appalachians, spreading by birds, winds, and possibly by commerce. It may kill every chestnut tree in North America that is not immune.

So far as I know, the only successful orchards of improved chestnuts in America at this time are a few small ones in the Middle West not yet visited by the blight. That of the late E. A. Riehl, Godfrey, Illinois, is worthy of special mention. He turned the steep Mississippi bluffs to good account with an orchard of grafted chestnut and walnut trees that has proved productive and profitable.

THE FUTURE VARIETIES OF CHESTNUTS FOR AMERICA

This chestnut blight which is so deadly to the American [13] and European chestnuts has been found to be a native to China. Chinese chestnuts have been exposed to this blight for centuries and have, therefore, developed immunity or high resistance. The Japanese nuts are also more resistant than the American, and it is possible, even probable, that some Japanese trees producing nuts of good quality and much larger than the native American nut have survived the blight in Maryland and that from these a chestnut orchard industry can be built up in the eastern United States. The restoration of our chestnut forests and orchards, therefore, seems to be a problem capable of solution along known lines.

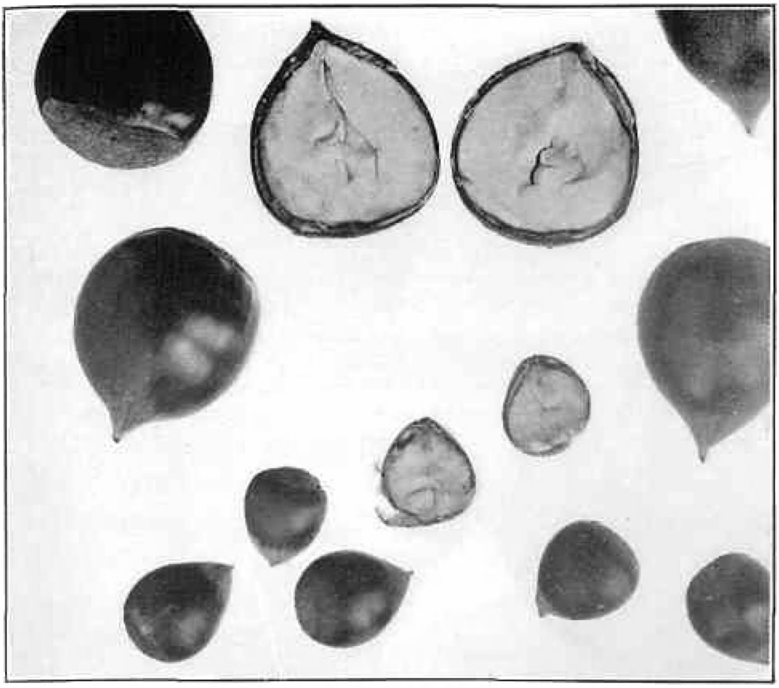
In case they are not already surviving in our midst we may introduce blight-proof trees from the blight region into our own blight-ridden territories. The Federal Government has done this with diligence, and they have introduced and distributed several thousand trees of the Chinese varieties. Some of these have died with blight and some have not. I know one which has given two small crops and seems to be perfectly healthy, after ten years' exposure to the blight at Swarthmore, Pennsylvania, near Philadelphia. The nuts are like the American nuts in size and quality, but very few in quantity on this particular tree.

[13] A few groups of natives have resisted the blight, but their seedlings have succumbed. However, this is a promising lead for the tree breeder. The survivors might be valuable to hybridize with some more resistant strain.

Another way to restore our chestnut orchards and forests is for the plant breeder to create the desired varieties. There is a promising collection of varietal material now at hand in the Chinese chestnut (castanea molissima), one or two other species of Chinese chestnut, the Japanese chestnut (c. crenata), and in one American variety, the chinquapin (castanea pumila), which, strange to say, is perfectly immune to the blight. The chinquapin offers an interesting element for the plant breeder in that it has sweetness to a high degree, while the Japanese nuts are large and coarse like a raw sweet potato. However, latest reports seem to indicate that there are orchard varieties of Chinese chestnuts, large, of good quality, and not yet introduced into the United States.

The theory of plant breeding depends upon (1) the fact of variations of individuals within the species or within the crossing range, and (2) crossing to get new combinations of qualities. The amount of variation among trees of the same species is a surprise to most laymen. One of the qualities in which trees differ is that of precocity. Those who think of all nut trees as being so very slow in coming into bearing may be amazed at the precocity shown by some trees as reported by Dr. Walter Van Fleet, at one time experimentalist for the *Rural New Yorker* and later with the Department of Agriculture. Dr. Van Fleet wrote to me on April 13, 1914, giving the following surprising results of a series of experiments in getting a precocious strain of Japanese chestnuts:

No. 1. 1898. Japanese chestnut seeds planted.
No. 2. 1902. Fruit produced by trees from No. 1.
No. 3. 1903. Cross pollination of earliest ripening trees of No. 2.
No. 4. 1904. Cross pollinated nuts of No. 3 planted.
No. 5. 1906. No. 4 bore fruit, immediately planted.
No. 6. 1909. No. 5 bore fruit profusely (in 3 years)—immediately planted.



Courtesy U. S. Dept. Agr.

FIG. 53. *Top*. Below, American chinquapin (Castinea Pumila), natural size. Above, good-tasting hybrid, chinquapin x large tasteless Japanese.—FIG. 54. *Bottom*. Fourth generation of selection in Japanese chestnuts. Tree twenty-three months from seed.

FIG. 55. *Top*. The Portuguese oak tree (ilex) that bore 1200 liters of acorns, close rival to an acre of American corn.—FIG. 56. *Center*. Grafted oak trees standing in grainfields in Spanish island of Majorca.—FIG. 57. *Bottom*. The Portuguese swineherd leading his wards from the earth-covered houses to the cork forest in the background where they harvest their own living. (Photos J. Russell Smith.)

No. 7. 1911. No. 6 bore fruit (as much as 32 nuts per tree, in two years after seed ripened)—fruit planted.

No. 8. 1913. Trees from No. 7 bore in two years.

In each generation of those crossed he selected the earliest ripening nuts for seed. Note the increasing precocity of the generations.

The above experiment was started before the blight came. After the blight appeared, Dr. Van Fleet started to breed blight-proof chestnuts by crossing Chinese and Japanese chestnuts with the chinquapin. One of the results from among many, many nuts thus produced (chinquapin x molissima—[Chinese]) is described as follows by the United States Department of Agriculture:

"The original tree is growing at the Bell (Md.) garden. This tree is more than ten years old and for the past five years has borne heavily each year. The nuts are about double the size of our native chestnuts and are sweet and palatable. The tree has shown no signs of blight. This tree and others are being made the subject of breeding and pathological studies by G. F. Gravatt, in charge of the chestnut-blight investigation of the Office of Forest Pathology."

Unfortunately Dr. Van Fleet is dead and this work is not now being continued on any large scale. This is regrettable, for there is no reason to think that he made more than a beginning at the possibilities.

Private experimenters[14] have done breeding work almost

[14] *The Journal of Heredity*, Vol. XIII, No. 7, July, 1922, pp. 311-14. "Eventually (1899) he (George W. Endicott, age 60, Villa Ridge, Illinois) produced five hybrid seeds (by crossing Japanese and American chestnuts) from which he raised three trees, naming them the Blair, the Boone, and the Riehl. Like the American sweet, the Blair and Boone produced three nuts to the bur, while the Riehl produced a single perfect nut with an aborted nut on each side like the Japanese parent. All three first-generation hybrids produced nuts free in the bur like the Japanese parent. All of these trees showed tremendous vigor; the largest, the Riehl, had a spread of forty-five feet when twenty years old. The Blair and Riehl began to bear at four and five years, respectively, while the Boone bore its first nuts at seventeen months. When we compare this with the Japa-

as suggestive of results and possibilities. Mr. Endicott, of Illinois, working with the enthusiasm of a creative mind, hybridized American and Japanese chestnuts. Some good nuts were produced, and, what is of far, far greater significance, he produced some which were proof against a local weevil, but unfortunately it was not the dread chestnut weevil of the forests of the eastern United States. The chestnut weevil (worm) is at present a more deadly enemy of the chestnut industry in many locations than even the blight. This is because there has not yet been found any successful means by which we can attack this insect. Perhaps it is time that ornithology became

nese and the American parents, which begin to bear at about six and twelve years, respectively, we gain some idea of the precocity which accompanied the hybrid condition. Van Fleet reports similar vigor in crossing Asiatic and European chestnuts with the chinquapin and the American sweet—the Japanese hybrids being again the most precocious. These hybrids were likewise heavy bearers, the Boone producing as much as six bushels in a single season. The vigorous growth of the hybrids is shown by their having a spread of over forty-five feet, while the American sweet and the Japanese parents measured about thirty and sixteen feet, respectively.

"The second generation trees were very uneven in growth and size. The smallest was hardly more than eight feet high while the largest was about twenty feet high, when they both were fourteen years old. None of the trees showed the extreme vigor or precocity or heavy-bearing qualities characteristic of the first generation. While the original Boone tree bore its first nuts at seventeen months, the second generation Boone trees were from five to nine years old before bearing; this range almost covers the difference between the original Japanese and American sweet parents. Inl 1920, for example, the second-generation trees ripened their nuts from the first week in September through the middle of October.

"While the nuts on different trees showed a great range of variation in size, form, and tomentum, the nuts on any individual tree were remarkably uniform.

"For many years all the trees of both generations with one exception have been resistant to weevils like the Japanese parent. The single exceptional tree has always given nuts badly infected with weevils, while all the rest of the trees in the orchard have been immune."

In his private experimental grounds at Baldwin, New York, Mr. Willard Bixby planted the seeds of one of his chinquapin bushes. The nuts from one of these seedlings are *three times as heavy as the nuts of the parent tree*. Perhaps it is a variant. Perhaps it is a hybrid; if so it does not show it, but with dimensions of .87 inch x .87 it ranks with good American chestnuts in size. Perhaps a new industry can start with this unusual little tree. (*American Nut Journal,* December, 1927, p. 115, for details of Mr. Bixby's tree.)

more constructive. Why cannot the ornithologists work out some technique whereby we learn to grow insect-catching birds which would do for bothersome insects what the cat does for the mice?

The chestnut-breeding achievements already attained do seem to prove that the chestnut for human food is about to come back to America, and that, too, chiefly through the efforts of one man (Van Fleet) working on introduced material.

I now have a hundred little Chinese seedling chestnuts growing on my blight-ridden mountainside, and I am hoping that in a few more years I can graft them with some good, hardy, reliable blight-proof tree such as the one by Van Fleet above mentioned; then we can again have chestnuts at Hallowe'en. However, Hallowe'en nuts are not the great chestnut need of America. A few tens of thousands of acres will probably glut the Hallowe'en market. Chestnuts in America will probably be, as they have been, a special, not a standard, article of diet.

The great chestnut need of America is for a forage nut to enable the Appalachian mountaineer and the owners of hill lands almost anywhere to abolish the corn field, as they now have it, by growing instead tree corn (chestnuts) for their pigs and cows. This market is hard to glut. For this purpose we need the largest and the most prolific nut, regardless of its quality as human food. If it tastes as bad as raw cornmeal or dried sweet potato, that will not interfere with its being good for pig feed or for chestnut flour that can be baked in the oven and seasoned with whatever seasoning may appeal. As possible raw material for breeding this kind of nuts, I recall a seedling Japanese chestnut grown by Julius Schnadelbach,[15]

[15] "From a nut borne by the early-ripening 'Japan Mammoth' chestnut disseminated nearly twenty years ago. Japan Mammoth bears very large nuts, generally two in a bur, but we do not recollect any quite as bulky as those Mr. Schnadelbach sends. There were two in each bur as usual, each nut perfect and containing a 'meat' almost as large as a moderate potato. The quality when eaten raw was very tolerable for a Japan variety, being

Grand Bay, Alabama. Its photograph, life size, shows a profile 2.5 x 1.9 inches. A similar profile of a Paragon chestnut measures 1.63 x 1.37 inches. A large egg measures 2.16 x 1.72 inches. Multiplying the length of the Schnadelbach chestnut by its breadth gives 4.75 square inches; the Paragon gives 2.23, and by the same process the egg gives 3.715 square inches. Therefore, harvesting chestnuts like the Schnadelbach is like gathering eggs or potatoes and can be done by hand for forage purposes even in high-wage America.

To get the corn-substitute tree, we need one set of breeding experiments to produce the largest possible Japanese chestnuts.[16] Then if they are not hardy they should be crossed with something that is hardy, continuing until a hardy strain is produced. We will then be ready to clothe hundreds of thousands and even millions of acres of our hill lands with a crop like that of Corsica. We can make an Appalachian Illinois which will yield for centuries, preserve the lands, and support generation after generation of people in greater physical and intellectual comfort than are the lot of the present generation of hill destroyers.

You say this is too slow for the average American. There is the rub, but perhaps there is a way around this difficulty if we can focus a small fraction of our brains and money on it. One moderate-sized philanthropy can produce the new varieties and the farm technique. Then we need some philanthropy

neither bitter nor astringent. The flesh was solid throughout, having no divisions filled with bitter skin as is commonly the case with very large chestnuts. A dozen of these monsters, properly boiled or roasted, would come near to making a hearty meal for a workingman." (Walter Van Fleet in *Rural New Yorker,* 1908, pp. 83s and 838.)

[16] The small size of the American chestnuts and most of the wild oriental chestnuts gives us reason to suspect that the native chestnut of Europe and eastern Asia might have been as small as our own and have been improved to a very great size by the process of chance breeding, more fully described in the chapter on the Persian Walnut. (See p. 164.) Since these astonishing results have been obtained prior to the discovery of the science of plant breeding, we have good reason to suppose that larger and finer nuts than any now known may easily be produced by a moderate amount of patience and skillful work.

at five per cent. to make such orchards in thousand-acre blocks judiciously scattered and to sell them to bona fide farmers in small blocks at cost plus interest. Thus two decades might witness an amount of progress that would otherwise require many decades, if indeed it could come at all by individual enterprise.

CHAPTER XIII

A CORN TREE—THE OAK AS A FORAGE CROP

THE SURPRISING AND NEGLECTED AGRICULTURAL POSSIBILITIES OF THE OAKS

The oak tree should sue poets for damages. Poets have symbolized the oak tree as sturdy and strong, but slow. The reiterations of poetry may be responsible for the fact that most people think of this tree as impossibly slow when one suggests it as the basis of an agricultural crop. On the contrary the facts about the oak are quite otherwise.

The genus of oak trees holds possibility, one might almost say promise, of being one of the greatest of all food and forage producers in the lands of frost. Why has it not already become a great crop? That is one of the puzzles of history, in view of its remarkable qualities.

(1) Some oaks are precocious in bearing nuts (acorns).

(2) Some grow swiftly.

(3) Some are very productive.

(4) Some acorns are good to eat in the natural state, and most can be made good to eat by removing the tannin (a useful product, easily removed), which makes some acorns bitter to the taste.

(5) The acorn has been used as a standard food for ages.

(6) The food value of the acorn (pages 151, 304) shows that it stands well in the class of nutrients. Historically it has been a food for ages of the squirrel, opossum, raccoon, and bear. Among the four-footed brethren the hog above all might almost be called an acorn animal. For untold ages he has lived in the forests from Korea to Spain. In the autumns he has larded himself up with a layer of fat to carry him through

the winter. As food for man the acorn has probably been used for unknown ages in many lands. It is still being used as food by man, his beasts, and the wildlings.

As the pioneer farmers of Pennsylvania pushed aside the flowing stream of oil from their springs so that animals might drink water, so the modern world has pushed aside this good food plant, the oak tree.

There is a strip of hills from New England to Alabama, from Alabama to Ohio, from Ohio to Missouri, and from Missouri down to Texas. On these hills men have been making their living by growing wheat, corn, oats, clover, and grass. Yet I am confident that in every county there are oak trees of such productivity that if made into orchards they would in any decade yield more food for man or beast than has been obtained on the average in any similar period on the hill farms of this wide region.

THE PRODUCTIVITY OF THE OAK TREE

The oak tree is productive. Down in Algarve, the southernmost province of Portugal, I heard of an ilex that bore 1,200 liters (35¼ liters equal 1 bushel) of acorns. The definiteness of the report was pleasing to the ear of one in search of facts, and the size of the yield was surprising. I went to see the tree. It stood alone in an unfenced outer yard at the edge of the village of St. Bras. The branches had a reach of only fifty-one feet. By long and devious methods I cross-questioned the owner, a widow of sixty. She always told the same story, and the neighbors believed it. The woman said that the tree bore 1,200 liters on full years and 240 liters in the alternate years, and that the average yield was 720 liters per year. She said that she knew this because she had picked the acorns and sold them in the village.[1] Selling acorns is a common but not

[1] The usual price was 260-300 reis per 20 liters. This made 15,600 milreis —18,000 milreis or $16.84 to $19.44 American gold for the one tree on the big crop year. Data 1913. This income was based on pork, which brought nearly double the American price because of Portuguese tariff.

FIG. 61. *Top Left.* The light-colored background at lower right side of picture is a stream bed. It helps to show the extreme steepness of this 'hillside orchard of oaks (ilex) on the slopes of the Sierra Nevada Mountains (Spain). The farmer shown in picture said he pastured his small pigs here but not the large ones. He said he was afraid they would fall down the hill, which is so steep as to make climbing difficult. (Photo J. Russell Smith.)—FIG. 62. *Top Right.* One of the many grafted oak trees on the stony hills of an estate at Espoelas, Majorca. The bark of stock is light, that of graft is dark. (Photos J. Russell Smith.)—FIG. 63. *Bottom Left.* One of nature's miracles. Large good thin-shelled beaver hybrid from small hard-shell shagbark, left, and bitternut, right; 55 per cent. of life size. (Photo Willard Bixby.)

The late Freeman Thorpe of Hubert, Minnesota, after some years of experimentation and actually measuring the acorns from test trees, was confident that the Minnesota black oak would average one hundred bushels of acorns per year on sandy land of low fertility—land that would make not more than thirty bushels of corn. He also thought that he could harvest the nuts as cheaply as he could harvest corn. Perhaps Colonel Thorpe was over-enthusiastic. He was a man with a flame in him, and he loved his trees. However, we can cut his production estimate in two, and double the cost of harvesting[4] and still have a sound business proposition and an astonishing production for *chance seedling trees*. And that is virtually all the labor there is to producing the acorn crop.

The late R. O. Lombard, of Augusta, Georgia, had worked out a series of tree crops for an almost automatic production of pork. He experimented with oaks, deliberately planting them for acorn production. As a result of years of experimentation he was sure that on the sandy soils of the coast plain of Georgia the water oak was much more productive per acre of hog meat than was corn.

Through the kindness of Mr. Raphael Zon, and other members of the staff of Bureau of Forestry, forest rangers gathered acorn-production data. They report yields of two bushels per tree, of two hundred pounds per tree, of three hundred pounds per tree, of four hundred pounds per tree, even of six hundred pounds of acorns per tree.[5] These figures seem to

[4] It was told by landowners in Majorca that a woman could pick up 100 liters of wild acorns in the woods and 200 liters under the grafted trees.

[5] "Forest Service
District 5

"First National Bank Building,
San Francisco, California,
January 27, 1914.

The Forester,
Washington, D. C.

"DEAR SIR:

With reference to the Acting Assistant Forester's letter of September 23: I requested several Forest officers to take observations and collect as give a sense of verity to the claims of Messrs. Thorpe and Lombard quoted above and a sense of reasonableness to my own claim that an oak orchard of *selected* trees would be more productive than the existing agriculture of the American hills.

much information as possible on the seed production of oaks last fall, and the following data have been submitted:

Q. CALIFORNICA

Shasta Forest. Maximum seed production about 225 pounds per tree. A crop annually unless blighted, usually two crops in three seasons. Partial crop every year.

Q. DENSIFLORA

California Forest. Two and one-half bushels of acorns were collected at Summit Valley, T. 24 N., R. 13 W., M.D.M., from a tree 30" D.B.H., 60 feet high, and with a crown diameter of about 20 feet. This tree is at an elevation of 3,500 feet on a north exposure and receives considerable fog. Other trees of approximately the same size were estimated and show that two and one-half bushels is about the average crop.

Trinity Forest. One tree at a high elevation produced thirty pounds of acorns, and another under very favorable conditions produced three hundred pounds. Seed is borne at irregular intervals, but there is at least a partial crop each year.

Q. GAREYANA

Trinity Forest. One tree noted produced five hundred pounds of acorns, and another six hundred pounds. A third, rather small, produced two bushels. Crops occur at intervals of from three to four years. Fruit is frequently killed by frosts.

Q. LOBATA

Sierra Forest. Maximum seed production about one hundred and seventy-five pounds per tree. Good crop one year out of three, and partial crop two years out of three

Q. WISLIZENI

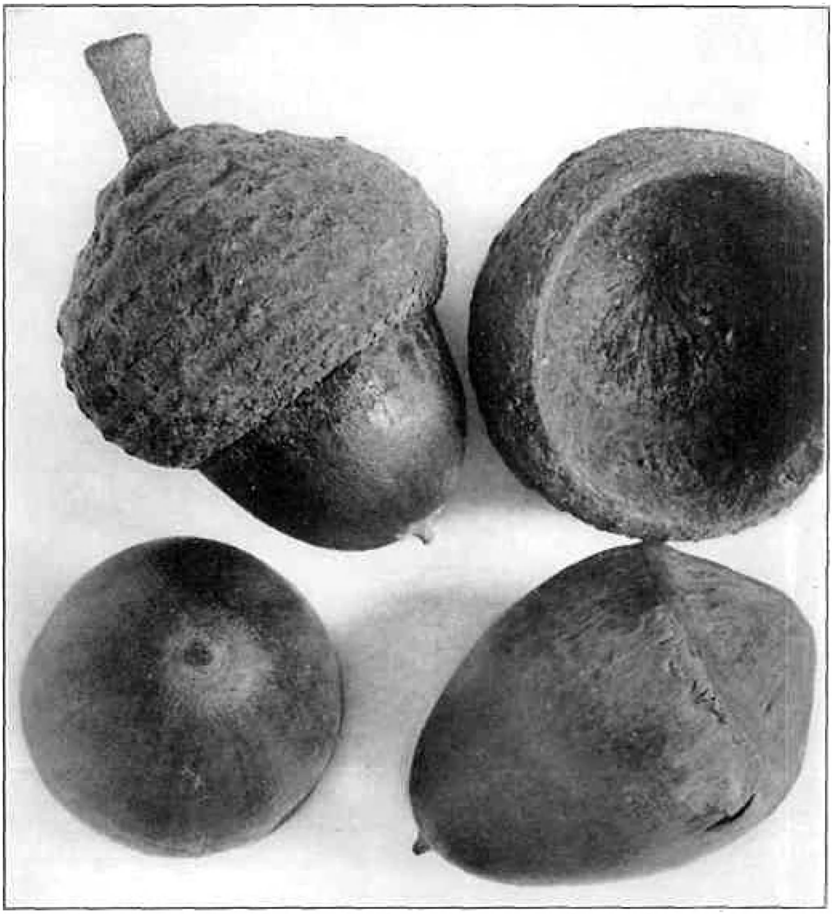
California Forest. Observations on twelve trees, average D.B.H. 26", indicates that the maximum production is about two bushels per tree and that there is a crop every two years.

"(Signed) C. S. SMITH,
Acting District Forester."

"Cochise Ranger Station,
October 17, 1913.

"Señora Librado of Black Diamond, who is the widow of a Mexican who has cut wood in the Dragoons for the past thirty years and raised ten little Mexicans mostly on beyotes (acorns) and cactus (baked mescal), with an occasional piece of choice beef or venison as opportunity occurred, tells me that she has gathered two barley sacks of acorns from

Is the oak slow? FIG. 64. *Left.* A Portuguese ilex that litters the ground with acorns.—FIG. 65. *Center.* Four-year-old sprouts of Turkey oak from Virginia Blue Ridge set up in front of five-inch weather boarding. *Note* acorns.—FIG. 66. *Right.* Seven-year-old sprouts of Virginia Blue Ridge chestnut oak bearing acorns. (Photos J. Russell Smith.)



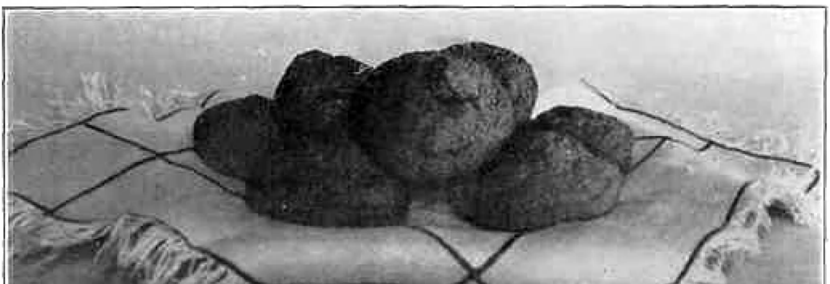


FIG. 67. *Top*. Life-size acorns (Quercus Insignis) from Orizaba, Mexico, the largest known, 1¾" x 1-3/16". Trees growing at Punta Gorda, Florida. (Courtesy *Journal of Heredity*.)—FIG. 68. *Bottom*. Muffins made of Missouri acorns. Said to be good. (Courtesy Missouri Botanical Gardens.)

Even more astonishing is the report of a Michigan man traveling in Colombia, South America, telling of solid forests of oak in the mountains of that country, yielding acorns four times as large as those in Michigan (forty of them weighed a

one tree on patented land at the Horse Ranch on the west slope in the fall of 1911. I know the tree. It is an emory oak with a trunk about twenty inches in diameter, and the top is sixty to seventy feet in diameter. She says that she has gathered acorns there several years and that the tree bears heavily when there are heavy snows in the winter preceding. There are very few acorns on it this year. The sacks mentioned above are the ordinary sacks that hold about sixty-five pounds of rolled barley.

"(Signed) BIRTSAL W. JONES, Forest Ranger."

"Apache, Arizona, October 21, 1913.

"The emory oak bears nearly every year; in fact there have been some acorns every year since I have been in this part of the country. Last year (1912) I saw trees that I would judge bore at least four bushels of acorns.

"(Signed) MURRAY AVERETT, Forest Ranger."

"Bonita Canyon, Arizona, Oct. 29, 1913.

"The quantity produced by one certain tree—the one standing in my yard, and under which my office tent is located—bears fruit nearly every year; a maximum crop it was considered to have had last year, 1912, would have amounted to at least one hundred pounds (100 lbs.). This year it produced not more than fifty pounds on account of the few very cold nights that froze many buds. The fruit is very sweet and relished by nearly all who have tasted it.

"(Signed) NEIL ERICKSON, Forest Ranger."

"University of California, Berkeley, August 4, 1912.

"The valley oak, quercus lobata, yields, in the case of adult trees, about sixty to one hundred and twenty pounds of acorns per tree in the heavy acorn years. Every other year or every third year the yield is light or wanting.

"The California black oak trees yield about twenty to one hundred pounds per tree. It is a species much more abundant in individuals than the valley oak.

"The figures given above are simply estimates based upon my field experience.

"(Signed) WILLIS L. JEPSON, Botanist."

"University of California, Berkeley, California, August 22, 1912.

"California black oak trees in the coast ranges near the coast will average two to three feet in trunk diameter and are fifty to seventy feet high. The diameter of their crowns would be forty to eighty feet. Where they are fairly abundant in a pure stand, the trees will run five to ten trees to the acre.

"A friend of mine thinks that two hundred or three hundred pounds might be a maximum yield of acorns.

"(Signed) WILLIS L. JEPSON."

pound) and lying so thick upon the ground that he thought he could pick fifty bushels in a day.[6]

ABILITY TO YIELD HEAVILY, AND ON POOR SOIL

The oak tree is productive in the quantity of fruit produced, and some species seem to display a well-nigh marvelous ability to produce heavily while still very small in size.[7] Sometimes

[6] "U. S. Department of Agriculture,
Bureau of Plant Industry,
Washington, D. C, August 6, 1914.

"A letter received from Mr. W. O. Wolcott, Bucaramanga, Colombia, says, 'By this mail I am mailing you one hundred acorns of a species of oak that grows in this state of Colombia. I traveled for two days on mule, coming from Ocana through these oaks all the way. You will notice these acorns are about four times the size of our acorns in the United States and as the trees are wonderful bearers these nuts should be of use as a stock and hog feed. The trees grow in the mountains at about four thousand to seven thousand feet altitude, and so close together that they grow to thirty to sixty feet high and not over four to six inches in diameter. Where the trees are in the open some of them are from ten to twenty inches in diameter. In many places the trees were not over two feet apart like the cedar swamps in Michigan when I was a boy. The natives fatten their hogs on the acorns. I could have gathered fifty bushels in a day, I should judge. . . .'

"Very sincerely yours,
"(Signed) DAVID FAIRCHILD,
"Agricultural Explorer in charge."

In a letter addressed direct to me Mr. Wolcott said, "A man told me that wherever there is a forest of these the natives never clear off the forest, as the land is so poor it won't grow anything, and now I remember that all through that section what few ranches I saw were awful miserable shanty ranches and yet all of them had fat hogs and goats. I believe goats can be fattened on these acorns the same as hogs.

"They tell me the acorns begin to fall in February. I gathered those sent on the second and third of June. Then there were piles of them in the very trail itself. They tell me they bear only once a year but every year."

[7] "Office of Experiment Stations, Honolulu, Hawaii, July 18, 1916.

". . . A small oak tree growing near Manhattan, Kansas, which is very peculiar, its small size being ordinarily less than two feet in height. I have taken specimens of an entire tree, shrub, or bush, which had acorns on it weighing in the aggregate more than the tree from which they came.
"JOHN M. WESTGATE, Agronomist in charge."

"Quercus primus pumila, chinquapin or dwarf chestnut oaks, one of the smallest of genus of two—four feet high. The acorns are of middle size and very sweet. Nature seems to have sought to compensate for the diminutive size of this shrub by the abundance of its fruit; the stem which is this fruit weighs more than the tree. Some dwarf forms bend over to the earth with the burden of their crop.

Some of the oaks can produce their burdens from soil of the greatest variety and great sterility.[8] In this connection it should be remembered that the hopeless sand barrens of Long

sometimes no bigger than a quill is stretched at full length upon the ground by the weight of its thickly clustering acorns. This shrub grows most abundantly in the northern and middle states of America and is usually found in particular districts of very poor soil where alone or mingled with the bear oak it sometimes covers tracts of more than one hundred acres in extent." Loudoun, *Arboretum et Fruticetum,* Vol. III, p. 1875.

Britton, *North American Trees,* p. 327, emphasizes its great fruitfulness and wide distribution, Maine to Minnesota, North Carolina, Alabama, and Texas.

Sargent, *Silva,* Vol. VIII, 59. "Q. prinoides, chinquapin oak. The acorns are produced in the greatest profusion, covering the branches in favorable seasons with abundant crops one-half to three-fourths of an inch in length and from one-third to nearly one-half an inch in breadth, with a sweet seed. Massachusetts to North Carolina, southeast Nebraska to Texas, rocky slopes and hillsides."

[8] "I would like to have the opportunity to demonstrate whether the California scrub oak, quercus dumosa Nuttall, could be made to yield a return such as you have described for quercus ilex. This little oak grows in a country that has no further value. It produces acorns freely and with great variation." (Letter—Wm. E. Lawrence, Oregon Agricultural College, Corvallis, September 17, 1916.)

Loudoun, Vol. III, p. 1889. "Q. catesbaei. The barren scrub oak. Carolina and Georgia. It grows on soils too meager to sustain any other vegetation, where the light movable sand is entirely destitute of vegetable mold. Old trees only productive and only a few handfuls."

Quarterly Journal of Forestry, Vol. V, No. 2, p. 119-20, 122-23: "On getting out of the train at Holkam station, England, the first thing that attracts the eye of the visitor is an avenue of quercus ilex, stretching from the uplands through the marshes to the sand dunes, each tree standing quite isolated, exposed north and south, east and west to the bitter cold winds sweeping across the marshes and off the sea.

"It can be seen growing on the sand dunes in pure sand, exposed to the sea winds, on the marshes in strong marsh clay, and on the upland; it seems to thrive equally well on gravel, chalk, or sand; good soil or bad makes little apparent difference to its well-being.

"From its earliest stages it is not difficult to raise, but is rather slow of growth. Most years there is an abundant crop of acorns."

Loudoun, Vol. III, p. 1890. "Q. Nigra. Black Jack oak. Often called barrens oak in New Jersey and Maryland, grows in forests impoverished by fire and cattle and on sandy soil. Baltimore to North Carolina. It is the chief tree of these soils, which are too poor for cropping. Few handfuls of large acorns. It takes abandoned fields."

Island, New Jersey, North Carolina, and of the Appalachian summits are shunned by the farmer as though they were the Sahara Desert, yet these sand barrens are often productive of many acorns—good carbohydrate nutriment.

THE CORK AND ACORN AS A COMMERCIAL CROP

It is not unnatural that the oak tree should render its greatest service to commercial agriculture in the modern world through the cork oak, the species which has the greatest number and variety of products.

The oak tree is the source of one of the chief exports and two of the important industries of Portugal. If I wanted to secure permanent and comfortable financial ease from agricultural land, few more secure bases need be sought than the undisturbed possession of a large tract of Portuguese land having a good stand of cork-oak trees (quercus suber) and evergreen-oak trees (quercus ilex). If the stand of trees were good, it would make little difference even if the land happened to be rough untillable hillsides. Such land would still yield its crops of cork and pork (the pork made of acorns). The virtues of the Portuguese cork forests are quadruple, and the forests are almost perpetual if given a little intelligent care.

With reasonable care, which consists of occasional cutting-out of an undergrowth of bushes inedible to the goat, and occasional thinnings, the forest will live and reproduce itself for centuries and yield four kinds of income. The trees yield best of cork and acorns when the stand is not thick enough for the trees to crowd each other. Thinning to attain this end permits some forage for sheep and goats to grow beneath the trees. It is the common expectation that the pasturage income in a proper oak forest will pay for the labor of grubbing bushes, which, aside from fire protection, is the only maintenance charge. That leaves the other three sources of income—wood, cork, and pork—to offset interest and taxes and to make profit. The landlord's task is easy, as the pasture is rented by the tract, the cork is sold to contractors by the ton, the wood by the cubic meter, and the hog pasture on some lump-sum arrangement. Absentee ownership could scarcely be more providentially arranged. If you wish to see the Iberian owners of cork estates, go to Lisbon, Madrid, or Seville.

Every nine or ten, or eleven or twelve years, according to locality, the cork bark is stripped. An acre with a full stand of young trees should have seventy trees yielding fifteen kilograms per tree, or 2,300 pounds [9] per acre per stripping.

As the trees grow older and are thinned out to prevent crowding, the increased yield per tree keeps the cork output up to the average which, with care, can be maintained indefinitely at over a ton per acre per stripping. Cork is now worth about seventy-five dollars per ton. When the trees come down, they make the precious charcoal for the domestic fires beside which the Portuguese nation shivers in winters while it cooks its simple meals. In a properly cared-for forest every old cork tree has beneath its branches several half-starved understudies all leading a submerged life until it comes their turn to have space in which to spread.

I have seen a large cork tree, fifteen feet in girth and with a reach of fifty-six feet, that had yielded 1,980 pounds of cork at a stripping. An acre will easily hold eleven such trees, and I am told by competent authority[10] that there are many

[9] Consul General Lowrie at Lisbon reported (1913) the annual average cork production of the 900,000 acres of Portuguese cork forests was 240 kilos per hectare, 214 pounds per acre per year.

The average annual yield of cork per acre in Portugal is put at 275 pounds per acre by the *Quarterly Journal of Forestry,* Vol. VII, No. 1, p.57.

[10] Mr. John L. Wilson, an Englishman and educated as an engineer and for many years managing director of Bucknall Brothers, Lisbon, English owners of cork estates, cork merchants and manufacturers, reports one particular cork oak, the trunk twenty-four feet in circumference, seventy-two foot spread, which yielded at one cutting 2,112 pounds of cork; twelve years previously 2,310 pounds of cork, giving this tree an income value at that time (1913) of about one pound sterling per year from cork alone.

such acres in Portugal. It is an interesting and peculiar fact that the poorer the land the better the cork. This superior quality results from a finer texture due to slower growth.[11] Therefore, some fine cork forests are on sandy or stony land, which in any other country would be called "barrens" and would find its highest productivity by growing a pine forest. In some districts the trees are made the sole basis of estimating the value of the land on which they stand. Near Evora, in south-central Portugal, the method of calculating the value of a cork forest is as follows: The twenty-year yield of cork (two strippings) is taken as the basis. The buyer pays 600 to 650 reis (1913) (1,000 reis=$1.08) per arroba (33 pounds) of cork capacity. Thus a good acre of cork trees would bring $125 or more, and the man who sells throws in the land.

English owners of cork estates in Portugal estimate that acorns alone produce from a half to two-thirds of the total pork crop of that country.[12]

	Area thousand sq. miles	*Population million*	*No. of swine * million*
Portugal	35	60	about one
Virginia	40	2.4	½ to ¾

* *Yearbook,* U. S. Department of Agriculture.

The Portuguese hog leads a lean and hungry life for a year and a half or two years, and then comes an orgy during which he eats acorns all day and sleeps on them at night, as he lives in the open beneath the trees. In three months he doubles or triples his weight and passes on to the ceremonies at the abattoir.[18]

[11] So pronounced is this influence of slow growth that cultivation of cork oak trees often injures the quality of cork.

[12] The *Quarterly Journal of Forestry,* Vol. VII, No. I, p. *37,* estimated the annual acorn consumption of the Portuguese pig at 200,000 tons. This figure is interesting when compared with the one million tons of corn produced in the state of Virginia by cultivating 1,300,000 acres to its serious injury by washing away of soil.

[18] Separate tracts are fenced off for the winter food of hogs that are to be kept until the next year.

Careful experiment in central Portugal has shown that 5.3 liters[14] of acorns will make one pound of pork. Thirty-five and one-fourth liters make a bushel. Therefore, a bushel makes 6.6 pounds of pork.

As the acorn crop is not under much control of man, does not come regularly, and above all is not harvested and measured, it is difficult to make an exact approximation of pigs and acorns. This difficulty is met by the organization of fortnightly markets in the villages of the cork regions where pigs in any and all stages of fatness and leanness are bought and sold at any and all times. Two weeks before the pig is completely fatted, he may be sold by the man who has a shortage of acorns to the man who has a surplus. In estimating the number of pigs that he should buy, the Iberian oak tree farmer walks through his forest scanning the trees and noting the number of acorns lying on the ground. Every time he sees the fattening for one more pig, he puts another acorn into his pocket.

On the unfenced acres of a cork estate two kinds of herders are daily abroad; the swineherd, whose wards eat grass and acorns, and the shepherd, whose sheep and goats browse the bushes and grass and furnish wool and milk—the fifth and sixth products of the cork forest.

As I rode through one of these estates on an April day, I came upon a long lane full of sheep, seven hundred of them, crowded solidly between close fences. Two shepherds were busy at their regular afternoon job of milking the sheep. They started at one end of the long and motley mass and worked their way through it. One presided over the milk bucket, the other caught a ewe, backed her up to the bucket, and held her while the milker extracted a few spoonfuls of

[14] These figures were given me by Mr. John L. Wilson, mentioned above. An American finding is as follows: Mr. G. T. McNess, Superintendent, Nacodoches, Texas, Sub-experiment station said (letter, Feb. 11, 1914) to W. J. Spillman, of U. S. Department of Agriculture, "One gallon of acorns is equal to ten good ears of corn."

rich milk, after which the ewe was pushed aside to join the growing mass of the recently milked. That evening at the house of Joao Dias, estate foreman, I was offered rich cheese of sheep's milk, but my previously good appetite for it was diminished by my memory of the milking in the lane.

The bark of the evergreen-oak (quercus ilex) is of no value, but the tree yields more acorns than the cork oak. No Portuguese will cut down the one tree to make room for the other, so absolutely alike does he value the trees. Often the two species are mixed indiscriminately in the same tract, but in some localities the ilex forests are almost pure stand and are cared for exactly as are the cork forests. At Evora in south central Portugal—a locality famed for its pork production—Mr. Estevao Oliveira Fernandes, a graduate of a German engineering school, told me that the local estimate of production for a ten-year period was as follows: for a cork forest 34 kilos of pork per hectare (30 pounds per acre) and for an ilex forest, 68 kilos per hectare (60 pounds per acre). Compare these with pasture yields (on page 268) and then consider the low rainfall and dry summer of Portugal, and its age-long exposure to a robber agriculture, and the oak tree stands forth as a crop plant most worthy of consideration.

TWO-STORY AGRICULTURE

In some sections of Spain and Portugal the young ilex trees are allowed to grow where they have by chance sprung up in the fields. Around and under the trees the machineless cultivation of wheat and beans, barley and hay, goes on just the same. This combination of trees and crops gives a beautiful parklike landscape. The cultivation helps the oaks to make acorns, and after the grain and other crops are harvested, the hogs are turned in to gather the mast crop.

On the slopes of the Sierra Nevada in Spain, a few miles south of Granada, I saw the ilex rendering its supreme service—the oaks and their under-thicket holding the earth for man as no other crop could have done and at the same time giving him a living. In this locality the formation was unconsolidated clay and gravels of such depth that bed rock was nowhere in sight. The slopes and height were such that the term mountain would be applied, perhaps even by the Swiss. On one of these slopes I examined an ilex orchard (or forest) that was giving a fair return as part of a farm. A part of this orchard was so steep as to be very difficult of ascent. When the tenant told me he let his hogs run there, I asked him how he kept them from falling out into the stream below.

"Oh," he said, "I don't let the big fat ones come here. I am afraid they would fall. I bring only the little ones into this part."

A mile away, on a less steep part of the same slope, for centuries men had been supporting themselves by the agriculture of the plow, and nature had shown her resentment of this act of violence. In some places from half to three-fourths of the original land surface was gone, through the work of gullies that had become from fifty to two hundred feet deep. "After man the desert" was here demonstrated. Of the two slopes the ilex slope was much the more productive. It had been saved from the plow only by being so steep that it could tempt no plowman.

Apparently there is no reason except inertia why we should not in time have an extensive cork industry in the United States. The tree is remarkable in its ability to survive both the drought of California and the humidity of the Cotton Belt.[15] As a result of sporadic seed introduction, there are excellent cork trees scattered in many parts of California. There are good specimens in Byronville, Georgia; Atlanta,

[15] Letter, Raphael Zon, Chief of Forestry Division, Bureau of Forestry, Washington, D. C, dated September 28, 1915, and from George B. Sudworth, Dendrologist, U. S. Bureau of Forestry, September 25, 1921.

Georgia; Columbia, South Carolina; in Florida; and in Louisiana.[16]

The excellence of the cork produced on the humid Mediterranean shores near the base of the Pyrenees in Spain gives further evidence of the apparent and rather surprising ability of these trees to thrive in the heat and humidity of the American Cotton Belt, as well as in the dry summer climate of California.

THE AMERICAN ACORN CROP

In America our frontier farmer [17] ancestors fed themselves in part for generations on mast- (chiefly acorn-) fattened pork, and the raccoon, opossum, and bear also subsisted mainly on the acorn in the season of autumn fattening. Well fattened on acorns the bear had nothing to do, so he hibernated till spring, thereby lengthening the season of acorn service. Yet no agriculturalist seems to have applied constructive imagination to the very suggestive facts which have been thrusting themselves upon our attention over hundreds of thousands of square miles for several generations. Some agriculturists, however, are beginning to appreciate the possibilities of this neglected field. For example, Professor H. Ness, Chief Horticulturist, Texas Experiment Station, College Station, Texas, has begun to experiment with hybridizing the oak, and he thinks that experiments with feeding mast might "give results which would be of the greatest value to the farmers throughout our southern region." In the explanation of this belief he says:[18]

[16] See *American Forester,* January, 1921, article by George N. Lamb; *Technical World,* September, 1911, p. 103; *Hardwood Record,* December 25, 1912, p. 29.

[17] "Battle Creek, Michigan, April 6, 1927.

"My father was a pioneer in this country nearly one hundred years ago, and I understood from him and other pioneers that acorns constituted a considerable part of the sustenance of the hogs who found their living exclusively in the forests. These hogs were nearly as wild as wild bulls.

"JOHN HARVEY KELLOGG."

[18] Letters of May 28, 1913, and April 18, 1923.

"I wish to say that throughout the forest region of Texas which constitutes the eastern part of the state, the acorns furnish a very important part of the hog feed. As to the classes of this feed, there are two: namely, (1) from the white oaks, that is the oaks that mature this fruit in one year and furnish what people call 'sweet mast,' which is considered equal to the best of our cultivated grains as hog food. Among the oaks of this kind may be mentioned the post oak (quercus minor) because of its number and great fertility, and the white oak proper (quercus alba) because of the excellent quality and size of the acorns, as well as their abundance. (2) The second class is furnished by the black oaks, (q. trilobata, rubra, and marylandica) or those that mature the acorns in the second year from flowering. This is called the 'bitter mast.' It is very abundant, but is considered inferior because it gives inferior meat and lard of a dark color.

"These five trees, when full grown, are all heavy yielders of acorns. Those (the white oaks) that produce what is called the 'sweet mast' are especially abundant yielders in very nutritive food for hogs. Where the trees are properly thinned so as to develop freely and hence bear freely, an acre of land properly set with either the white oak or the post oak is almost equal to an acre of corn. The trouble in these forests is that the trees are prevented from producing fruit by being densely crowded. Many of them, therefore, develop no fruit at all, but act as a hindrance to others that are larger and would develop more fruit.

"There is no attempt made to manage the oak forest for this purpose, although management to that end would be very effective in increasing the amount of hog feed, and would consist simply of thinning the trees to a proper stand for bearing. This could be done without decreasing the amount of wood produced, because each tree, if given a larger space, would not only produce a larger crop of fruit, but would grow to a larger size.

"In the eastern part of Texas, or throughout that large forest region east of the Trinity River, I wish to say that the possibility by proper forest management of obtaining large quantities of feed for hogs is very great, and unappreciated by the people. It is merely incidentally taken advantage of, a good deal of the forest being unfenced and proper thinning and care of the trees utterly unknown.

"The oaks of that region can easily furnish in the fall and throughout most of the winter the major part of the large amount of food necessary for raising and fattening hogs.

"Proper thinning and judicious selection of good bearing oak trees would be a measure of high economic importance. The various individuals of the same species vary very much both in the amount of production and in size of the fruits. In many cases heavy-bearing trees can be selected, and the others of lesser value for the purpose might be cut out.

"It is not only hogs that thrive and fatten on the 'mast' of the forest, but also goats. During the early part of the season they feed on the underbrush and sprouts from the stumps of trees, and when fall comes they fatten readily on the acorns and other fruits. My personal experience is that in east Texas hogs can be raised cheaper than anywhere else, provided advantage is taken of the forest. It also happens that much of the land covered with forest is of such nature that it cannot be readily put into cultivation, owing to the unevenness of the ground in some cases; to poor drainage in others."

John C. Whitten, long horticulturist of Missouri, in discussing Missouri acorn pork production (see pages 143-144) concluded as follows:

"I am convinced of this, however, that a considerable portion of the hilly, not easily tillable, regions of this state may more profitably be left in woods to produce hog feed than cleared off for other purposes."

And all of this on the basis of wild seedling trees unimproved by selection, by breeding, or by grafting. What possibilities are yet in store if and when we apply known and proved methods of scientific horticulture?

Our forests are steadily being reduced in area and thinned out by the removal of good timber trees, but there still continues an amount of mast utilization that will probably be a surprise to many.[19] It is still common in Texas and Minne-

[19] "Jena, Louisiana, April 14, 1923.

"The locust, walnut, and hickory are found almost altogether in the lower lands that are subject to overflow. These trees there together with the oaks supply the almost entire feed for the hogs for the people who live in or near this section of the country.

"L. O. SUMMALL, County Agent."

"Maryland State Board of Forestry, May 29, 1913.

"There are many groves of oak trees in the state that have a recognized value for producing food for hogs, and it is a common practice for many people to gather acorns for feeding to hogs. The honey locust and mulberry are likewise utilized for this purpose.

"F. W. BESLEY, State Forester."

"West Virginia University, June 20, 1916.

"In this state, where more than half of the farm land is in rough pasture land and forest that is only partially cleared, the trees furnish a considerable amount of forage for farm animals. There is no way of knowing the amount of forage contributed by the trees growing on the land, but the total amount of meat produced each year by this means must be quite large. In some counties there are several hundred hogs fattened each year by this means.

"O. M. JOHNSON."

"Kentucky Agricultural Experiment Station,
Lexington, Kentucky, September 8, 1916.

"Quite a large number of hogs are annually fattened on acorns in this state, especially in the mountain regions. A number of these hogs find their way into the Blue Grass region where they are finished on corn, mainly for the purpose of hardening the fat. Lard of the acorn-fed hog will not, of course, congeal.

"E. S. GOOD, Head of Department."

"University of Missouri, Columbia, Mo., May 23, 1913.

"In the southern half of the state, embracing the Ozark region which is more hilly, uneven, and has a larger proportion of its area in woodlands, many of the farmers feed their hogs entirely throughout the year on the 'mast' that grows in the woods. Some of them fatten the hogs to maturity without additional feeding of corn or grain. Pretty nearly all the hogs of south Missouri get at least a part of their feed in this way. I have no actual data on the subject but in my judgment fully half the food supply of the hogs in south Missouri is this native mast. Professor Chandler, one of my colleagues in this department, who grew up in south Missouri, estimates (I did not express my opinion in order to prejudice his own) that fifteen per cent. of the pork production in the southern half of the state is produced from native products of the woods.

"J. C. WHITTEN, Horticulturist."

"Covering the greater part of southern Missouri, Arkansas, and the eastern third of Oklahoma are low-lying hills, better known as the Ozark Mountains. This region is naturally a timbered country where black and shellbark hickory, blackjack, red, post, and white oak, and walnut grow abundantly. These trees never fail to produce part of a crop of 'mast' and usually are heavily loaded with nuts, especially in the higher parts not so readily affected by the late frosts, which in the low regions kill the blossoms of the young fruit. From a rough estimate the bulk of the whole crop will run about ninety per cent. acorns of the different varieties.

"The general practice in the case of the hogs is to train them to come to the barnyard once or twice a week for corn to keep them tame and to enable the rightful owner to mark his pigs."

	Acorns per cent.	*Cornmeal per cent.*	*Jap clover (hay) per cent.*	*Red clover (hay) per cent.*	*Cowpeas (shelled) per cent.*
Water	55.3	15.0	11.0	15.3	14.6
Protein	2.5	9.2	13.8	12.3	20.5
Carbohydrate	34.8	68.7	39.0	38.1	56.3
Fat	1.9	3.8	3.7	3.3	1.5
Ash	1.0	1.4	8.5	6.2	3.2

(*The Country Gentleman,* December 13, 1913, p. 1821, "Ozark Nut-fed Pork," by J. C. Holmes.)

This table of food values submitted by Mr. Holmes shows the vital necessity of some protein food to make a balanced ration. This is furnished by wild lespedeza (Japanese clover).

Another form of acorn analysis is as follows, furnished by S. S. Buckley, Associate Animal Husbandman acting in charge, Swine Investigations, U. S. Department of Agriculture and sent to me by Governor L. Hardman, of Georgia.

The digestible nutrients may be seen from the following analyses:

	Acorns, kernel and shell	*Acorn kernel*
Total dry matter in 100 lbs.	72.1	65.6
Digestible crude protein in 100 lbs.	2.3	2.9
Digestible carbohydrates in 100 lbs.	36.2	27.3
Digestible fat in 100 lbs.	3.8	4.7

"Fruitville Farms and Villages,
Fruitville, Missouri, October 7, 1913.

"At the time I purchased my lands here (10,000 acres) they were unfenced, and a large number of hogs ran in the oak forests. I estimate that the first year that I owned the property my neighbors sold $25,000 worth of hogs, the growing and fattening of which had not cost them a cent—they having eaten acorns on my lands.

"JAY L. TORREY, Proprietor."

"Muscatine, Iowa.

"I have seen farmers in Keokuk and Iowa Counties of this state gather acorns and feed them to hogs. I have also known of farmers who depended upon acorns, pig nuts, and shagbark hickory for partially fattening their hogs in the fall. It was usually done by turning the hogs out in the timber and allowing them to roam.

"The red hickory or pig nut is quite prominent and is an annual and abundant bearer of nuts that are relished by hogs.

"(Signed) K. A. KIRKPATRICK,
County Agricultural Agent."

"Coöperative Extension Work in Agriculture,
and Home Economics, Minnesota.
Minneapolis, Minnesota, February 17, 1923.

"Farmers in those counties usually feed the acorns by running the hogs in woods pastures. The lots have hog-tight fences, or in some cases the whole farm is fenced hog-tight.

"I have known personally of a few persons who have raked them up with rakes and hauled them to hogs that were fed in closed pens. However, the former is the more general practice.

"As to their feeding value in comparison with corn, I would not be able to state except in a general way. They seem to give very good results in fattening or finishing hogs that were sold in the fall. The acorn pastures feed the hogs from the time the acorns begin to drop about the 1st of September until around November 1, when a short feed of four or five weeks on corn finished the hogs for market.

"K. A. KIRKPATRICK, County Agricultural Agent."

"Office of State Forester, Colorado Agricultural College,
Fort Collins, Colorado, June 20, 1916.

"In southwestern Colorado, I have seen not a few farmers who counted considerably on the acorn crop of the scrub oak, quercus gambellii and quercus undulata, to fatten hogs, which grazed freely through the 'oak brush' during the fall.

"W. J. MORRELL, State Forester."

"Coōperative Extension Work in Agriculture and Home
Economics, Logan, Utah, June 6, 1923.

"Find that in several sections acorns are used extensively in feeding hogs. Hogs are ranged on the mountains and hills, where our scrub oak grows profusely, and usually bearing a heavy crop of acorns. The hogs are carried through on the acorns and available grass until fattening time, when usually a small ration of grain is added.

"Logan, Utah, July 26, 1923.

"This practice is carried on principally in Washington, Iron, and Beaver Counties. A number of other counties range hogs in the oak-covered hills to some extent. Some of the farmers feed their hogs nothing except the grass and acorns which they are able to forage.

"R. J. EVANS, Director, Extension Service."

"Coöperative Extension Work in Agriculture and Home Economics, Reserve, New Mexico, April 30, 1923.

"In October, 1921, we found the white oaks in the county had a big crop of acorns, and we turned our young pigs out weighing about thirty pounds, The pigs were sold in January, February, and March, 1922, weighing about 150 pounds dressed, and the pork was reasonably hard and firm.

"In Catron County on the west side of the continental divide, the live oak is by far the greater part of the range, on which the cattle winter. The live oak has a more regular crop of acorns, which are used by swine as well as by the cattle, and the leaves of which form almost the entire roughage, during the winter months, for many thousands of cattle, which must keep them alive until the perennial range plants start in the spring, and the grass in the summer.

"JOHN G. KOOGLER, County Agent."

"We have a great many oak trees, especially of the scrub oak variety, all through the mountains in the state, and the acorns from these furnish a great deal of food for hogs. Many ranchers throughout New Mexico who live in the mountains raise hogs and fatten them exclusively on acorns, mesquite, beans, and so on.

"H. H. SIMPSON, New Mexico College of Agriculture, June 13, 1913."

"Coöperative Extension Work in Agriculture and Home Economics, Willcox, Arizona, April 9, 1923.

"Acorns appear in great abundance in the mountainous sections and have attracted large flocks of parrots from Mexico into the Chiricauhau mountains in this county when the supply in Mexico was diminished by a semi-drought. These acorns are also greatly relished by hogs, which are turned loose in the timber after the acorns begin to **fall.**

"C. R. ADAMSON, County Agricultural Agent."

"University of Arizona, Agricultural Experiment Station, Tucson, Arizona.

"I have occasionally seen Indians driving into Tucson with several sacks of these nuts, acorns of quercus emoryii, which they had gathered from under trees in our mountain canyons. These nuts are purchased from the Chinese stores in Tucson by Mexicans and Indians throughout the fall and winter seasons in small lots as a food, and they are considered quite **a** delicacy with the Indians and Mexicans.

"J. J. THORNBER, Botanist."

"University of Arizona, Agricultural Experiment Station, Tucson, Arizona, September 4, 1913.

"I will state that perhaps without exception the one known as Emory's oak or quercus emoryii yields more abundantly than any other oak tree. I have seen Indians gather as much as two or three gunny sacks full of acorns from a single large tree. The acorns of this particular oak are sweet and very agreeable to the taste; and if I am not mistaken, some of them find their way to the market. We have other good species of oak trees that produce heavily, among which are the Arizona oak and the oblong-leaf oak. The acorns of this latter, however, are bitter to the taste, though they are excellent hog feed.

"J. J. THORNBER, Botanist."

Speaking of mountain land near the divide between Eel and Sacramento Rivers in Northern California, Will C. Barnes in a personal interview and in an article in *Breeder's Gazette* for May 29, 1912, said, "For forty miles we worked our way upward through the brush-covered foothills into the zone of cedar and piñon, and finally reached the great forest of yellow and sugar pine and firs. . . . This is sheep and cattle country, but the most profitable animal these men are raising is the hog. There are vast ranges of oaks all over the mountains and the hogs which run at large the year round get their living entirely on the acorns and other feed which they find. Last year was an especially fine one for acorns, and we saw them under trees where they lay thick on the ground to the depth of an inch. Some of the oaks had very long acorns, almost two inches in length, and there was a keen rivalry for them between the hogs and the Indians. Sacked and packed on their ponies to the settlements below, the acorns were bringing the Indians from 50 to 75 cents per bushel for hog feed where the ranches were not near the forest. It was no trouble at all to gather from a peck to a bushel of acorns from beneath a good tree. Indians just scooped them up in armfuls. Everything in the line of live stock seemed to be fond of acorns. One saw the horses and cattle rooting among the leaves under the great trees for them, and at times the crunching of them in their teeth sounded like a lot of Missouri hogs eating corn.

"I stopped to photograph a band of fine Shropshire ewes under an oak, all hunting for the toothsome acorns."

If acorns should be on 100 square feet of ground to an average depth of one-half inch, the amount would be more than three bushels.

A newspaper report from California said:

"Los MOLINOS, CAL., Sept. 9—The crop of acorns is unusually abundant, both in the valley and the foothills. Many farmers are beginning to gather them for hogs. By September 10 or 15 the ground under many oaks will be covered with acorns.

"Women and children take an active part in this work. Often one family will gather ten to fifteen bushels a day. The deer come down from the mountains during the latter part of October, and it is expected the venison taken this season will be of unusual quality, as the deer live largely on acorns for several weeks.

"According to the Indian's theory this will be a hard winter. There are seven different kinds of oak in the Sacramento Valley, but only three varieties produce acorns to a profitable extent."

"Coöperative Extension Work in Agriculture and Home Economics, Berkeley, California, July 13, 1927.

"The clipping (above) states a fact to be found in California during the fall months, usually in September. Some years the crop of acorns is quite large and they are gathered for the feeding of stock, particularly hogs. However, the usual custom is to turn the hogs into the pasture land sota, in Appalachia and California, and it would doubtless be greater than it is but for the fact that the flesh of the acorn-fed hog is soft.

THE SOFT MEAT OF THE ACORN-FED HOG

In America acorn-fed hogs bring lower prices in the wholesale market because they have soft flesh. Is this a permanent handicap?[20] I doubt it if the problem is studied in a scientific way. In the first place, acorn-fed pork has fine (perhaps finer) flavor. "For local consumption the meat (acorn-fed hogs) is satisfactory."[21] If the lard is liquid instead of solid, what is the difference? One kind may go into a can while the other goes into a carton. Its meat drips; if so the drip is good lard. Perhaps it needs to be subjected to some process such as 120° F. for a stated period to force and finish the dripping. This reduction of the fat might make bacon better.

where the oaks are growing and allow them to pick up the acorns themselves.

"(Signed) C. F. ELWOOD."

[20] It is certainly no handicap to animals on a maintenance ration. Experiments in feeding may evolve a satisfactory combination of foods to avoid softness. Some Ozark farmers give other feeds to hogs in combination with acorns. The following results have been reported:

"It might be stated his hogs would not eat corn in quantity until the acorns were gone.

"The acorn has the reputation of making soft meat. It produces in the fat a large percentage of low-melting oils, causing a shortage of stearin or body in the lard. It is a proved fact, however, that by adding supplements and finishing on corn, after the bulk of the acorns is gone, the flesh hardens so that the packers do not object at all to the quality of the meat produced." (J. C. Holmes, *The Country Gentleman,* Dec. 13, 1913, p. 1822.)

[21] "There are a few hogs slaughtered in the smaller towns and on the ranches for local consumption. These animals are for the most part eaten within a short time, very little of the pork and meat being pickled or salted, and the animals which are used for local consumption in the region seem to be satisfactory to the consumers even though they are acorn-fed. I believe that the packers desire as uniform a grade of meat and pork as is possible to secure, and the acorn-fed hogs would give a different quality and softer pork than the grain-fed animals. This I believe is the reason that the packers discriminate against the acorn-fed hogs." (C. F. Elwood, Director, Coöperative Extension Work in Agriculture and Home Economics, Berkeley, California, letter, August 1, 1927.)

We probably need to have packing plant processes adjusted to the soft-meat hog. We probably need more of this kind of hogs.

The present discounting of the acorn-fed hog may be largely a matter of psychology of the market. During the meat shortage of the World War reindeer meat was brought forward to be used in place of beef. It was said to be as good, but the psychology of the process was that it was a substitute. This strange substitute sold at a discount in comparison to beef. It was withdrawn from the market, advertised a little, and sold as a novelty in exclusive clubs at a high price, which it continues to bring. Acorn-fed pork properly cured and properly sold might have a similar experience.

ACORN MEAL AS A DAIRY FOOD

The question of breeding better oak trees is presented in the next chapter. However, I may point out here that it looks reasonable to expect scientific work to produce great improvement in acorns, improvement similar to that which has occurred in Persian walnut (page 164), chestnut, and nearly every crop grown in our gardens and orchards.

There seems to be no reason why acorn meal[22] should not be a food of unsurpassed excellence for cows, stock hogs, all work animals, and probably for beef cattle.

[22] If an acorn meal industry were established and a person (man, woman, or child in early teens) could pick up 500 pounds of acorns in a day (footnote, page 129), it seems to be a foregone conclusion that the Appalachian and Ozark Mountain regions of the United States could enter upon a new era of prosperity. Apparently present prices for cow feed would enable a good acorn crop to double the wages that thousands of American mountaineers now receive.

CHAPTER XIV

SOME BREAD AND BUTTER TREES—THE ACORNS AS HUMAN FOOD

ACORN FOOD AMONG PRIMITIVE PEOPLES

As to the oaks, the primary object of this book is to call attention to the excellence of acorns as a farm crop producing forage for pigs, sheep, goats, cows, horses, chickens, turkeys, ducks, and pigeons. Yet any balanced presentation of the economics of the acorn must point out its great nutritive value and its great use as human food.[1] It may be possible that the human race has eaten more of acorns than it has of wheat, for wheat is the food of only one of the four large masses of humans, the European-North American group. The other three groups, the Chinese-Japanese, the Indian (Asiatic), and the tropical peoples, pay small attention to wheat; hundreds of millions of their people have never heard of it. Meanwhile those humans (and possibly pre-humans) who dwelt in or near the oak forests in the middle latitudes—Japan, China, Himalaya Mountains, West Asia, Europe, North America—have probably lived in part on acorns for unknown hundreds of centuries, possibly for thousands of centuries.

It is almost certain that wheat has been of important use only in the era of man's *agriculture,* while the acorn was almost surely of importance during that very, very long period when man was only a food gatherer. (See Fig. 69.)

[1] Persons interested in the possibilities of the oak will probably be surprised at a collection of thirty-eight references to edible acorns in many parts of the world published by Dr. Robert T. Morris, in the 1927 *Proceedings* of the Northern Nut Growers' Association, H. D. Spencer, secretary, Decatur, Ill.

The excellence of acorns as food for man was forcibly called to our attention during the food hysteria of the World War by the well-known scientist, Mr. C. Hart Merriam.[2] He pointed out that for an unknown length of time acorn bread had been the staff of life[3] for the Indians from Oregon to Mexico except those in the desert; that there were 300,000 of these Indians in California when it was discovered by the white man, and that "acorns of several species were eaten by various eastern tribes from Canada to the Gulf of Mexico."

ACORN BREAD AND ACORN BUTTER FOR MODERNS

Mr. Merriam stated in his article in the *National Geographic* that John Muir often carried the hard dry bread of the Indians during his arduous tramps in the mountains of California and deemed it the most complete strength-giving food he had ever used. Merriam gave the following analysis of California acorn and rival foods:

	Cornmeal	*Wheat flour*	*Leached acorn*[4]	*Cal. valley white oak, unleached*
Water	12.5	11.5	11.34	8.7
Ash	1.	.5	.29	2.
Fat	1.9	1.0	19.81	18.6
Protein	9.2	11.4	4.48	5.7
Carbohydrate	74.4	75.4	62.02	65.
Fiber	1.0	.2	2.06	
Tannin				6.63

[2] See *National Geographic Magazine*, August, 1918.

[3] Mr. George B. Sudworth, Dendrologist of the United States Forest Service, told me (1909) that an Indian tribe in western Nevada made an annual autumn excursion over the Sierras into California. There they busied themselves in the national forests gathering acorns and carrying them out to the trails in sacks. Thence they were packed or hauled over the mountains to the tribal home, and the bread supply for a year was secure. It was a part of the squaws' daily routine to pound up a portion of acorn meal and soak it in water that the tannin might be dissolved and the bitter meal made sweet. The coarse, wet farinaceous mass that remained was the oatmeal, shredded wheat biscuit, cornmeal mush, pone, wheat flour, potatoes, bananas, or boiled rice for the family.

* California black oak, kept 12 years.

In looking at this table please note the very high percentage of fat[5] which makes it as nutritious as richly buttered bread. Dr. Merriam pointed out that one part of acorn and four parts of corn or wheat make palatable bread and muffins, adding to the cereal the value of a fat nut product. No wonder the Digger Indians who feed upon acorn trees are reported as being sleek, fat, and in good order.

The Missouri Botanical Gardens, one of the great institutions of the world for studying trees, is working on the problem of tree utility. It recently published a bulletin (1924) showing photographs (see Figs. 68 and 70) of acorns and muffins made from them. It says:

"With a modern kitchen equipment acorn meal can easily be prepared at home. After husking the acorns they should be ground in a hand-grist mill or food-chopper. The meal is then mixed with hot water and poured into a jelly bag.[6] The bitter tannin, being soluble, will be taken out by the water, but sometimes a second or even third washing may be necessary. After washing, the wet meal is spread out to dry and is then parched in an oven. If it has caked badly, it should be run through the mill again before using.

"In cooking acorn meal may be used in the same way as cornmeal. Its greatest fault is its color, muffins made from it

[5] Loudoun, Vol. III, p. 1919. The acorns of q. virens, the green or live oak, were used by Indians to thicken their venison soups and to express an oil which was very much like the oil of sweet almonds.

C. S. Sargent, *Silva of North America,* Vol. VIII, p. 19, quotes Parkinson, 1640, first describer of the white oak. "The akorne likeweise is not only sweeter then others but boyling it long it giveth an oyle which they keepe to supple their joynts."

[6] This simple process of straining by the jelly bag seems to be a good substitute for a much more cumbersome method used by original Americans still in use by the Klickitat Indians of the Pacific coast and described by this same Missouri bulletin.

"The acorns are bitter and cannot be eaten in their natural state. When properly cooked and prepared they are palatable. The first hull is cracked and removed when the kernel is pounded or ground to fine meal. Soft sandstone mortars once were used for grinding, but now modern equipment is in the possession of every family. After grinding, the next process is removal of the bitter tannin. The Indian chief makes a long, shallow basin being a dark chocolate brown. The taste suggests a mixture of cornmeal and peanut butter, and some people relish it at once, but others, it must be confessed, have to be educated to it. Because of the high oil and starch content of the acorn, it is very nutritious and is reported to be easily digested. Only acorns from white oaks should be gathered, as those from the black oaks are too bitter.[7] Typical Missouri representatives of this group are the white oak, the swamp oak, the bur oak, and the chestnut oak. The small pile of acorns shown at the left (Fig. 70) made nearly two quarts of meal."

FOOD FACTORIES—THEIR SIGNIFICANCE IN RELATION TO THE ACORN

In this age more and more food is being prepared in factories and delivered to the consumer in packages ready to serve. Many new materials are contributing to the success of machine production. In Michigan prepared wheat bran is put into boxes in factories, and millions of people eat it with apparent relish.

The Californians are actually making human food of carob

in clean washed sand in which are laid a few flat, fern-like ends of fir boughs.

"Small stones, heated white-hot, are placed into kettles of water. The water so heated is mixed with acorn meal to a consistency of porridge. This mixture is emptied into sanded molds, and as the hot water runs out into the sand, it carries away the substance causing the bitter taste. The meal is then washed clean of sand and worked into dough. The pasty cakes are baked flat, and when worked possess the oily taste of peanut butter."

This process is somewhat like one described by Mr. Merriam in the *National Geographic Magazine*. He said the California Indians boil their acorns with hot stones in baskets.

[7] "New York, November 4, 1926.

" 'The world do move.' I have some perfectly good edible acorns without astringency and with real flavor which do not belong to the white oak group sent me by a doctor in Zenia, Ohio." (Robert T. Morris, M.D.)

The *Rural New Yorker*, p. 17, 1928, mentions edible acorns in Burnett Co., Wis. This prompted Mr. A. C. Innis (Connecticut) to write in the issue of Feb. 11, 1928, about the great abundance of these acorns which grew on the bur oak. He had eaten them "much as we eat chestnuts here in the East." He also spoke of the rapid growth of these trees.

beans and selling it in California (see Chapter VI of this book). Some factory may soon be giving us artistic boxes of acorn cakes under an attractive name. We need be surprised at nothing, now that the food factory has come. One man is now selling each week one and one-half million sandwiches made of peanut butter and crackers. A few generations ago the peanut was unknown. Then for a few decades it served as the pocket food of the socially unsophisticated while enjoying the circus or the horse race. Finally some enterprising enthusiast took the peanut to the factory. Millions now eat the one-time lowly nut in its various dignified forms. Peanut butter and the salted peanut have an established place at the American table.

Will the acorn be next, blended with some other cereals? The fact that the acorn carries its own butter is an attractive feature. Its amazing keeping qualities are also greatly in its favor. The acorn bread of the California Indian keeps indefinitely. This is a wonderful quality for factory foods that are to be distributed in packages.

Then there is that six per cent. of tannin. How easy for the chemical engineer to get it out if he had 50,000 tons of acorns a year to deal with! Tannin is worth money. We scour the ends of the world for it. It is quite possible that income from tannin might put a premium price on bitter acorns.

In praising the excellence of the acorn as food, Dr. Merriam showed that it can probably be kept in good order for a longer time and more easily than any other food product known. A common method of storage by the Indians was to bury acorns in mud kept cold by a spring of water. Dr. Merriam reports the discovery of such caches as these that had lain for a period of thirty years in which the acorn remained unsprouted and unspoiled. They were merely discolored. If there is another product capable of such preservation I have not heard of it.

THE ACORN AS HUMAN FOOD IN EUROPE

Dr. Merriam states[8] that "in Spain and Italy sometimes as much as twenty per cent. of the food of poorer people consists of sweet acorns." This statement chimes in well with a circular letter of a French bishop in the 9th century who called upon his priests to see that his people were supplied with acorns during a food shortage.

I have sat by the fire in Portugal and again in Majorca and eaten roasted acorns exactly as one eats roasted chestnuts in America. The variation among the fruit of the different trees of the evergreen oak (ilex, pages 156-157), like the variation among seedling apples, has caused some to be as good as chestnuts.[9] Twigs of these selected trees have been

[8] *National Geographic Magazine,* August, 1918.

[9] Loudoun, Vol. III, p. 1905. Oak. Q. ballota. The sweet acorn oak. Chêne à glands doux, chêne ballota. 20-30 ft. high, 3-6 circ., fruit 8-20 lines long, 4-6 wide.

"Vast forests on the mountains of Algeria and Morocco, but only in small quantities on the plains.

"The Moors eat the acorns raw or roasted in ashes; they are found very nourishing, and are not bitter. They are regularly sold in the market place, and in some places an oil is extracted from them which is nearly as good as that of the olive."

Loudoun, Vol. III, p. 1907. Q. gramuntia. Holly-leaved Grammont oak. Native of Spain, cultivated in England, 1730. Chêne de Grammont (French). Wellenblattrige eiche (German). Encina dulce and gouetta (Spanish).

Blossoms June, ripens fruit in autumn of next year. Fruits annually. Acorns edible, and when in perfection are as good as or superior to a chestnut. To give this sweetness they must be kept, as at first they have a considerable taste of the tannin like those of the other species.

"These are the edible acorns of the ancients which they believed fattened the tuna fish on their passage from the ocean to the Mediterranean. A fable only proving that they grew on the delicious shores and rocks of Andalusia, which unhappily is no longer the case." They fattened the swine which produced the celebrated salt meats of Malaga and that vicinity.

"The wildest forests of it are now in Estremadura, where the best sausage and other salted meats are made from the vast herds of swine which are bred in them.

"Produced by individuals and offered to the company as sweetmeats. Very hardy. Mountainsides in Castile and Arragon and in the wintry valley of Andorra."

Loudoun, Vol. III, p. 1902. Q. ilex 1. Common evergreen or holm oak.

grafted[10] for some centuries exactly as we in America have grafted Baldwin apple trees, and these grafted trees (Figs. 56, 62) are commercially grown to a small extent in Majorca and some parts of the Spanish mainland. They rank with chestnuts in the market. If the price of chestnuts is high, the price of the acorn (ballota) is high. If the price of chestnuts is low, the price of the ballota is low.

BREEDING TREES

When I suggest that we deliberately set out to make a crop of the oak tree, I am sure that some typical American, accustomed to American speed, will say, "Too slow." At this point I wish to get the mind of the objector quickly shifted to the fact that *variations among individuals of oaks* [11] exist similar

Chêne weit. Encina Span. Deep rooter on well-drained soil. Garcillasso of Spain writes:

"Hast thou forgotten, too,
Childhood's sweet sports, whence first my passion grew,
When from the bowery ilex I shook down
Its autumn fruit which from the crag's high crown
We tasted, sitting chattering side by side,
Who climbed trees swinging o'er the hoarse deep tide,
And poured into thy lap, or at thy feet,
Their kernel's nuts, sweetest of the sweet."

WIFFENS GARCILLASSO.

[10] "Most sorts of the American oak can be propagated by grafting on the common oak close to the ground; and largely earthing up the graft afterwards." (Loudoun, *Arboretum et Fruticetum,* Vol. III, p. 1863.)

[11] *Quarterly Journal of Forestry,* Vol. V, No. 2, p. 119-23.

It (quercus ilex), growing at Holkham Station, England, is a tree of many types of habit, of infinite variation in the size of leaf and fruit. Speaking of bur oak in Sundance National Forest, Wyoming, Mr. Louis Knowles, Forest Supervisor, said in letter to the Bureau of Forestry, October 6, 1913:

"Heavy seed crops occur about once every three years, while a considerable crop of seed seems to grow on individual trees *every year.*" (Italics are mine. J.R.S.)

Dr. Robert T. Morris in *Proceedings,* Northern Nut Growers' Association, 1927, quotes Professor W. L. Jepson, University of California, to the effect that all varieties of acorn were used as food by California Indians, and further:

"There is undoubtedly very great variation in the quality and yield of the various individual trees of one species, even in a given locality. Trees notable for their yield and especially for the quality of their acorns were to the variations in precocity of chestnuts. Regarding the matter of slowness, I insist that it is unfair to judge as slow every individual oak of the whole genus of fifty American species.[12]

Some oaks grow rapidly.

Some oaks bear acorns when the trees are very young.

Some oaks bear heavily.

Some oaks bear regularly.

Next I wish my objector to think also of the remarkable effects of hybridizing when one starts with trees of unusual excellence.

The poets who have written of the strength and the long life of the oak tree, pointing a moral of patience and achievement in the progress of mighty oak from the small beginning in an acorn, probably based their poetic utterances upon the few oaks that happened to grow in their own neighborhood. Of other more speedy oak trees[13] poetic pens were silent. Trees are not used by poets to symbolize speed.

Loudoun [14] says of quercus palustria, "Most beautiful of the American oaks. One hundred plants in London seven

the special property, in aboriginal days, of a particular family or small tribe. This fact of variation is true as well of the black oaks; for example, the coast live oak, quercus agrifolia, varies so remarkably in the edibility of the acorns as borne by these trees that the yield of certain trees is esteemed by white men as a substitute for chestnuts. There are gardeners in the great Del Monte grounds at Monterey who gather the acorns of a certain coast live oak tree which stands in that area and eat them as they go about their work just as they might chestnuts."

[12] Merriam points out *(National Geographic Magazine,* August, 1918) that there are fifty species of oak in the United States, fifteen in California alone, and thirty in the eastern part of the country.

[13] R. O. Lombard, Augusta, Georgia, had a water oak tree which he said he trimmed with a pocket knife when it was the size of a pitchfork handle. Nineteen years later I measured it—girth 67 inches, spread 51 feet.

A chestnut oak planted in a yard in the clay hill country of Georgia by Governor Lamartine Hardman made the following growth in thirty years: girth, 67 inches; reach 34 feet one way and 30 feet the other. So far as I know there is nothing unusual about these trees except that their history seems to be known with reasonable definiteness by persons who had lived with them.

[14] *Arboretum et Fruticetum,* p. 1864.

years from acorn and 15-20 feet in height. Most American kinds 10-12 years from acorn 20-30 feet in height." I add, apples rarely do better. Loudoun's figures come from cool Britain. Ness (page 141) reports greater speed of growth in Texas.

As to precocity—while walking through a Portuguese fig orchard, I came upon a little ilex tree (evergreen oak) shoulder high and full of bloom (Fig. 64). The ground beneath was littered with acorn cups. I asked the Portuguese laborer who was working near by if this tree bore nuts the previous year. He said it did and, pushed for the number, he said it might be two hundred. The figure may have been high, but the acorn cups under the lonely little bush in a neglected fig orchard are good evidence of some crop. I have seen bloom on hundreds and thousands of such small ilex trees in Portugal, Spain, Algeria, and Tunis, and was repeatedly told by residents that they bore fruit at an age which we in America think suitable for a young apple tree.

I came home from Africa and looked along my own Blue Ridge Mountain lane and found two chestnut oak suckers, each bearing fruit, and each in the seventh summer; one having grown from a stump the size of my finger and the other from a tree two feet across (see Fig. 66). I have no reason to think these were the best and most precocious trees of my Blue Ridge mountainside. They merely grew by my lane.

More remarkable in my opinion was the performance of turkey oaks on the top of the ridge. They grow in soil weathered from quartsite sand-stone. This sandstone is cemented with quartz. It makes one of the poorest soils known. This particular tract has been further cursed by forest fires every few years for a period of forty years or more. The pines had long since succumbed and only huckleberries and turkey oaks remained. In April, 1910, a fire killed everything to the ground and in September, 1913, the turkey oaks were full of fruit. (See Fig. 65.)

CREATIVE WORK WITH OAKS—HYBRIDIZATION EASY, RESULTS PROBABLY STUPENDOUS

Like the hickories (see Chapter XIX) the oaks will hybridize themselves. Sargent reports [15] a number of hybrids of one species with several others. He further remarks that the hybrid offspring *grows more rapidly than the parent.* Professor H. Ness, Texas Experiment Station, who has hybridized oaks,[16] says they do it with great ease and that it has great promise. He finds that during an unfavorable season these hybrid offspring made an average of three or more feet on every main limb, and nuts were borne in 1917 from an acorn planted in 1913. These are facts for pondering. Especially so is the fact that in the second generation of breeding some seeds planted in 1920 bore acorns in 1923 and bore a very large crop in 1925. Starting with their present amazing qualities, what may not hybridization produce among fifty American (and some foreign) [17] species of oaks?

[15] *Silva of North America,* Vol. VIII, p. 19.

[16] See *Journal of Heredity,* October, 1918. From further experience he summarizes {*Journal of Heredity,* September, 1927) his experience with hybrid oaks, at College Station, Texas, as follows:

"The indications observed on this soil are to the effect

"(1) That the hybrids descended from the live oak, as mother, are of a stronger growth in both the first and the second generation than either of the parent species.

"(2) That they are fertile at an early age in both generations, producing seed of normal viability.

"(3) That the first generation, while very variable in some combinations, is uniform and intermediate of the two parental forms in other combinations; but this uniformity is followed by the segregation of characters in the succeeding generations.

"(4) Because of the ease with which the hybridization of the live oak may be affected, the high fertility of its hybrids and other virtues already mentioned, to which very likely may be added improvement of the timber, there can be no doubt but that the breeding of new forms of oaks, as here indicated, has great economical and aesthetic possibilities."

[17] As one of many promising foreign oaks, I submit the valonia oak, q. alglops (chêne velani f.) Trabut says (Bulletin *27,* Gouvernement Gen-

I submit that the conservation of our resources demands that a half a dozen men should be assigned immediately to the task of seeking the best oak trees and of breeding still better oak trees. There is excellent prospect of their being able to add millions to the wealth of the United States (and also other countries) during the period of a normal lifetime.

But more important than the *cash* value of their work would be the conservation of the soil. Oak orchards could hold the hills that are now washing away as we plow them and attempt to grow cereals upon them.

éral de l'Algérie, 1901, p. 56) : "The acorns are sweet and edible and abundant when the 'valonie' is not harvested." The "valonie" (valonia) is the large thick cup of this acorn. It carries over thirty per cent. of tannin and is a regular article of commerce, gathered to the extent of several million dollars worth per year in the eastern Mediterranean countries. A tree producing such a double-barreled crop should be an interesting basis for breeding experiments.

CHAPTER XV

NUTS AS HUMAN FOOD

HIGH FOOD VALUE

Up to this point we have been considering tree crops chiefly suited to feeding domestic animals, but now we come to the consideration of a series of crops that should be grown primarily for human food. I refer to the nuts. Walnuts, for example, like many other nuts, are a substitute for both meat and butter.

Tables of food analysis (page 304) show that nuts have higher food value than meat, grains, or fruits. Six leading flesh foods average 810 calories per pound. Half a dozen common nut kernels average 3,231 calories, about four times as much. Cereals at 1,650 calories are about half as nutritious as nuts. Fresh vegetables averaging 300 and fruits averaging about 275 calories per pound are less than a tenth as nutritious as nut meats.

HIGH QUALITY OF NUT FOODS

The quality of nut food is also of the very highest. Early food chemists called nut protein vegetable casein because of its close resemblance to the protein of milk. When the Chinese mother's milk fails, her babe is fed on milk made of boiled water and the paste of ground walnut (j. regia) meats.[1]

[1] P. W. Wang, curator, Kinsman Arboretum, Chuking, Kiangsu Province, China, says (1922 *Proceedings* of the Northern Nut Growers' Association, page 120) :

"In China there is no baby fed by cow's milk. When the mother lacks milk and the home is not rich enough to hire a milk nurse, walnut milk is substituted. The way of making walnut milk is rather crude here; they simply grind or knock the kernel into paste, then mix with boiled water."

Dr. J. H. Kellogg, of Battle Creek, militant nutivorous vegetarian and in his amazing person a substantial vindication of his theory, backs up the Chinese milk-substitute theory[2] (practice) and further points out that while many vegetable proteins are hard to digest, those from nuts are very easy to digest. He further avers that nut fats (the other chief food elements of nuts) are "far more digestible than animal fats of any sort."

The freedom of nuts from putrefactive germs and from ptomaine poisoning are points which we may esteem more highly as we increase our knowledge of what occurs in our digestive tracts.

[2] On pp. 83-92, 1920 *Proceedings* of the Northern Nut Growers' Association, Dr. Kellogg claims that animal feeding experiments show that twenty ounces of milk will furnish complete protein enough to supplement a vegetable diet otherwise deficient in complete protein or that the same amount of protein can be furnished by the amount of nuts shown in column four in the following table:

	Pints of milk containing as much Protein as one pound of named nut	*Calories in amt. of milk shown in column one*	*Calories in one pound of nuts*	*Ounces of named nuts needed to replace 20 oz. of milk*
Acorn	2.4	780	2620	8.3
Almond	6.4	2080	3030	3.2
Beechnut	6.6	2145	3075	3.0
Butternut	8.5	2762	3165	2.4
Chestnut	3.2	1040	1876	6.4
Chinquapin	3.3	1072	1800	6.4
Filbert or Hazelnut	5.0	1625	3290	4.0
Hickory nut	4.6	1495	3345	4.8
Pecan	3.6	1170	3455	5.6
Peanut	9.2	2090	2600	2.2
Piñon	4.4	1430	3205	4.8
English walnut	5.4	1555	3300	3.7
Black walnut	8.5	2762	3105	2.4

"For example, shelled almonds, at a cost of $1.00 a pound (retail) supply for 19.2 cents the same amount of supplementary protein furnished by milk at a cost of 24 cents. Black walnuts supply the same amount for 15 cents, pine nuts (piñons) for 20 cents, hickory nuts 15 cents, and peanuts 4 cents."

The sufficiency of nuts as a substitute for meat[3] in human diet seems well established alike by modern dietary experiment and by the experience of many primitive peoples. The sufficiency of a fruit and nut diet for humans is strongly hinted by its success with such physically similar animals as the orang-utan and the gorilla.

NUTS AND THE FOOD SUPPLY

Nuts offer a double opportunity for the improvement of our food situation. They can enable us to increase both the quantity and the quality of our food supply. During our frontier period of abundance nuts were neglected in America both dietetically and agriculturally; but their use as food is increasing rapidly now, and their culture is receiving attention which promises a widespread industry in a short time.

The value of nuts as a means to increase the quantity of our food supply is forcibly suggested by the established practice of French farmers who expect a good English (Persian) walnut tree to yield 150 pounds of nuts per year on the average. (Page 166.) These have food value greater than that of 150 pounds (live weight) of sheep, which is the total produce of a whole acre of good pasture for a year even in such good pasture countries as England or the United States. Good blue grass pastures in the United States produce about 150 pounds of beef per acre.

Careful study of the ingenious table (page 305), especially the last column, indicates the high possibility of nuts as food producers, if the problem of food scarcity should ever present itself to us. The nut trees appear to be veritable engines of food production.

[3] Dr. Kellogg reports successful substitution of nuts for meat for a period of several months with a young wolf and fish hawk and many other carnivores. {*Proceedings*, Northern Nut Growers' Association, 1916, p. 112.)

CHAPTER XVI

A MEAT AND BUTTER TREE FOR MAN—THE PERSIAN WALNUT (JUGLANS REGIA)

THE ORIGIN, DEVELOPMENT, AND SPREAD OF THE PERSIAN WALNUT

At present the Persian walnut (commonly called English walnut) is the food nut most widely used in America.[1] It is, however, but a type. It might in a few decades be replaced by any one of half a dozen nut species now growing in the United States (black walnut, butternut, Japanese walnut, pecan, shagbark, shellbark).

This assertion is supported by the following remarkable statement about the Persian walnut, which we all know to be a delicious and expensive article of food, as well as a large nut with easily accessible kernel:

"The nut of the wild tree is small, with a thick, hard shell, and a small kernel, and is scarcely edible, but centuries of cultivation and careful selection have produced a number of forms with variously shaped thin shells, which are propagated by grafting and budding."

At first it is hard to believe the statement even though it is from the great authority, Sargent.[2]

How came such noble offspring in the garden from such ignoble parentage in the wood? The answer is that this prehistoric achievement *probably* resulted from artificial selection and chance cross breeding. It *probably* happened in this way: in the beginning of Mediterranean or western Asian agriculture, some villager brought from the woods the best nuts

[1] The peanut is not a nut in any agricultural or botanic sense.

[2] *Silva.*

FIG. 69. *Top*. Caches for acorns built by Indians in the Nevada foothills of the Sierra Nevada Mountains. Acorns brought over the mountains from the California side. The winter bread for the family—the most nutritious bread in the world—possibly the oldest, perhaps a bread of the future either through machines or a return to the primitive. (Courtesy George B. Sudworth, U. S. Forest Service.)—FIG. 70. *Bottom*. Acorns from which the muffins shown in Fig. 68 were made. They are 1/3 to 1/4 natural size. The largest are those of Quercus Macrocarpa Mich.

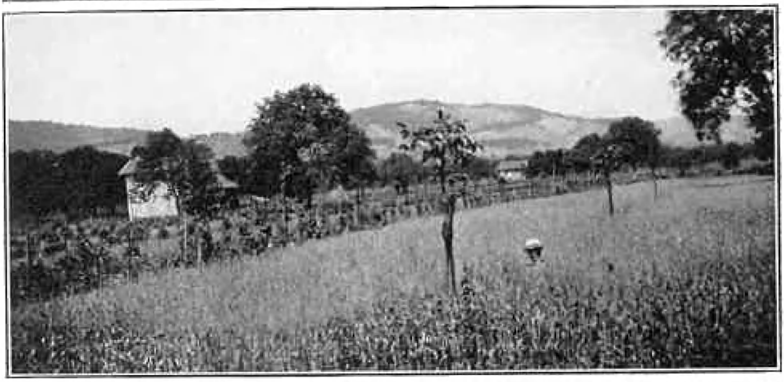


FIG. 71. *Top*. Persian walnut shade trees down a monastery lane, Grenoble, France. Annual income about $150 gold, average pre-war.—FIG. 72. *Center*. Young Persian walnut trees standing in wheat, Grenoble, France. Note man's head near tree. Other walnut trees in the background. The-scatter-them-over-the-farm system.—FIG. 73. *Bottom*. A hayfield showing system of planting tall Persian walnuts with a pole in South Central France. Background, walnuts. (Photos J. Russell Smith.)

he (probably she) could find and planted them. The next generation took the best nuts from the village trees and planted them, the next generation of man did likewise, and so on. Thus we have tree generation after generation, each grown from the best selected seed the people knew. This process of bringing the best trees together in the villages where trees were scarce gave a chance for both parent trees of the crossing to be of good stock.

This has been going on for an unknown period of time, certainly for many centuries, and has extended over a wide area—from Persia to Spain and from Persia to Japan.

As a result of this deliberate selection, and extensive, though not deliberate, cross breeding, have been developed many excellent and varied types of Persian walnut.

The tree is thought to have been a native of Persia, whence it spread, going into the mountains of Syria, Asia Minor, and the borders of Palestine. Today the ruins of the temple of Baalbek, which contains the largest quarried stones in the world, rest each morning and evening in the lengthening shadows of splendid Persian walnut trees that cluster around the ruins and dot the adjacent gardens. Persian walnuts overhang the ruined walls of Constantinople, where Turks slew Greeks in 1453. They are scattered through Asia Minor, the Balkan States, Greece, Italy, Spain, and Portugal, France, Switzerland, and even in Scotland.[8]

Similarly this process of planting the best nuts has been going on for two centuries in the eastern United States, where the trees are scattered from Massachusetts to Ontario, Michigan, and Georgia. In California (with its Mediterranean climate) progress has been more systematic and rapid and an important orchard industry has been thoroughly established,[4]

[3] Professor William Somerville of Oxford tells me in correspondence of British trees of seventeen feet in circumference and some that are ripening fruit at Gordon Castle in Scotland.

[4] For a good summary see *Yearbook,* U. S. Department of Agriculture, 1925, pp. 284-304.

with a product of thirty thousand tons in 1925 valued at thirteen million dollars. This is about two-thirds as great as the French production.

The California walnut industry is not of especial interest to the purpose of this book because it is not in need of aid. This book is written in the hope of starting something. The California walnut industry is well established. Furthermore, as now conducted it has little relation to the problem of soil conservation—the primary objective of this book.

The Old World walnut industry of the scattered trees has more significance than the cultivated orchards of California with regard to future developments of importance to the human race.

THE HARVEST OF THE SCATTERED WALNUT TREES OF EUROPE AND WEST ASIA

The United States imports millions of pounds [5] of Persian walnuts each year from France and Italy.

Having visited most of the European walnut districts, I consider it doubtful if anywhere in Europe one could find a place where there are half a dozen forty-acre orchards of walnut trees planted in rows and given systematic cultivation. In the province Dordogne, one of the leading French walnut sections, orchards are almost unknown, but trees are exceedingly common along roadsides and field sides and in door yards and even scattered about the fields. The mature tree there is expected to yield one hundred and fifty pounds [6]

[5] Total imports of walnuts now about ten million dollars per year.

1926 walnuts shelled:

France	17	million	pounds
China	3	"	"
Unshelled:			
Italy	9	"	"
France	7	"	"
China	2	"	"

[6] Professor Grand, Professor of Agriculture at Grenoble, the leading walnut district of France, told me that trees 20 meters apart would bear from

or more of marketable nuts on the average and very large trees more than this. These trees stand alone, fine and shapely in the fields. Some farmers plant them about the fields at irregular intervals and then go on with their farming.[7] If the walnut interferes a little with the growing wheat, oats, barley, potatoes, or hay, it pays for it in nuts, and the cultivation of the field crops helps the trees. The value of these trees is attested by the rental practice of the locality. Land owners and farmers there rent one good walnut tree at the same rental as that received from an acre of plow land. Thus the fifty-acre farm with fifty good walnut trees scattered about rents for twice as much as a similar adjacent farm without trees.

When pushed for an explanation, the farm owner hesitated for a moment and then said, "You see, monsieur, it is zis way. It is income wizout labor."

I found an identical scattering of fine walnut trees along roadside, field-edge, and farmyard in many parts of Switzerland and elsewhere in southern and southeastern Europe.

In the Grenoble district of France, near the city of that name, is the village of Tullin, the birthplace of one Mayette, a pioneer horticulturist, who lived about the time of George Washington. Mayette seems to have started the art of grafting walnut trees in that locality; he picked out the parent tree of

80 to 100 (176-220 pounds) kilos per tree and an average of 1500 to 1800 kilos per hectare. (1300-1600 pounds per acre.)

While journeying through the walnut districts of France, I was repeatedly told of trees that yielded 150 to 200 kilograms (330 to 440 pounds) of nuts.

It should be remembered that these trees usually *stand alone* with almost limitless root space and light. (See Van Duzee on pecan space, page 209.)

[7] I found one man who had planted out his whole farm with walnut trees ninety feet apart.

The wood is a substantial element in the value of the enterprise. 1913 (note the date) I was told in Grenoble that a sixty- to seventy-year-old walnut had wood worth forty dollars, and a hundred-year-old tree was worth sixty dollars, while there was a local record of three trees one hundred and fifty years old having been recently sold for four hundred dollars.

the variety which bears his name. It is now widely scattered in France, California, and the eastern United States.

Mayette has a green and noble monument—his native village is embowered, almost buried, in the shade of Mayette walnut trees. They line the roadsides, the yards, the gardens, and in some cases they cover the surrounding hillsides, for here are some small orchards, often well cultivated. Most of the formal orchards are badly overcrowded, for it takes nerve to plant walnuts fifty to sixty-five feet apart, or to plant them closer and then take out trees when they attain a size that maizes overcrowding a serious damage to them.

PERSIAN WALNUT IN OLD "WORLD MOUNTAIN VALLEYS

The Persian walnut seems to appeal to owners of Old World mountain valleys—probably because of their air drainage. The Paris express from Milan climbs up to its Alpine tunnel through a valley where the walnut trees get thicker and thicker before the train finally dives into a tunnel to come out on the Swiss side of the mountain. This Swiss valley is also dotted with walnut trees. The upland valleys around Lake Geneva must have an average of two or three to the acre for a number of miles, so thickly are they scattered along roadside, field edge, village garden, and on pieces of land that are not easily tillable.

Onward through France to Paris and on to Havre they are a common sight. The German armies invaded France in 1914 under long avenues of walnut trees that lined the roadsides.

Asia Minor has interesting examples of mountain valley orchards. The railroad from Tarsus, the birthplace of Paul, to Constantinople climbs up the Taurus Mountain wall through steep defiles and tunnels and then near the top comes out on a fine agricultural valley where hundreds of walnut trees are scattered about roadsides and fields. I have never seen finer specimens.

The interior of Asia Minor is too dry for the walnut except where irrigated, but this tree reappears on the other side of the plateau where the train comes down to Constantinople through a valley that opens out to the Mediterranean. This seaward-facing valley has more rain than the interior and again the fine walnut trees appear scattered about as in France and Switzerland. I think I may say that for thirty miles there is scarcely an interval of two hundred feet without one of these magnificent trees. On a branch of the Morava River in Jugo-Slavia is another similar valley. There the walnut vies with cherry and other fruit trees for efficient use of corners of land.

Along the plain of the Danube and the Save in Jugo-Slavia, west of Belgrade, the walnut is a common shade tree for railroad station yard and village street.

THE IRRIGATED PERSIAN WALNUTS

In the drier sections of Europe and West Asia the walnut goes into the irrigated vegetable garden, where it becomes a part of a two-story agriculture. The United States receives a substantial import of nuts from Naples. Most of them are grown on the slopes of Vesuvius and the nearby Sorrento peninsula, where it is a common practice to cover the vegetable garden with walnut trees. These trees stand up tall and spare like the common black locust (robinia pseudacacia) of the United States. Because they carry their heads high and because they leaf late in the season, the trees permit the Italian sun to reach the garden crops beneath, thus making a profit through two sources of income. The same type of gardening prevails in the gardens of Baalbek, in many other parts of Palestine and Syria, and throughout Persia, where one frequently sees the white branches and green foliage of the walnut standing above the wall that protects every garden of that hungry land. The California walnut industry is nearly all of the irrigation type, but because there is plenty of land in California the two-crop system has not been highly developed.

It is probably a mistake that this has not been done. (See Chapter XXIII.)

THE ORIENTAL WALNUTS

The European practice of scattering trees about the farm and the village seems to be extensively worked out in many oriental localities. One often sees a walnut tree or two near the mud-roofed houses and on the little farms of Cashmere. Nuts are one of the exports of this mountain valley, and carved walnut work of great beauty is one of its most prized handicrafts and an important export.

The United States derives a substantial supply of walnuts from North China, where they are grown on seedling trees scattered about the farms in the hill country west and southwest of Peking. Here they grow in an interior continental climate closely resembling that of Iowa and eastern Nebraska —making this a very promising place to seek for parent trees for use in America.

THE PERSIAN WALNUT IN EASTERN NORTH AMERICA

In eastern North America we had the misfortune, though very naturally, to start the walnut industry with European strains in a climate that was strange to them. West Europe, namely France and England, has an oceanic climate, which is characterized by cool summers lacking our hot humidity. It also lacks the sudden shifts from warm weather to cold weather in spring. In southern Europe the Mediterranean climate is characterized by an open winter with rain and a hot dry summer without rain.

Now it so happens that the climate of eastern North America, being continental, has a spring with cold and warm spells alternating. Therefore vegetation tends to start growth too early and plants like the apricot, peach, and Persian walnut sometimes get frosted. Furthermore, this eastern North America has a summer with rain and humidity to which the European plants are not accustomed, heat and humidity constituting the chief idea of heaven for fungi.

Consequently many European plants come down with leaf blights when brought from England, France, or Italy to New York or Carolina or any other place east of the Rocky Mountains.

Spring frost or leaf blight is a detriment to most of the thousands of Persian walnut trees in the eastern United States. But here and there stands a tree so immune that an orchard of them would be very valuable. Nothing is a more natural thing to do than to get a good walnut from such a tree and plant it, expecting to grow a tree producing fruit like the nut that was planted. Hundreds and thousands of people (myself included) have done this, not even knowing the source of the walnut, nor thinking that the resulting tree being a seedling is a cross bred or a hybrid (Figs. 74 and 90) and therefore almost guaranteed not to produce fruit like the seed.

I cannot better illustrate this situation than by giving my own experience. With an interest in trees but no horticultural education, I had a vision of the old farm in Virginia waving green with English walnut trees and enriching me with their fruit. I knew of one tree, some fifty miles away, that bore barrels of nuts, which were eagerly bought by local grocers at a good price. The seedlings from this tree perished in my yard the first winter. Then in 1896 I sent to a New Jersey nurseryman, bought seedlings, and planted out three acres of three-foot trees. I thought that New Jersey stock would thrive in slightly warmer Virginia. The next year they were two-foot trees; the next year they were one-foot trees; and then they died from the repeated winter-killings.

I was no more stupid than many other people, but I did not know, and no one in the eastern United States seemed to know, that people had been grafting walnut trees in France and selling them for centuries. I knew of no place in America where grafted trees suitable for Virginia could be bought, if they could be bought at all, and my walnut enthusiasm had to rest awhile.

Meantime, many people here and there had succeeded with a seedling tree or two, and Mr. Daniel Pomeroy, near Niagara Falls, with an orchard protected from the warm spring days by the cool waters of Lakes Erie and Ontario, was having such success with them, that for a long time he sold his seedling trees far and wide. Several orchards of these trees are thriving near the protecting lakes, but being seedlings, they are not yielding heavily on the average.[8]

Many of the Pomeroy trees have perished in the more changeable spring of localities farther south (Maryland, southern Pennsylvania, et cetera) not so specially protected in spring by the tempering influences of water.

PERSIAN WALNUTS ON THE PACIFIC COAST

California, on the west side of the continent, in latitude 30° to 40° north, has the Mediterranean type of climate. There the whole Mediterranean flora is at home, including tender apricots, wine grapes, and Persian walnuts; and, therefore,

[8] "80 South Lake Street,
North East, Pennsylvania,
May 27, 1927.

"The orchard was set in 1900; there are two hundred and sixty trees of which *two hundred are bearing*. They are set fifty feet apart, each way, with four rows of Concord grapes between two rows of trees; the grapes cover about half of the orchard, red raspberries are set on the other half. The trees do not affect small crops because the roots are very deep. Clean cultivation is recommended, and it is best to plow under a 'cover' crop in the spring. The orchard bore 1800 pounds in 1924, 2400 pounds in 1925, and 4500 in 1926. Last year we gathered from five to six bushels off the largest trees.

"Very truly yours,

"E. A. JONES."

This report shows well the weakness of the seedling tree. At the end of twenty-seven seasons with good culture twenty-three per cent. of the trees were not bearing, while some trees were yielding two hundred and fifty to three hundred pounds each. Apparently ten per cent. of his trees, all as good as the best, would have yielded as much or more than the whole lot. Because of similar performances, many seedling orchards in California have been topworked.

experimental plantings of Persian walnuts have thriven. The first commercial attempts succeeded instead of being smashed out by frost as was my attempt of 1896, at which date the California walnut industry was well under way and has thriven ever since.[9]

The elimination of seedling orchards is increasing the California yield. The technique of the walnut-growing industry has developed, and now it has an association of growers carrying on national advertising and selling campaigns and marketing tens of millions of pounds of nuts each year.[10]

As the climate of Portland, Oregon, is a near duplicate of that of Paris[11] and Seattle that of London, we see why western Oregon and Washington have promising Persian walnut orchards (over 12,000 acres). However, occasional freezes such as that of 1919, more severe apparently than those that come to France, do great damage to the trees occasionally.

THE SEARCH FOR VARIETIES IN EASTERN AMERICA

While California successfully transplants another European industry, the eastern states having started with European strains are still deluded by them and are still experimenting with them and hunting for good parent trees among them.

[9] "In reply to your question, 'Is it a fair statement that a first-class matured English walnut orchard will produce two thousand pounds annually?' will say that there are a number of such orchards in the state, but they are considered as you say in your letter strictly first-class orchards and considerably above the average production. The average for the state, I think, is about eight or nine hundred pounds per acre, per year, so that you see an orchard which produces a ton per year is considerably above the average." (Thomas Francis Hunt, University of California Experiment Station, letter, July 13, 1913.)

[10] California Walnut Growers' Association worked for seven years to perfect a walnut-branding machine which puts their name on each nut. They offered a ten thousand dollar prize for the mechanical principle and then spent years in working it out into a machine that will brand 2,000 nuts a minute, or a 30,000 pound carload in a day. In October, 1926, they had 125 of the machines running at a cost of only five cents for the 4,000 nuts in a one hundred pound bag—one-thirtieth of the cost of small sealed cartons on which they had previously been working.

[11] For details, see *North America,* by J. Russell Smith,

This continued dependence on European strains is not unnatural. Professor F. N. Fagan, of the Pennsylvania State College, has made a partial survey of Pennsylvania and has found walnuts growing in at least twenty-five counties. Mr. Fagan estimates that the aggregate number in the state must be at least five thousand trees. Some of them are bearing regularly at elevations of fourteen or even eighteen hundred feet. Trees of local repute have been reported from southern Ontario, New York State, Massachusetts, and as far south as Georgia.[12] Their total number runs into many thousands. Where are the best trees? Are they fit to become the basis of a commercial crop in the East? It is doubtful if anyone yet knows. Nearly all of the nuts have enough tannin in the pericarp or brown skin of the kernel to give the kernel a slightly bitter taste. Only a few of them are absolutely sweet. Most of the trees are subject to leaf blight; nearly all of them are winter killed in exceptionally severe winters. I may add in passing that I saw a surprising amount of winter killing on the commercial trees of France and Italy. Mostly these European trees looked no more physically prosperous than some of the trees in the eastern United States.

It is probable that two or three dozen of these trees of the eastern United States are worthy of commercial propagation. There are several varieties on sale in accredited nurseries [13] that are worthy of propagation on an experimental scale.

[12] There has not been very much success with Persian walnuts west of the Appalachians. Mr. Riehl at Alton, Illinois (climate of St. Louis) reported failure with all he tried; but Mr. Otto Witte at Amherst, Ohio, thirty miles west of Cleveland, and five miles from Lake Erie (lake climate) reports success with trees from German seed.

Upon the whole the country west of the Appalachians is very debatable ground for the European strains with which we now experiment.

"I am not sure whether any of the Persian walnut trees I now have will prove commercially successful here, but some of them give fair hopes and may lead to something better. It is too early yet in my experiments to know what degree of success I may have in the near future." (Letter, N. F. Drake, Fayetteville, Arkansas, Feb. 28, 1927.)

[13] See Northern Nut Growers' Association, H. D. Spencer, Secretary, Decatur, Illinois, or the U. S. Department of Agriculture at Washington.

As an example of the small botanic factors upon which commercial success may depend, I cite a variety called the Alexis. The parent tree stands about thirty miles from Baltimore, Maryland. The observant Mr. J. F. Jones, of Lancaster, Pennsylvania, owner of a very interesting test orchard, reported that this variety is one of the most dependable known to him. This tree has borne regularly for Mr. Jones. This fact he explained as resulting from one habit of the tree, namely, it makes a quick growth in the spring like the hickory, hardens its new wood, and makes no late summer growth. From varieties making a late summer growth the late grown and therefore tender leaves are eaten off by a leaf chafer. This loss of late summer leaf-growth apparently weakens the twig, causing it to become an easy prey to winter-killing (really spring-killing).[14]

HOW TO GET BETTER PERSIAN WALNUT VARIETIES FOR EASTERN NORTH AMERICA AND OTHER AREAS

We should have Persian walnut trees as hardy as our native black walnuts. They should be resistant to blight and of good bearing qualities. There is good reason to believe this thing can be done.

First we need to search the world for the best trees that have already resulted from the chance labors of Nature and man. It was a great agricultural and horticultural misfortune for America that we got our plants and trees from Europe

[14] The observations of Mr. Ford Wilkinson, of Rockport, southern Indiana, give an interesting confirmation on Mr. Jones' observation and upon the widespread belief that the Persian walnut will not thrive in the Mississippa Valley.

Mr. Wilkinson reports that five of his forty English walnut trees have escaped fatal winter kill. One seven-year-old tree bore more than a half bushel of fine nuts in the fall of 1926. All of these five survivors are growing near a large tree or in a crowded position where they are partially shaded in hot weather and also robbed of moisture in late summer, causing them to go dormant early and be prepared for winter weather.

Mr. Wilkinson has investigated many Indiana trees of reputed unusual hardiness and of actual unusual success and finds in every case lawn grass competition or some other protection from late summer growth.

rather than from China and Japan. There are three great regions of the Persian walnut: (1) the Far East; (2) the Near East; and (3) Europe. We drew from the worst of the three, Europe, the one having a climate that permitted the survival of the tenderest trees.

We should institute a careful search of the Near East and Far East to find good and hardy parent trees. For example, Lorin Shepherd, M.D., who has served as missionary at Aintab, Turkey, reports having hunted through the mountain districts fifty miles north of that place in a locality which was depopulated by war a hundred and fifty years ago. In that time, the Persian walnut has run wild. Up near the snow line at six thousand feet elevation it associates with the beech. It grows in thickets, and the trees are only four or five feet in height because they are kept nearly prostrate by the great burden of snow that lies on them each winter. Yet Dr. Shepherd reports that they bear good nuts.

Caravans have been carrying walnuts back and forth across Asia for unknown centuries. The splendid walnut trees and nuts in the Vale of Cashmere and its adjacent hills are well known, but there are many other valleys opening out of the Himalaya Mountains and west of them in Afghanistan and east of them in southwestern China.

It is interesting to speculate on the crop-tree resources of this old region, where each valley is a plant world to itself, and where valleys are separated from valleys by snow-covered ranges or bleak plateaus. For many centuries skillful farmers have been making their living in these remote mountain valleys and in the remote provinces of China. The Chinese province of Yunnan, with a great variety of elevations, seems to be a veritable tree laboratory[15] with interesting walnut tree developments. We should have a half-dozen men exploring this region at once.

[15] See the explorations of Joseph Rock, National Geographic Society, Washington, D. C, and U. S. Department of Agriculture.

We might begin on walnuts with deliberate science where the Asiatics left off their chance improvements.

It should be a comparatively simple matter for us to get the best walnut trees from the many thousands whose crops are now exported to us from the Chinese provinces of Chihli and Shansi.

Korea and Japan also offer promising fields for search. The Japanese walnuts are perhaps the most promising of all, because they have been subjected to great heat and humidity, and, therefore, like most Japanese trees should have leaves very resistant to blight.[10]

It is probable that trees from the Korean and Japanese areas can be secured without even the trouble of sending a man to look for them.

The Yokohama Nursery Company has already demonstrated what can be done in this line. They propagated for me ten different strains of Korean and Chinese persimmons from cions, which I secured in person or by friends in Northwest China and sent to Yokohama by mail. The Yokohama Nursery Company grafted the cions upon native stocks and shipped them to America under the care of the United States Department of Agriculture.

The Horticultural Department at the University of Nanking stands (or stood, 1925) ready to propagate trees, and its students from nearly all parts of China and its faculty have better opportunity than a traveling explorer has to observe and secure desirable parent trees. With a small expenditure of American money, some commercial arrangement could probably be made; at least it could have been made in 1925. Many wide-awake American missionaries, provided they can

[16] I have seen very fine trees bearing very good-looking nuts (which I did not taste), and this (at Kamisuwa) in the part of Japan which has skating for a winter sport and rice (indicative of humidity) for its chief crop. These trees were in Buddhist temple grounds at Kamisuwa and in several villages a few miles to the north. The whole locality merits careful exploration.

continue in China, would also be glad to coöperate in this work of local observations and sending specimens of both nuts and cions.

While we are searching foreign countries, we should also carefully search for the good trees in America, a task which is far from complete. This world search, thoroughly made, would probably give strains of Persian walnuts which would be hardy throughout almost all the territory now occupied by any native American walnut.

BREEDING PERSIAN WALNUTS

With a world collection of walnuts as material to work upon it seems plain that much improvement would result from scientific breeding. Five hundred acres of land and a staff of men should be busy at this work at once.

The Persian walnut is especially alluring to the plant breeders because of its great variation within the species—variation as to blight-resistance, frost-resistance, speed of growth, size, shape, quantity, and flavor of fruit, thickness of shell, and in other ways. One of its chief troubles is early spring growing and consequent frost injury. Yet there are strains here and there that remain dormant to an unusually late period in the spring.[17]

[17] For example, I happened to be walking through some orchards near Grenoble, France, on the 10th of June, 1913, and inquired what had killed a tree that stood leafless in the orchard. The owner replied, "It is not dead. It has not come out in leaf yet." This incredible fact was evidently true. A perfectly healthy tree it was, just beginning to show the first sign of growth. Across the road cherries were ripe, farmers were making hay, and the wheat was in head. This late-blooming tree was not of the best, but its nuts, though scanty, were of quality good enough to cause the tree to be kept.

This type of variation is not rare. As I rode from Milan to Paris, May 18, 1926, I saw from the car window, shortly after entering Switzerland, a number of trees that were much less advanced in foliage than their fellows near by. Trees with similar habits have been found in America.

"We have one tree among our hybrids that continues dormant until about the first of June, about four weeks later than the normal, but after it puts forth its leaves it makes three or four times as much growth as the other trees of the same age." (J. W. Killen, Felton, Delaware, February 8, 1916.)

Using these late-blooming strains (and there are others) as a base for breeding gives a reasonable certainty of getting an almost frost-proof Persian walnut. Working with East Asiatic strains should give us blight-proof walnuts. It appears reasonable to think that a hardy Persian walnut might eventually be found or bred to grow almost anywhere that our native black walnuts now grow.

So much for this one species. But it hybridizes with other species. It does it with great ease. For example, a farmer near Camden, New Jersey, having one tree which he liked, had a nurseryman grow a hundred seedlings from its nuts. The little trees did not look like their mother; and when they began to bear they indicated that they had a butternut father.[18] The farmer dug up ninety-nine as worthless and the hundredth was scarcely worth keeping. Episodes like this have happened again and again, but this method can produce great results if skillfully used.

Professor Ralph E. Smith of the University of California

"Our English walnut tree, it is thirty years old and for the last fifteen years it has borne annually. I think that it has averaged about 1¾ bushels for the last five years. It has over two bushels this year. It blooms so late it looks like a tree in mid-winter up to the first week in June and then the leaves grow very rapidly. I am not positive that it bore in 1899 (a year of terrible winter), but I think it did. I am positive that it bore a good crop last year and that the mercury was 20 degrees below the previous winter." (Asa M. Stabler, Spencerville, Md.)

[18] There is a locally famous Persian walnut tree in Berks County, Pa. It is supposed to be two hundred years old. The owner has been offered five hundred dollars for the tree as lumber, but it bears so many good nuts that he holds it. Innumerable seedlings have been grown from this tree by the thrifty Pennsylvania Germans. Almost invariably they are worthless. Apparently they are the hybrid progeny of a butternut father which stands a quarter of a mile to the northwest.

A Persian walnut, hybridized with bitternut, produced a nut which looked like English walnut. Planted at Chatham, Ontario, in the fall of 1910. December, 1924, it was 41 feet high, 52 feet spread, 19 inches in diameter; grew in good alluvial soil with plenty of room. Produced a few nuts, large, thick-shelled, with a small kernel which came out almost entire. Tree stood the severe winter of 1917-18 without the slightest injury. (Information from Professor James Neilson, Port Hope, Ontario.)

These facts indicate both the troubles of growing seedlings and the possibilities of breeding better trees.

says [19] that in almost every case the crosses between a black walnut and a Persian walnut "show a rapid development and within the first four or five years they assume a size and rapidity of growth several times as great as that of other seedlings" (i.e., either parent). The rapid growth of some of these trees is truly astonishing. Professor Smith points out that these hybrids stand excess of water and drought better than the Persian parent. Then he tells one more exceedingly suggestive thing. While trees of this cross are almost invariably worthless for fruit, he reports *one* that "seems to produce every year a very large crop of nuts." It only takes *one tree* to found a variety. All the Baldwin apples and all the navel orange trees in the world started from one tree.

The application of Mr. Burbank's methods to the development of the various species of walnuts is an interesting task with promising possibilities. It awaits imagination backed with money.

[19] Bulletin No. 231, p. 154-5. *The Economics of the English Walnut.*

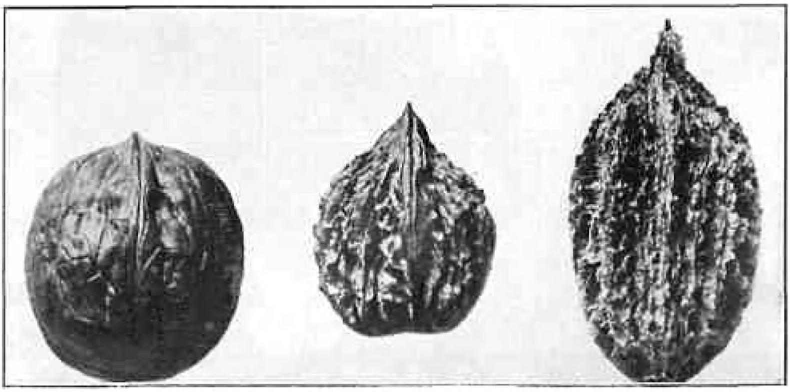


FIG. 74. *Top*. English walnut and its seedlings. (Courtesy U. S. Dept. Agr.)—FIG. 75. *Center*. Black walnut. Top-worked with English walnut in J. Russell Smith's fence row.—FIG. 76. *Bottom*. Persian walnut shade tree in Washington, D. C. (Photos J. Russell Smith.)

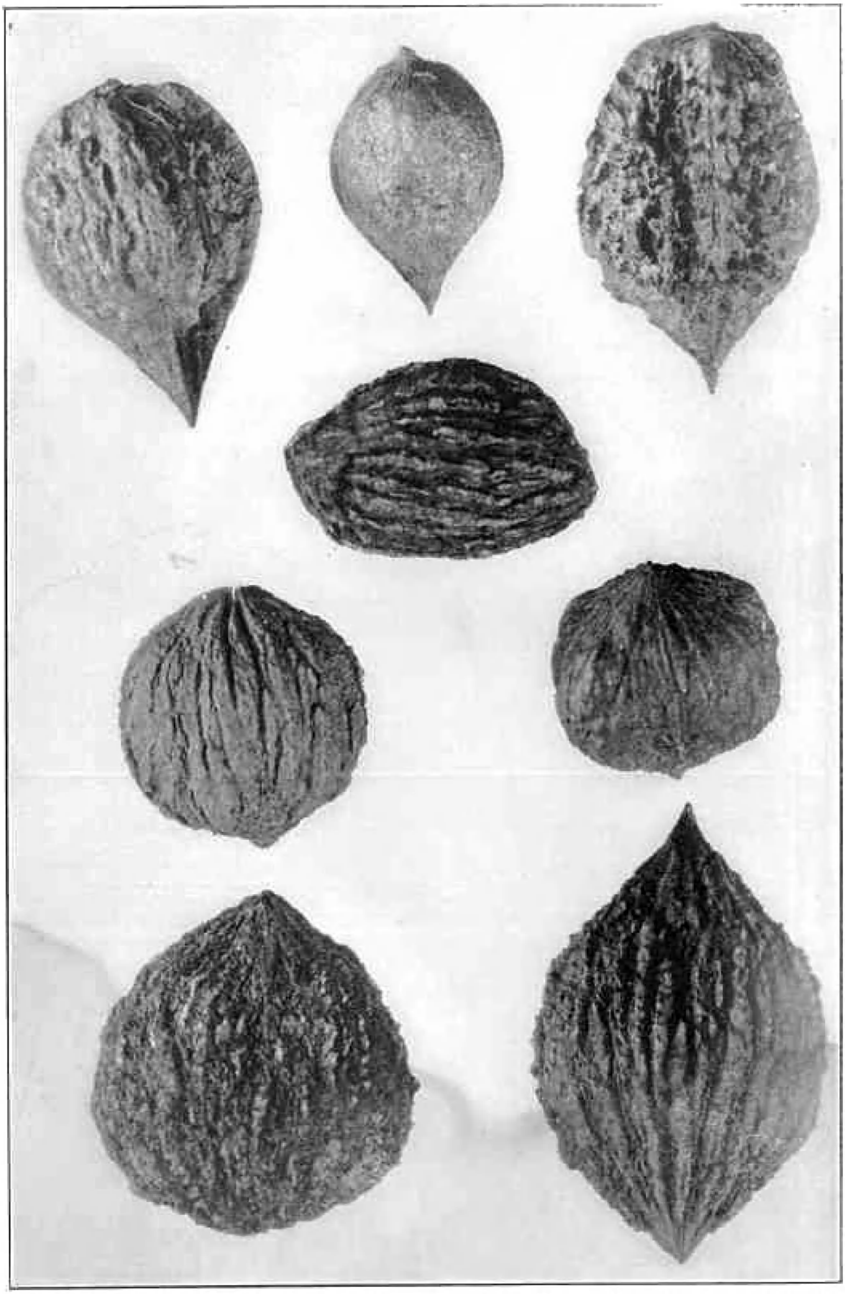


FIG. 77. *Top Row*. Japanese walnut (center) and two of its butternut hybrids, life-size. Remainder, natural variants of American black walnut. (Photo E. R. Deats.)

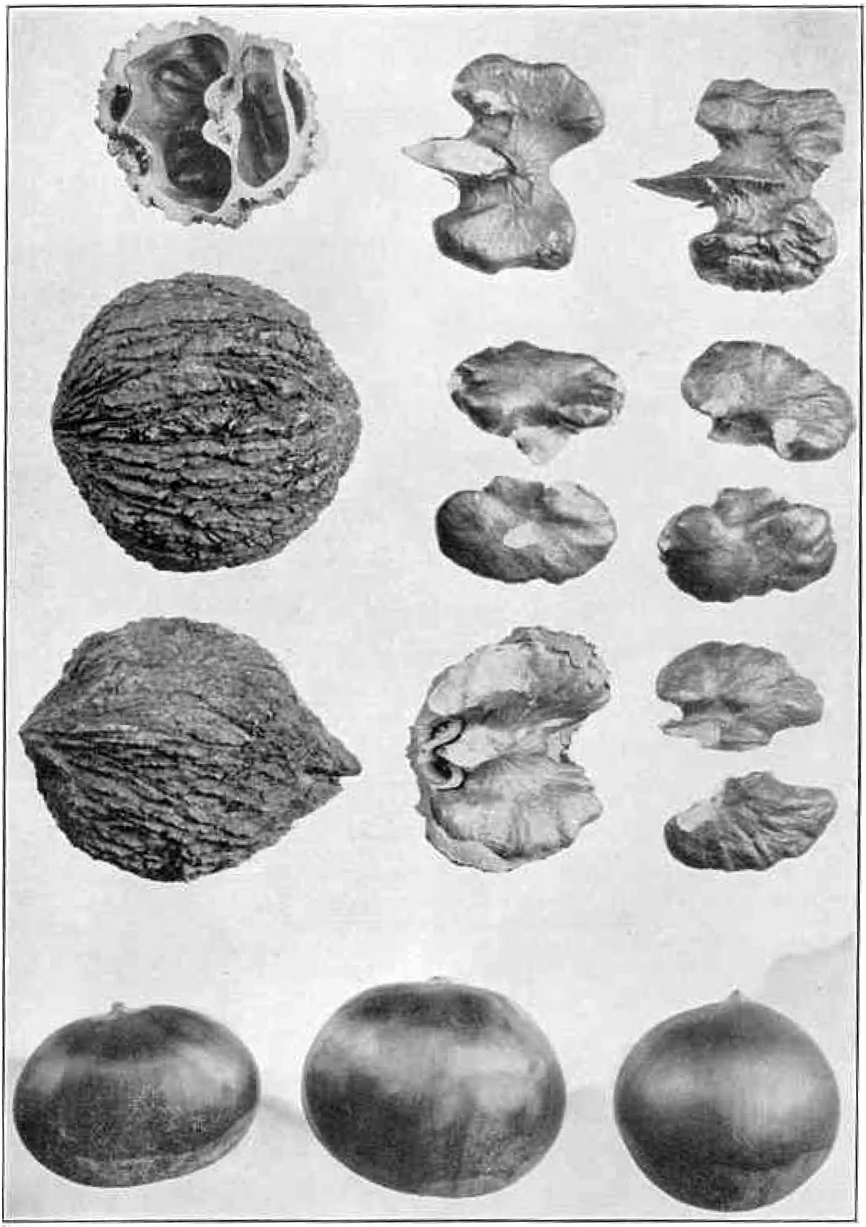


FIG. 78. *Top,* Stabler walnut shell and kernels; next, Thomas walnut and kernels; next, Ohio walnut and kernels; *bottom,* some Maryland chestnuts, probably Japanese, that have survived the blight. All life-size.

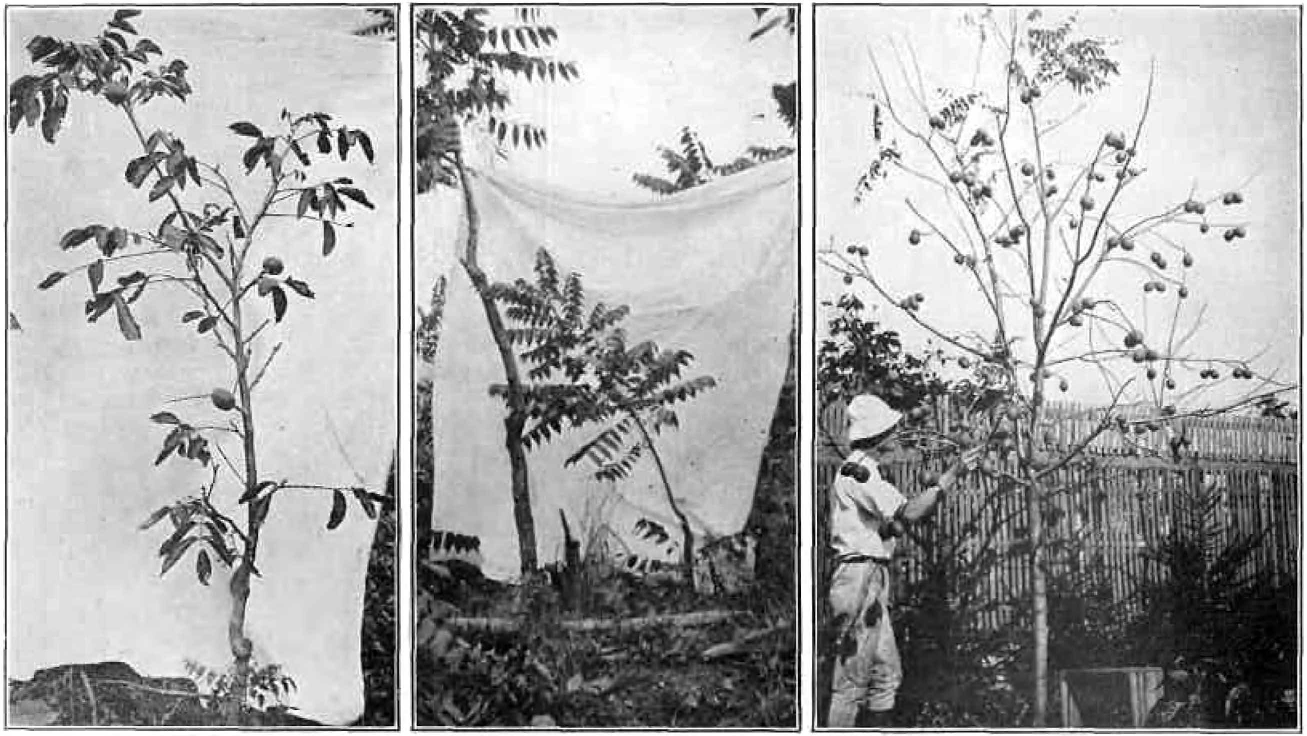


FIG. 79. *Left.* Two-year-old Persian walnut tree bearing nuts in nursery. (Courtesy J. F. Jones.)—FIG. 80. *Center.* Grafted Thomas black walnut tree, two years old, bearing nuts in nursery. (Photo J. Russell Smith.)—FIG. 81. *Right.* Ohio black walnut tree, four years planted, bearing 105 nuts. (Courtesy S. H. Graham, Ithaca, N. Y.)

CHAPTER XVII

ANOTHER MEAT AND BUTTER TREE—THE EASTERN BLACK WALNUT (JUGLANS NIGRA)

A NEGLECTED GIFT OF NATURE

The American black walnut may become a greater future asset to the human race than its now more appreciated rival, the Persian walnut. It will surely become a greater asset than the Persian walnut if it should be as much improved. While the Persian walnut started as an almost worthless product of a wild tree, nature has, at the beginning, produced in the American black walnut a product of substantial merit and of some commercial value.

Nothing has been done to improve the black walnut. We have even mercilessly destroyed many fine nut-bearing trees in the quest for its valuable timber.

It has helped to fatten countless American frontier herds of swine.[1] The American Indian made use of the walnut as food. It has been a food of some importance to the colonial American.[2] For generations gathering black walnuts has been

[1] "Hogs do exceedingly well on walnuts. Stock hogs will winter nicely on walnuts exclusively, but small hogs cannot break the walnuts. Brood sows, for example, will do well on walnuts, needing corn only while suckling actively. Tons of the very richest poultry and hog food can be produced on one acre of land. Two or three mature walnut trees will supply food enough for from one to two dozen hens the three winter months in Kentucky." (Dr. P. W. Bushong, Edmonton, Metcalf County, Kentucky, August 12, 1913.)

Governor Hardman of Georgia tells me that he sometimes hears the following sequence of sounds: first, falling walnuts; second, hogs in motion towards the tree; third, the popping of walnuts in the porcine jaws.

[2] "Several years ago one fine fall day I was over in Kentucky scouting for a pecan tree I had heard of and went to the cabin of an old negro whom I knew and found him hulling a very large pile of black walnuts he

a joyful autumn labor of the American country boy, and much rural sociability has centered around apples and walnuts beside the autumn and winter hearth fire.

THE INFLUENCE OF FOOD FACTORIES ON THE WALNUT

Now the wild black walnut is participating in the new food era—the era of machine-made foods.

Since the commercial manufactures of candy and ice cream have become an established American industry, there has sprung up a surprisingly large trade in wild walnut kernels.[3] The *American Nut Journal* for December 3, 1922, reports the following:

"Greene County, Tennessee, this season shipped two hundred and ten thousand pounds of nut kernels, according to a dispatch from Greeneville. On one day late in October seven thousand dollars were paid out in Greeneville for the kernels. A good cracker can earn forty cents an hour."

For two reasons eastern Tennessee and adjacent states are an important region in the production of walnut kernels. One reason is that it is a good place for walnut trees and the other is that it is a country of limited available resources and rather overcrowded population. Many of the families are large, and many boys, girls, and women have few opportunities for employment. Picking out walnut kernels offers profitable addi-

had gathered. 'Uncle Abe, what are you going to do with all of those walnuts?' I asked. 'Cap'n,' he replied, 'I'se gwine to eat these this winter when I don't have any meat.'" (Letter, J. Ford Wilkinson, Rockport, Indiana, January, 1928.)

[3] "The sale of hulled nuts is increasing. One merchant in Beaverdam, Kentucky (fifty miles southeast of Evansville, Indiana) bought seven hundred bushels this season for shipment to Memphis." (Letter, Sam C. Baker, Beaverdam, Kentucky.)

A walnut-meat factory, employing thirty to fifty women who were receiving twenty cents a pound for picking out the meats after the nuts were cracked, was established in 1926 in Carlisle, Kentucky. It resulted from the efforts of State Forester Merrill to buy a couple of tons of nuts to plant. He received offers of a thousand tons, and the establishment of this industry resulted. {*American Nut Journal,* December, 1926.)

tional employment. It is like the cottage loom of Revolutionary days.

Persons who have never gathered walnuts fail to appreciate the great productivity of these trees in localities where they grow abundantly. The *Madison Survey,* a paper published by a vegetarian disciple of Dr. J. H. Kellogg, who runs a school for mountain boys and girls not far from Nashville, reports that the school went to the autumn woods with a picnic dinner one day in October, 1920, and brought back in trucks and wagons over two hundred bushels of black walnuts in the hull.[4]

THE BLACK WALNUT ORCHARD

All of the above-mentioned commercial facts have depended upon wild nuts—the chance product of nature. Few of the readers of this book have seen any black walnut except the wild one. An industry is now starting on the basis of commercial propagation of a few varieties of black walnuts—the best wild trees that have been found. The parent trees of these varieties have been selected from millions of wild trees. The search for varieties was made by the Northern Nut Growers' Association[5] working in conjunction with the Department of Agriculture and a few members of state staffs.

This new industry depends upon four facts:

(1) The technique of budding and grafting nut trees which has been recently developed in America. By skillful use of the new technique we may multiply any tree that we may choose and make of it a variety with an indefinite number of specimens.

(2) Several parent trees of superior merit are now available for propagation.

(3) An increasing demand for black walnut kernels.

(4) The new industry has possibilities of heavy production

[4] *The Madison Survey,* October 27, 1920.

[5] This association is a very interesting group of pioneers with a membership of diverse and often distinguished attainments. (H. D. Spencer, Secretary, Decatur, Illinois.)

because of the wide range of territory suited to the black walnut.

THE TECHNIQUE OF GRAFTING AND BUDDING WALNUT TREES

This technique has been worked out to the point where it is safe to say that trees of any desired variety can be had in any desired quantity in a comparatively short space of time. Many private experimenters scattered over the country are successful in grafting walnuts, both black and Persian, and also many varieties of pecan and hickory. Success in grafting nut trees is by no means as sure as with apples, and the degree of success seems to vary very greatly from year to year, probably due to the fact that we do not yet know or observe all of the controlling factors.

This technique seems to have been first explained for the layman in terms easy to follow in a book called *Nut Growing* by Dr. R. T. Morris (Macmillan, 1921).[8] I think I am right when I say that all of the essentials of his methods are explained in the Appendix of this book. I have myself taught the art to half a dozen farm hands. I would not hesitate to take any dozen illiterate mountaineers, good whittlers or fiddlers, fiddlers preferred; and if they tried, I could make eight or ten good (but slow) grafters out of the dozen in two hours' time.

People in many lands have successfully followed the directions in Dr. Morris' book, but some have not been so successful.

THE VARIETIES

Mr. Willard G. Bixby, of Baldwin, Long Island, New York, has probably done more scientific work on varieties of nuts than any man in the world (page 29). Following the example

[6] Any one interested in nuts should read the book because of its valuable information. It is also worth reading because the author has a sense of humor.

The U. S. Department of Agriculture also has a bulletin on nut propagation.

of Dr. Robert T. Morris he started with a diligent search for the best varieties of American nuts. By offering prizes he set many people to hunting for nuts. This process has been repeated many times by the Northern Nut Growers' Association. The United States Department of Agriculture is also continually on the lookout for new varieties.

As a result of extended search several varieties of black walnuts are now considered worthy of commercial propagation. Several others are believed to be of great merit, but having been only recently discovered there has not been time to test them. One of the varieties most favorably known is the Stabler. The nuts come out of the shell very easily, usually in unbroken halves. Some of the nuts have kernels of only one lobe of meat, which comes out in one piece. The tree is a slow grower, apparently a rather poor feeder, and, all things considered, is perhaps no better than half a dozen others now under test.[7]

The Thomas and Ohio varieties have fruited at Fairhaven, Vt.—winter temperature —30° F. The Stabler and Ten Eyck are not hardy there.

The first orchard of black walnut trees to make a commercial income was that of E. A. Riehl of Alton, Illinois, who planted some gulch banks and bluff sides overlooking the Mississippi River to walnuts and chestnuts.

[7] "The tree (parent tree still standing twenty miles north of Washington, D. C.) is about twelve feet in circumference, has a spread of limbs of seventy-five feet and bore sixteen bushels of nuts this year. The tree is said to be about sixty years old and has a timber value of about one hundred and fifty dollars. Tradition has it that this is a grafted tree and that the cions were brought from Baltimore County, Maryland, about sixty years ago by John K. Harvey, an expert apple grafter. There seems to be some foundation for this tradition." (Letter, T. P. Littlepage, Washington, D. C, December 14, 1915.)

"So far as I can find out it has not missed a crop in its bearing year in the memory of any man that knows the tree. It bears only in the odd years, and usually about fifteen bushels. The old branches do not bear one walnut in even years, but in late years some watersprouts that grew up where the top was broken in the hurricane of 1896 have been bearing about half a bushel." (Henry Stabler, Washington, D. C, January 26, 1916.)

"We have found by actual test that the Thomas gives over ten pounds of meats to the bushel and with care ninety per cent. are unbroken quarters." [8]

The flavor of these nuts is of unusual excellence. The tree is a fast grower, somewhat subject to loss of leaves in late summer from fungus. I have had seven-foot trees of this variety produce nuts in the nursery row.

The Thomas, the Stabler, and the Ohio, which seems to be midway in qualities between the Stabler and the Thomas, were thought worthy of recommendation for general planting by the Northern Nut Growers' Association in 1926.[9] I have used them all in my own first planting of ten acres. I am one of many to start commercial plantings. Several thousand grafted trees have been planted in widely scattered locations east of the Mississippi River and a few west of it. Commercial data on the industry are likely to increase and become available in the next decade.

A crop of black walnuts to occupy winter hours of farm labor appears to be a very effective item in farm economy.[10]

[8] Letter, E. A. Riehl, January 19, 1915.

[9] See their Bulletin No. 6, in which they gave to the public the following advice: "The Northern Nut Growers' Association has been studying the varieties, propagation, and growth of nut trees for seventeen years. It now recommends the planting in orchard form of the better varieties of grafted and budded native American black walnuts in those parts of the country where the tree grows naturally."

[10] "I have not changed my mind a particle about the black walnut in the last four or five years. I knew that as soon as a black walnut that could be cracked was discovered it would take the place it deserves and as 'faith without works is dead' I expect to set about fifteen acres of the 'Stabler' black walnut next fall. I want something for my farm labor to do in the winter time anyhow, and if I could have about a thousand bushels of these walnuts for them to amuse themselves by cracking on wintry days, thereby producing about ten thousand pounds of walnut meats, even selling them at twenty-five cents per pound, you see, would return twenty-five hundred dollars.

"Mr. Riehl is getting eighty cents for walnut meats; it is certainly not out of reason to expect them to always bring at least twenty-five cents per pound." (Letter, Thomas P. Littlepage, Washington, D. C, January 19, 1916.) Eleven years later, with his trees in bearing, Mr. Littlepage is as enthusiastic as ever. Mr. Littlepage, a corporation lawyer, was one of the founders of the Northern Nut Growers' Association in 1910.

There is no reason to think that the best varieties of black walnut have yet been found, and it is highly probable that trees better than any now living have been destroyed in the slaughter [11] of trees which has marked the whole era of the white man in America.

THE DEMAND FOR BLACK WALNUT MEATS

The black walnut is unique among commercial nuts in retaining its flavor when cooked. Cooking makes many other nuts lose flavor, but the black walnut comes through as tasty and attractive as ever. This is a great advantage in this age of factory-made food—ice cream and candy, nut bread and nut cake.

With the movement on in America for good health and physical efficiency there is an increasing emphasis upon the meatless diet. A large increase in population will force us in that direction through scarcity of meat. Under such conditions tasty black walnut bread made of whole wheat flour is not only good, nutritious, and wholesome, but is almost a complete substitute for bread, butter, and meat.

Ice cream manufacturers have been trying to buy walnut meats in twenty thousand pound lots. Apparently the future demand for the black walnut may far outrank the demand for

[11] Some of these tree tragedies have probably destroyed parent nut trees that would have been worth millions if propagated in sufficient numbers. The following episode is a good illustration of this point.

Mr. Harry R. Weber, a lawyer of Cincinnati, with nut trees for an avocation, found in two successive years the shells of a black walnut resting on a wing dam in the Ohio River near Cincinnati. The shape of this shell both inside and outside bore such a resemblance to that of a Persian walnut that its kernel must have been very easy indeed to remove. Where had this nut tree grown—in all the wide reaches of the Ohio Valley above this dam upon which it had floated? Wide search, correspondence, and newspaper publicity all seemed finally to fix the place in Floyd County, Virginia, near the headwaters of the New River. Mr. John W. Hershey, of Pennsylvania, made a five hundred mile journey to investigate the hillsides of Floyd County. When he arrived, the farmer showed him a bare pasture field. The lumbermen had cut this probably matchless tree, and not a sprout remained, the Persian walnut, which must be eaten uncooked and is not the equal of the black walnut for candy, cake, or ice cream. Therefore, the Persian walnut has less potential value than the black walnut in American and European diet.

THE BLACK WALNUT AREA

The territory for the black walnut industry in the United States is wide. In this respect it is almost a rival of corn. This one single species (juglans nigra) thrives in northern New York and southern Georgia, in north central Wisconsin and south central Texas, and from central Massachusetts to western Kansas, Nebraska,[12] and Oklahoma, with a substantial slice of South Dakota and Minnesota included in its range. Roughly this walnut belt covers most of the Corn Belt, most of the Cotton Belt, and tens of thousands of square miles of Appalachian and other eastern hill country on which no type of agriculture can survive but grass, trees, or terraces.

BETTER VARIETIES OF BLACK WALNUT

We should never lose sight of the fact that at the present moment the black walnut industry depends on chance wild nuts and that we may find better specimens any day. Certainly we should expect to breed better nuts, much better, perhaps rivaling the Persian walnut in physical form or at least in availability of kernels. This can be brought about by deliberately breeding the best black walnuts we can find and hybridizing them with other species of walnuts.

The American nation should have two or three persons employed on this task of testing out several thousands of these hybridized seedlings of promising ancestry. Much time could be saved by grafting these young seedlings on to mature trees and thus bringing them to fruit sooner than by waiting for them to grow large enough to produce nuts on their own tops.

[12] Prof. G. E. Condra, University of Nebraska, reports that there are at least a few black walnut trees in every county of Nebraska,

THE BLACK WALNUT AS A FOOD PRODUCER

The black walnut has great possibilities as a food producer. Take the case of the parent Stabler tree. "About fifteen bushels of nuts every other year." To be safe call it an average of six bushels a year; call it ten pounds of meats per bushel or sixty pounds per year.

The food values of these can be seen by studying the food table (page 304) and then comparing the food yields of some other crops, especially pasture, because pasture produces meat, the rival of nuts in the production of protein as food. The good pasture of England or Illinois gives about one hundred and fifty pounds live weight of mutton or beef. Of this nearly half is waste in slaughter, and there is considerable waste in the meat. Therefore, sixty pounds per year of nut meats from the Stabler tree come close in actual pounds of edible food to the product of an acre of blue grass.[13]

The nutrition value of the nut meats is nearly four times as great as that of the meat from the acre of grass. There is room for five such trees to an acre, and there would still be the possibility of further produce from the same land. Mr. S. W. Snyder, Center Point, Iowa, knows of trees that are apparently more productive than the Stabler.

"Grass grows well beneath black walnut because of its deep root system and its thin open foliage, which casts only a light shade."[14]

Mr. James Dixon, land owner and bank president, Easton, Maryland, says that wheat beneath walnut trees seems to be actually better, and Mr. Ford Wilkinson, of Rockport, Indiana, says, "A catch of red clover can be gotten under a black walnut tree almost any season whether ground has been limed or not."

[13] There is a noticeable resemblance here between the French equivalence in the rental of an acre of land and a walnut tree (page 167).

[14] United States Department of Agriculture, Farmers' Bulletin No. 1392, p. 8.

The cost of extracting the kernels of the walnuts from an acre of land is probably more than that of slaughtering and dressing the meat from an acre of land. However, I am not certain of this. But now machinery is being developed for the black walnut, as it has been developed for the California walnut industry—for example, the important discovery (see U. S. Department of Agriculture) that a restaurant potato-peeling machine and a small hose stream of water take the black and dirty hulls off black walnuts and clean the nuts at a rapid rate. Perhaps this in conjunction with some kind of a mechanical crusher might open a market for inferior black walnuts for poultry food on the farm, the chickens picking out the meats.

CHAPTER XVIII

A GROUP OF MEAT AND BUTTER TREES—THE OTHER WALNUTS

In the preceding chapters I have given much space to presenting facts about two species of walnuts and the philosophy of the subject in general. In brief this is—(1) Find the best existing strains, and we have the basis of a good industry now. (2) Breed better strains by crossing and hybridizing, and we have the basis of a better industry.

This philosophy is applicable in varying degrees to each of the other species of walnuts which are as follows:

(1) Butternut, juglans cinera.

(2) California walnut, juglans californica.

(3) Texas walnut, juglans rupestris.

(4) Arizona walnut, juglans major.

(5) Chinese walnut, juglans regia var. sinensis.

(6) Siberian walnut, juglans mandshurica.

(7) Japanese walnut, juglans sieboldiana, var. cordiformis, sometimes called "heart nut."

The space limitations of this book prohibit full discussion of these several species,[1] but I wish to emphasize a few points of especial significance.

The butternut (number one above) grows in colder climate[2] than the black walnut, ranging from James Bay to

[1] For a fuller discussion of various species see *Nut Growing,* by Robert T. Morris, Macmillan. There is of course always Sargent's *Silva,* for an exhaustive presentation of questions of variety.

[2] 1922 *Proceedings* of Northern Nut Growers' Association, p. 72, J. A. Neilson, Professor Horticulture, Port Hope, Ontario, says, "The butternut is much hardier than the black walnut and has a much wider distribution in Canada. It occurs throughout New Brunswick, in Quebec, along the St. Lawrence basin, and in Ontario from the shore of Lakes Erie and Ontario

New Brunswick, thence along the higher Appalachians to northern Georgia and Alabama. The kernels of the better specimens come out of the shell more easily than do those of black walnuts. The butternut offers interesting crop possibilities for the northern section of the United States. Some people prefer its nuts to the black walnut. A selected grafted variety, the Deming, is reported by J. F. Jones, Lancaster, Pennsylvania, to bear when it is two feet high.

The Chinese walnut (number five above) was long classified as a separate species, but botanists have now become convinced that it is merely a variety (suggestive fact) of the Persian walnut. Therefore, it has been discussed, either directly or by implication, in Chapter XVI.

The Japanese walnut is a species of exceeding promise. In its native home it grows throughout the climatic range[3] of Japan, embracing climates as dissimilar as those of Nova Scotia and Georgia and all between, and accentuated by the reeking humidity of the Japanese summer with its strong fungus tendencies.

The tree also thrives in a great range of soil from sand to clay. Apparently it is a veritable goat in its feeding habits. This makes it a very rapid grower, and in rich soils a single leaf is sometimes a yard long. (See Fig. 83.)

It is precocious, some seedlings producing fruits at four or five years of age.

It bears its fruit in long clusters and is very prolific.[4]

to the Georgian Bay and Ottawa River. It has been planted in Manitoba and does fairly well there when protected from cold winds. West of Portage la Prairie the writer observed a grove of seventy-seven trees. Some of these were about thirty-five feet tall with a trunk diameter of ten inches and had borne several crops of good nuts."

[3] James Neilson reports (personal conversation) Japanese walnut, heart nuts. Seed planted in the spring of 1924 at Winnipeg. July 20, 1927, tallest tree was twelve feet high, one and one-half inches in diameter. They are also growing nicely at St. Anne's in Quebec near the mouth of the Ottawa River.

[4] "In a not especially favorable location in Sharp's backyard at Riverton, New Jersey, is a fifteen-year-old Japanese walnut, which receives no espe-

The wood, unfortunately, is soft and of little value, but we can scarcely expect one tree to have all the virtues until after breeding work has been done.

The Japanese walnut merits much attention at the hands of plant breeders. It is at present in rather bad repute because ignorant or unprincipled nurserymen have scattered its seedlings widely over the United States, calling it the English walnut; but the specimens were only seedlings of no particular merit. The result of this deception has been to dampen the ardor of many planters. Other nurserymen, in good faith, sold seedling trees produced from nuts borne on Japanese walnut trees in this country. These trees turned out to be hybrids that could scarcely be distinguished from butternuts. They had resulted from the very active hybridizing susceptibilities of Japanese trees growing within the wind-blown pollen range of butternut trees. It seems almost as if the Japanese walnut chooses butternut pollen rather than its own if it has the chance.

The heart nut, of which grafted trees are now available in

cial encouragement but produces annually four bushels of nuts." (Letter, Joseph H. Willits, Professor of Industry, University of Pennsylvania, October 10, 1912.)

"We found that the Japanese walnut was happy from the start, and three years after planting produced an abundance of nuts combining the good qualities of both the American butternut and the black walnut, with meat much thicker than the butternut and not nearly so oily, an improvement on the black walnut and butternut as well, and a vast improvement on these trees in respect to leafing, as the Jap is one of the earliest trees to put out its leaves in the spring, far ahead of the black walnut of equal size and at a much more tender age. It is one of the most interesting trees we have because of its bloom at the end of the branches and its marvelously long, plump catkins scattered along the trunk, and the nuts, instead of being formed singly, are produced on long stems like an elongated bunch of grapes, having as many as twenty-two nuts on a stalk." (*Long Island Agronomist,* Vol. VI, No. 6, January 1, 1913.)

"Mrs. R. S. Purdy, 218 South Willard Avenue, Phoebus, Virginia, has the j. seiboldiana sample I sent you. The year that I was at Lancaster (1912) I visited this tree; it was then eighteen years old and bore that year sixteen bushels of shelled or rather hulled nuts. . . .

"They grow in clusters of twenty-four nuts. The tree was planted by a little girl twenty years ago from a nut she got from a sailor at Old Point Comfort. The tree is about a foot in diameter. It is very powerfully rooted." (Letter, G. H. Corsan, University of Toronto, December 23, 1914.)

several nurseries, is merely a variety of the Japanese walnut. Some heart nut trees produce nuts whose kernel comes out in one piece—a fact of great commercial significance.

Consider the easy hybridization of the various species of walnut with each other. Consider this in connection with all the qualities above mentioned as well as the fact that Japanese and Manchurian and Chinese specimens come from sections of Asia having cold winters and hot humid summers.[5]

In view of these considerations it seems to be clear that we have the opportunity of making a great number of walnut hybrid varieties suited to a great number of climates and conditions. It may be easily within the possibilities that we can produce some kind of walnut to be grown especially for pig and poultry food.

[5] "You will be interested to know that a letter from Dr. Edwin D. Weed, Duluth College, Duluth, Minnesota, states that Chinese walnut trees I sent him went through the winter 1925-26 well and are growing vigorously. These were from ten thousand feet elevation in North China. (The seed)." (Letter, J. F. Jones, 1927.)

CHAPTER XIX

THE PECAN—KING OF HICKORIES—A TYPE STUDY IN TREE CROPS

The hickories are a great family of food producers. They will be even greater in the future if scientific agriculture prevails.

The pecan is, at present, the king of the hickory family, and affords an excellent and nearly completed case to illustrate the idea that wild trees can become the basis of new crops.

The pecan has passed rapidly through a number of interesting stages in its utilization by man.

1. It started as a wild tree, covering a large area and producing large quantities of fruit mostly unused by man.

2. Trees of superior producing quality were selected out of the mass of mediocrity, and the attempt was made to propagate them by planting seed.

3. Seedlings from superior trees produced many variations (Fig. 90), and almost without exception these seedlings were inferior to the mother tree. The result was paralysis of human enthusiasm and general neglect of the species.

4. The technique of propagation was worked out. Then in a manner exactly comparable to the development of varieties in apples, selected trees were propagated, giving rise to named varieties such as Stuart, San Saba, Schley, Busseron, Butterick, et cetera.

5. Grafted and budded pecan trees were planted by the hundreds of thousands. Orchards were developed. An industry was achieved.

The new industry gave proof of its reality by a product worth millions of dollars; a national association of growers; a widespread attempt to control diseases and pests and to solve the cultural problems; establishment of a national pecan experiment station; various state experiment stations to study the industry; and finally a flock of bulletins from many states and from the United States Department of Agriculture.

6. A final stage of the industry has been reached with laboratories for research and experimentation as to the use of the product, and their natural accompaniment of factories for the manufacture of pecan foods for distribution by bottle, carton, and can. This puts it in the rank of established American food industries.

The pecan has arrived. It is not merely prospective or possible as is the case with so many of the things discussed in this book.

The industrial record includes one more phase so typical of new and alluring American industries, namely promotion, speculation, and swindling enterprises. The pecan has been a shining example of this. Yet more, the bringing forward of the pecan has developed a substantial mythology which still has its faithful believers, especially as to where the pecan grows and will grow.

THE NATURAL RANGE OF THE PECAN

Before the white man began to spread the pecan, it was a native tree of a large part of the Mississippi basin south of Iowa. It also grew in the valleys of Texas and the adjacent parts of Mexico.[1]

Eastward of the Mississippi the pecan was found through central Kentucky and Tennessee and in a few parts of Ala-

[1]The pecan was found on the Ohio River from southern Ohio westward; up the Mississippi to southeastern Iowa; and thence southward almost to the mouth of the Father of Waters. In the Missouri River valley it reached the extreme northwestern corner of the state of Missouri. Thence southwestward across eastern Kansas, extending into this state about one hundred and twenty-five miles along the southern boundary. Pecans lined the streams in the greater part of Oklahoma, almost all of the streams of Texas, and on into Mexico.

FIG. 82. *Left.* Black walnut trees in J. Russell Smith's fence corner, grafted to Stabler black walnut, have borne several crops. (Photo J. Russell Smith.)—FIG. 83. *Center.* Fruit cluster of a Japanese walnut. (Courtesy J. F. Jones.)—FIG. 84. *Right.* Cluster of cork oak trees occupying rocky knoll in Portuguese wheat fields. Typical of a method of land utilization that might produce nearly all the nuts needed in America, leaving other crop area unaffected.

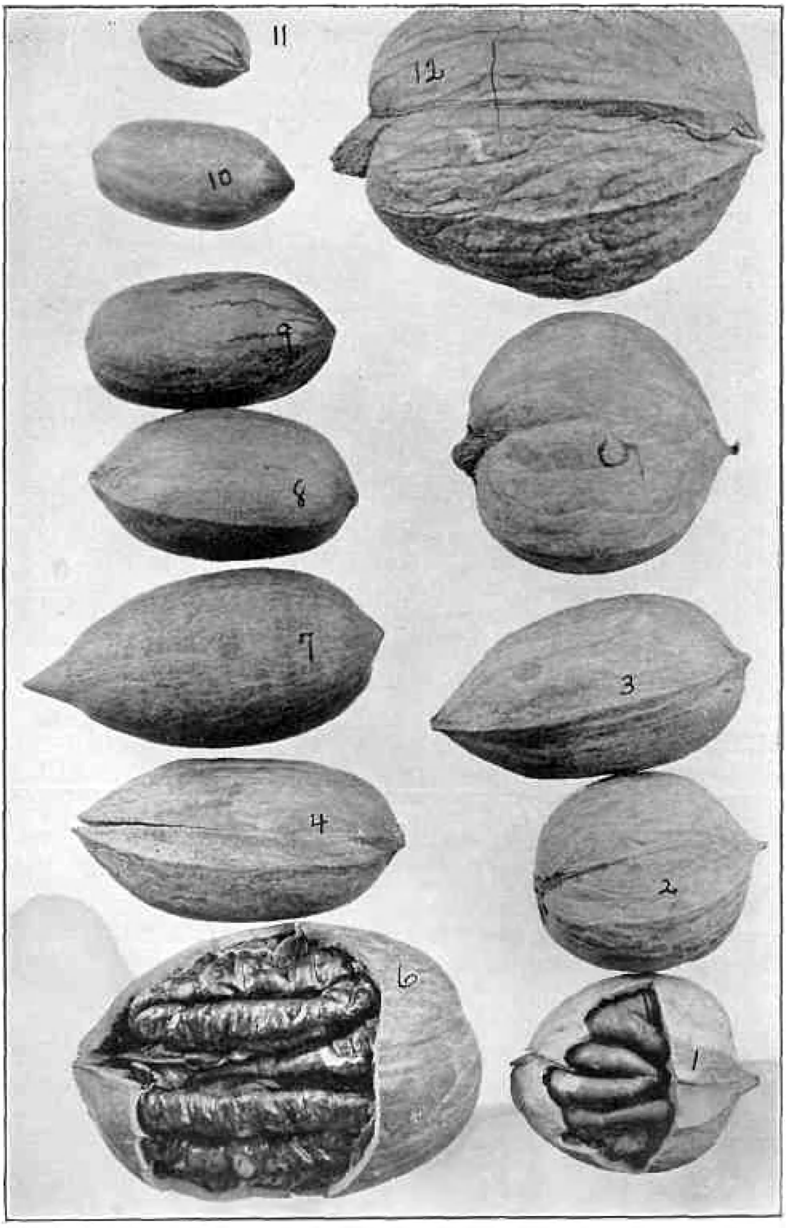


FIG. 8" Some life-size hickories, suggestive of breeding possibilities. (1) Wild shagbark. Pa. (2) Shagbark x bitternut. la. (3) (4) Pecan x hickory hybrids. Mo. (6) McAllister hybrid. Ind. Western shellbark (12) x (8 or 9) Indiana pecans. (7) Southern pecan (Schley $1.00 a pound, 1928.) (10) Wild Illinois pecan. (11) Nebraska pecan. (12) Laciniosa. Ill.

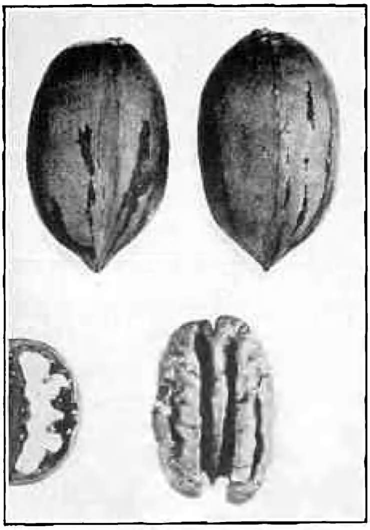


FIG. 86. *Top Left.* A Busseron pecan tree, nine years transplanted, bearing 18 pounds of nuts, its third crop. Southern Indiana. (Photo J. Ford Wilkinson.)—FIG. 87. *Top Right.* Pecan tree growing along the curb in Raleigh, N. C, bearing a fine crop. (Photo J. Russell Smith.)—FIG. 88. *Bottom Left.* Life-size Butterick pecan nuts, an Illinois variety, grafted 1914, gathered 1918. Climate of Philadelphia.—FIG. 89. *Bottom Right.* Pecan tree in park at Hartford, about seventy years old; southern seed; 10 feet in circumference; about 80 feet in height. (Photo William C. Deming.)—A very vigorous pecan tree from Georgia, U.S.A., is growing by Lake Ontario near Grimsby, Ontario.

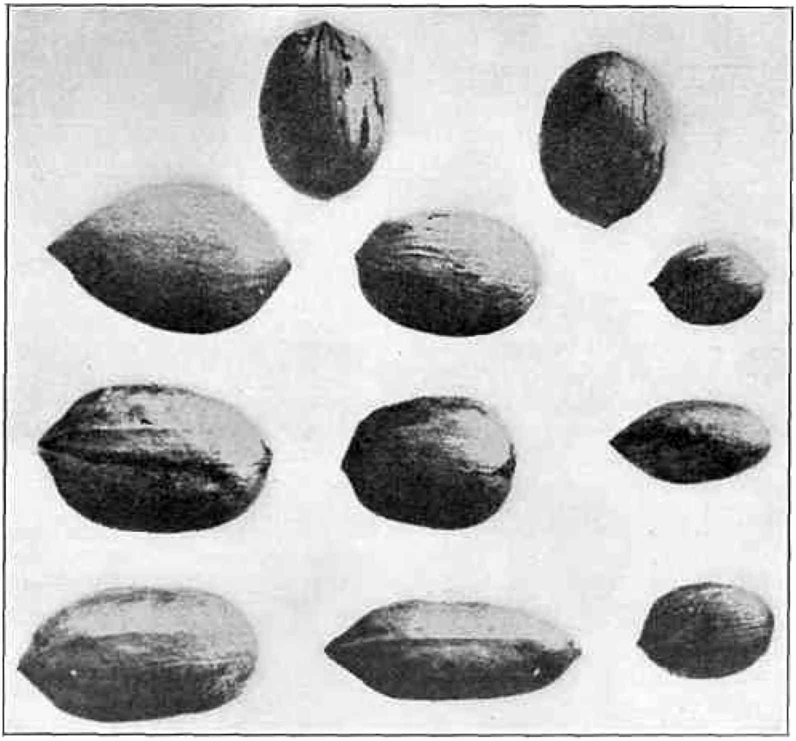


FIG. 90. *Top*. Some of the offspring grown from seeds from one tree. This picture proves the worthlessness of planting seedlings and suggests valuable results to be obtained by plant breeding. (Courtesy *Journal of Heredity*.)—FIG. 91. *Bottom*. Tree crop land. Rich hills of southern Ohio. Excellent for oaks, hickories, pecans, mulberries, persimmons, honey locusts, cherries, and many other crop trees. Land now almost unproductive. We have millions of hills like this. (Photo F. H. Ballou.)

bama. Altogether the area within these boundaries includes something over a half million square miles, including parts of thirteen states.[2]

Over this area there were many millions of wild trees. Mr. E. J. Kyle, Professor of Horticulture in Texas, claims seventy-five millions of wild trees in that state. For an unknown time these and previous millions of pecan trees have been producing hundreds of millions of pounds of nutritious crops. They went to decay or for the food of wild animals and to some extent to feed the American Indian.[8]

THE PECAN CLIMATE AND EXTENSION OF THE PECAN AREA

Pecan trees of great size bearing excellent nuts grow wild in the Ohio valley, but by chance the pecan received earlier and more attention in the South than in the North. Accordingly it spread more rapidly eastward through the South than through the North. As a part of the pecan mythology it may be stated that as late as 1910 the belief was widespread that the pecan would grow only in the South, and there was no reason to expect its expansion north of the Cotton Belt.[4]

This belief in Cotton Belt exclusiveness is an example of the ease with which patent error survives. For the first settlers of Illinois, Indiana, and Missouri found on their lowlands thousands of pecan trees from two to three feet in diameter and one hundred feet high. It was and is a common practice to leave them when clearing. Many stand in cornfields today. Stately pecan trees planted by George Washington in 1775 or-

[2] Illinois, Iowa, Indiana, Ohio, Kentucky, Tennessee, Missouri, Kansas, Oklahoma, Texas, Louisiana, Mississippi, and Alabama.

[3] During the régime of the tribal leaders in the old Seminole Nation in Seminole County, Oklahoma, they had a law that fined a person five dollars or more for mutilating a pecan tree. {*American Nut Journal,* August, 1927, p. 29.)

[4] That statement is still made by people who are supposed to be intelligent. *American Nut Journal,* April, 1927, p. 56.

nament the lawn of his home at Mount Vernon.[5] Large, beautiful, healthy pecan trees are scattered through northern Virginia, northern Maryland, and southern Pennsylvania, in a climate typified by that of Philadelphia.[6]

[5] According to the *Proceedings* of the Northern Nut Growers' Association, 1925, p. 98, Thomas Jefferson presented George Washington with some pecan nuts which he planted with his own hand around Mount Vernon, March 25, 1775. According to the late C. S. Sargent, director of the famous Arnold Arboretum, these trees, now respectively 86, 97, and 98 feet high, "probably have not lived out half their lives."

De Courset, a Frenchman who served with Washington, left a record that "the celebrated gentleman always had his pockets full of these nuts, and he was constantly eating them." It is amazing and also suggestive to know that Washington's fruitful diary speaks of them as paccane or Illinois nuts.

[6] I know a pecan tree near Hughesville, in Loudoun County, Virginia, forty-five miles northwest of Washington, at an elevation of five hundred feet, in a climate almost identical with that of Philadelphia, except that it has greater extremes of cold (—30° F.). That tree is about eight feet in circumference, eighty feet high, with a spread of seventy feet, bearing fruit and according to the oldest inhabitant of a generation now gone, it is about a hundred years old. A few miles away at the county seat of Leesburg there is another old pecan tree with a girth of eight feet four inches and with a spread of ninety feet.

Harry R. Weber, of Cincinnati, Ohio, reports a southern pecan tree about one hundred years old at Lebanon, thirty miles northeast of Cincinnati, girth twelve feet eleven inches, spread ninety-three feet, height eighty feet.

The Illinois origin of a perfectly healthy specimen at Mont Alto, Pennsylvania, altitude 1,100 feet, raises the interesting question of the origin of many of these northern pecan trees of great size.

"In the village of Mont Alto, Franklin County, Pennsylvania, a tree is growing with the following data:

Diameter breast high (D.B.H.) 22 inches; total height, 55 feet; clear length of trunk, 15 feet; height of crown, 40 feet; width of crown, 40 feet; age, 47 years.

"This tree bears fruit every year. The quantity is, however, small considering the size of the tree. The owner said the yield was about seven quarts above the amount that his own and his neighbors' children ate. I must admit that I would not wish to estimate the annual consumption by the children. I was told by a reliable person that this tree grew from a small tree that was brought from Illinois by a son of the then owner of the property. The son was later elected mayor of Quincy, Illinois, but as to whether he got the tree at or near Quincy, Illinois, I am not able to say." (J. L. Illick (now State Forester), Mont Alto, Franklin County, Pennsylvania, Pennsylvania Department of Forestry, State Forest Academy, June 5, 1915.)

A tree at Colemansville, Lancaster County, Pennsylvania, is nine feet, ten inches in circumference at two feet from the ground, stands on a rocky

Easton, Maryland, contains the largest planted pecan tree known:[7] girth (1920) 15 feet breast high; reach 129 x 138. In 1927 it measured 16 feet, 1 inch girth at 4 feet, 6 inches.

There is a pecan tree at Sayville, Long Island, on the estate of Morris J. Terry which is "45 years old, having a diameter of about two feet and bearing annually."[8]

In a park in Hartford, Connecticut, there is a pecan tree ten feet in circumference, perfectly hardy. It was planted as a nut in 1858 by Frederick Law Olmstead. It ripened at least one nut in the season of 1923.' It ripened that nut because Dr. W. C. Deming fertilized the blossom by hand with bitternut pollen, *a very significant fact.*

The pecan is a native of North America. Therefore, it is accustomed to spring frosts by hundreds of thousands of years' experience. Therefore, it sleeps late in the spring. Therefore, it can survive winters in places where the summer will let it ripen its fruit rarely or possibly not at all. Hence such surprising facts as these: (1) Thrifty trees at Michigan Agricultural College, East Lansing, grown from Iowa seed planted

hillside, and is reported to be bearing well. (Facts from J. F. Jones, Lancaster, Pennsylvania.)

[7] Information, C. A. Reed, U. S. Department of Agriculture,

On Spesutia Island in the Chesapeake Bay, latitude 39° 15' is "a giant one hundred and six feet tall. It has a spread of one hundred and ten feet. It has two limbs, respectively fifty-seven and sixty feet long, and is thirteen feet in circumference, three feet from the ground. It is an annual bearer of thin-shelled nuts that, though rather small now, are mighty good to eat."

"A seedling from this tree is eighty feet tall with an equal spread and is a particularly beautiful tree,—when I saw it there were two or three nuts on nearly every twig end. They are fair size too, very thin-shelled, and very pleasant-tasted." (Extract from newspaper article, by Wilmer Hoopes, Forest Hill, Md., information from Robert H. Smith, Spesutia Island, Perryman, Md., January 23, 1915.)

[8] *Long Island Agronomist,* published for a time by the Long Island Railroad.

[9] Information from Dr. W. C. Deming, long time Secretary of the Northern Nut Growers' Association. The tree would probably produce abundant crops except for a habit very common among pecans, namely that its pistillate blossoms do not mature at the same time as do its staminate blossoms.

by Liberty H. Bailey. (2) Trees grown from western Texas seed, latitude 35° 30', longitude 100° W. enduring —20° F. in latitude 39° in northern Virginia,[10] but not ripening seed. (3) Trees from Iowa seed ripening nuts at Lincoln, Nebraska. (4) Pecan trees thriving and ripening seed (rarely) fifteen miles north of Toronto, Canada; also trees from Georgia seed thriving in southern Ontario.[11] (5) Very surprising is a communication from J. U. Gellatly, Westbank, British Columbia *(American Nut Journal,* April, 1928, p. 65), reporting successful fruiting of good pecans five years after planting in the orchard. This is at an elevation of 1500 feet in the Okanogan Valley. (6) Most remarkable of all, perhaps, is a thrifty pecan tree at Fairhaven, Vermont, latitude 43° north, altitude 530 feet. This tree is the lone survivor of many attempts by Mr. Zenas Ellis, an enthusiastic private experimenter. It blooms, but being alone it does not set fruit. It is very suggestive breeding material.

All these facts go to show that the pecan has great possibilities as a shade tree in a large area where it cannot be a com-

[10] Shortly before the year 1900, Mr. Thomas Hughes, a schoolmate of mine, sent some pecan nuts from his home in Sweetwater, Texas, latitude 35° 20' north, longitude 100° 20' west, to Mr. A. B. Davis, nurseryman of Purcellville, Loudoun County, Virginia, Philadelphia climate. Trees from this seed seem to be perfectly hardy, but seldom if ever have time enough in which to ripen their fruit. When topworked to good Indiana varieties, they bear in four or five years and ripen the nuts nicely.

[11] James Neilson, Professor of Horticulture, Port Hope, Ontario, tells me of a thirty-foot pecan tree from Georgia seed growing on the farm of Theron Wolverton, Grimsby, Ontario; of one thirty-five feet in height at Simcoe, Ontario, on the farm of Lloyd Vanderburg, who brought the seed in person from Missouri; of a group of five trees at Richmond Hill, Ontario, thirty-five feet high, fifty years old, standing in sod with no attention, seed from southern Indiana.

Young grafted northern pecan trees are doing well and enduring ten degrees below zero on the farm of John Morgan at Niagara-on-the-Lake, Ontario.

Professor Neilson also reports, p. 25, Northern Nut Growers' Association Annual Report, 1923, pecan trees fifty years old, thirty-five feet tall, perfectly hardy on the farm of C. R. Jones, at Richmond Hill, fifteen miles north of Toronto, latitude 43.45° north. They rarely ripen, but in the year 1919 did do so. I have seen these trees. They are fine.

mercial dependence, but may produce an occasional crop. It is a beautiful and majestic shade tree, with alluring possibilities through hybridization.

Another piece of pecan mythology is to the effect that the pecan is limited not only to the Cotton Belt but to alluvial soil. Most people east of the Mississippi believed this in 1910. Perhaps this piece of mythology spread eastward from the West. It is true in the southwestern pecan country because in many parts of Kansas and Oklahoma and Texas natural tree growth is limited to the valleys,[12] beautifully pecan-bowered valleys reaching back with their long ribbons of green through the upland pastures of the hills yellow and brown with drought.

There was small reason for the people *east* of the Mississippi to believe the alluvium myth.

Mr. J. B. Garrett, Assistant Director in charge, North Louisiana Station, Louisiana State University, wrote me, July 22, 1913:

[12] In a large part of the Texas area good tree growth of any species is limited to the river valleys in an area where the upland is often too dry for agriculture or good forest. Indeed the river valleys of a great area in central and western Texas are forest islands nursed by the waters of the adjacent streams and nearly or quite surrounded by slightly arid land. In places one can stand on a plateau with a rocky shallow soil a hundred feet or more above the stream. On this height the rainfall of twenty or twenty-five inches will support only a scrubby growth of drought-resisting scrub trees, but from this point one can look down into the valley which a stream has carved from the plateau. Because of the moisture from the stream its banks and flood plain are covered with magnificent trees, among them tens of thousands of pecans. These pecan islands reach far back, almost to the headwaters of the streams that drain the Edwards Plateau in west central Texas.

William A. Taylor, Chief Bureau, United States Department of Agriculture, Washington, D. C, wrote me January 14, 1920:

"A cousin of my father, who located in what was then Tom Greene, a county of approximately the size of Massachusetts, told me thirty years ago that pecans were being wagoned to San Angelo from points 100 to 120 miles further up the north fork of the Concho and its tributaries. (Latitude 32° north, longitude 102° west.) . . .

"Seventy-five miles to the southeast of Sweetwater at Coleman, . . . and at Brownwood, a little farther east, it, the pecan, is or was altogether the dominant river and creek bottom tree twenty years ago, and I presume it is still a conspicuous feature of the landscape."

"We have scattering seedling pecans growing on all of the different types of soils in the state of Louisiana; and while they do not grow so large on the poor hill lands, some of them bear good quantities of nuts."

Testimony as to the upland growth of the pecan east of the Mississippi River can be piled up almost indefinitely.

A great many of the large trees of the North and East, including most of those previously mentioned, are on upland.[13]

In my experimental nursery on a slope of the Blue Ridge Mountains, fifteen miles southwest of Harpers Ferry, two varieties of pecans (Busseron and Butterick) bore well-developed nuts three years [14] after they were grafted. They did this in the cool season of 1926. Soil is one thing, but frost is another. Late frosts are as deadly to pecans as to most other blooming plants. Hence the following advice from one of the pioneer pecan experimenters, Mr. T. P. Littlepage, who has an orchard between Washington, D. C, and Baltimore, "Under no circumstances should northern nut trees be set on low land. The northern pecan on my farm is just as subject to frost as peaches or more so. As a result I do not think I will have a peck of pecans this year on thirty acres. But I am equally sure that were they on nice high peach land, the average successful crops would be equal to those of peaches or apples."

[13] Mr. B. T. Bethune, Georgia, wrote in the *Rural New Yorker,* February 3, 1912:

"In Middle Georgia in the 'Red old hills of Georgia' underlaid with granite, we have pecan trees more than three feet in diameter three feet above ground whose branches reach a height of seventy feet, with a spread of sixty feet, and which have born successive crops without a single failure for three-quarters of a century. . . ."

Elsewhere in his article Mr. Bethune speaks of a tree from which over nine bushels of nuts had been sold. "That tree grew on a poor ridge in the pine woods a few miles south of this city." Alas, I cannot learn what city.

"On the grounds of the Mimosa Hotel, near Tryon, North Carolina, there is a seedling pecan tree that bears well. The elevation is about 1,200 feet." *(The Pecan and Its Culture,* G. Harold Hume, p. 21.)

[14] These trees were eight to ten feet high and about one tree in fifty or sixty bore fruit.

THE IDEAL PECAN SOILS

The facts about the pecan seem to be that it was native to alluvium; therefore, having had opportunity to get food easily, it has not developed ability to fight for food in less favorable locations. The pecan, therefore, needs deep friable and moderately moist soil such as would naturally produce a forest of white oak, hickory, and walnut trees.[15]

With soil, as with probably everything else, continued experience will probably disclose new problems.[10]

A HARDY TREE

After fifteen years of experimenting with it and submitting it to many rough tests,[17] I find that the transplanted pecan

[15] W. C. Reed and Son, of Indiana, are pioneer experimenters with grafted northern pecans. They report as follows on their 1926 crop:

"Crop varied from twenty to fifty pounds per tree; think two trees bore seventy-five pounds each.

"Trees were planted twelve years ago on high clay land.

"They have been cultivated regularly.

"Were not fertilized, but were on good, strong land.

"Trees are from thirty to thirty-five feet tall."

Mr. Reed sold these nuts to nearby grocers at thirty cents a pound.

J. Ford Wilkinson, Rockport, Indiana, another pioneer, reports, letter, January 26, 1928, "My budded pecan trees growing on high-land clay soil are bearing remarkably well; in fall of 1926 transplanted trees from 10 to 13 years old produced from 25 to 85 pounds of nuts each, younger trees bore accordingly, some 5- to 6-year-old trees not transplanted produced from 5 to 10 pounds each.

"These trees are growing on good land, are fairly well cultivated, but have never been fertilized."

[16] "I am sending you the record of one row of eighteen trees that illustrates the utter impossibility of conveying precious facts briefly.

Year	10.	11.	12.	13.	14.
Average of first six trees	13.	28.	13.	22.	17.
Average of last six trees	½	3.	2.	3.	5.

"Here is the interesting fact that, because of the difference in the soil at one end of this row from that at the other, there is the difference of a profit or a loss. This difference was not to be discovered by the average man, for the land appeared to be much the same, and only years of careful observation have made clear the importance of selecting orchard soils with infinite care." (Letter, Mr. C. A. VanDuzee, Cairo, Georgia, May 11, 1927.)

[17] In 1916 I planted bunches of pecan seed and black walnut seed to-

tree needs distinctly more petting in its early stages than the apple tree. In contrast to this the seedlings are very tough.

The pecan can scarcely be called a tender tree. Once it is established its great root system makes it hard to kill.[18] Mr. Ford Wilkinson, of Rockport, Indiana, reports three-foot seedlings with roots nine feet long. Unfortunately the blossoms are not as hardy as the trees. I have not tabulated the record, but I have noticed that in some seasons a combination of weather factors will kill pecans, walnuts, and hickories, while apples and peaches come through with fair crops.

NATIVE PRODUCTIVITY OF THE PECAN

In its wild condition the pecan is a tempting tree. I am surprised that we have neglected it so long. It was an important asset to the early settlers of the central Mississippi Basin. In

gether in the blue grass (clay soil, good for about thirty-five bushels of corn per acre) along my upland lane in Loudoun County, Virginia, altitude 750 feet. They were not fertilized, cultivated, or in any way protected. It was a test. Both species were able to fight it out with the grass and make a high percentage of survival. In the dryer places it took the seedlings ten years to get five feet high, but they were very stocky and by the end of the decade they had begun to grow more rapidly. There is little doubt that most of the pecans will eventually become large trees if let alone. Where clumps of blackberry bushes invaded the grass, the trees are larger than the others. Grass is a deadly enemy to small trees and in some cases it may smother them fatally in the infant stage.

[18] An orchard of fine-looking trees has this history:

"This grove is located at New Harmony, Indiana, and was the first pecan grove planted in this state, and it has had a varied history. The seed was saved from a very fine pecan by John B. Elliotte of New Harmony and planted in the fall of 1876. Trees were grown in Elliotte's Nursery for two years and then planted in the grove by Jacob Dransfield. The first winter after setting the rabbits cut them all back to the ground. They came up nicely the next spring, and Mr. Dransfield, to keep the rabbits off, set a four-inch drain tile over each one, and as they grew and the wind switched them around, it cut every one of them off; so that the damage was the same as that done by the rabbits. Mr. Dransfield then gave it up. After the Ohio River had overflowed several times, he paid no attention to the trees for several years but cultivated the land in corn. The pecans, however, were not so easily gotten rid of and kept coming up each season until finally they let them grow and the grove is the result." (Letter, W. C. Reed, Vincennes, Indiana, June 19, 1916, who said information was from Mr. Elliotte's son and Mrs. Dransfield, who were still living.)

the valley of the lower Ohio, as in the vicinity around Evansville, there are almost solid forests of pecan. I have seen one tree there six feet in diameter; I have seen them towering twenty or perhaps thirty feet above the top of the white oak forest. This locality is one of many.[19]

Occasional trees are very productive and yield nuts of fine flavor. Mr. J. F. Wilkinson, of Rockport, Indiana, an intelligent and careful observer, says:

"I have gathered the crop from a particular tree four years

[19] "Up to four or five years ago wild pecan trees were very abundant along all the streams in certain sections in southwestern Missouri, particularly Bates County. They were so abundant that it was the practice of many rural residents to harvest the pecans in the fall by cutting down the trees. . . . In many a wood-chopper's cabin these wild pecans filled an important place in the dietary of the family. The same was true with the early settlers along the bottom lands of the Missouri and the Mississippi Rivers in the state of Missouri. Within my own recollection I have known cases where families looked upon their winter supply of nuts, including the wild hazel nut, black walnuts, and pecans, as necessities rather than luxuries. Of course, this order of things is entirely changed now except in remote regions." (Letter from W. L. Howard, Assistant Professor of Pomology at the University of California, January 16, 1917.)

Professor C. J. Posey, University of Kansas, tells me that between 1881 and 1886, when he was a boy, on the Kaskaskia bottoms fifty miles east of St. Louis, the land law was that each man had to fence his own crops against roving stock. The bottoms were open, chiefly wooded, and it was customary to let the hogs run. The farmers would gather up the sows and pigs in the spring before the young had left their mothers. Each owner marked his own with his particular brand, usually nicking their ears. He would let them run, giving them a little feed so that they would stay within reach. In the autumn the young were nearly as wild as deer and were sometimes ready to be slaughtered without feeding but were fed a little at the edge of the clearing to keep them within reach.

"With a little corn for bait, the farmer would go to the rail fence at the edge of the clearing and holler. With merry grunts up gallops your year's meat supply !"

No wonder the early settlers of Illinois settled in the timbered lands along the streams and thought the prairie worthless. (See J. Russell Smith, *North America,* p. 297.) By 1918 all this had changed. Each man had to fence in his own stock and waste became property.

As late as 1910 some persons known to Professor Posey were making ten dollars or fifteen dollars a day gathering pecans, then the nuts became so valuable that the owners began to keep the people away from their trees.

As boys Professor Posey and his brother gathered ten to fifteen bushels of hickory nuts in a day.

as follows: 1906—eight bushels; 1908—six bushels; 1910—twelve bushels; 1912—nine bushels; making thirty-five bushels in all. The tree is an every-other-year bearer, but has borne lighter crops of from one to three bushels in its off years; and as far back as I have known the tree, it has borne a good crop every other year and a light one between. After 1912 the land changed hands and the owner has gathered this tree, but kept no definite record except the crop of 1922, which was 600 pounds." This tree was 90 feet high, 100 feet spread, trunk four feet in diameter. An acre could only hold three of them.

Such trees are not very common, but there have probably been thousands like it; and there are now probably hundreds of them alive and bearing at this moment.

An observer in Texas says, "Native trees here have a habit of producing a full crop about once in two years. Many native trees have a record of over five hundred pounds' production in one year." [20] Claims apparently authentic are made for trees that yield a thousand pounds and even more.[21] The variation in the yield of supposedly meritorious trees under definite test

[20] F. R. Brison, County Agent, Coöperative Extension Work in Agricultural and Home Economics. San Saba, Texas, letter, February 14, 1925.

[21] Mr. M. Hull, Assistant Horticulturist, Louisiana State University, reports in *American Nut Journal,* October, 1926, p. 57, that a pecan tree twenty feet in circumference, at waist height, is one hundred and fifty years old, has a spread of one hundred and thirty-two feet, and has borne approximately sixteen hundred pounds of nuts in one season.

It grows on the farm of G. B. Reuss at Hohan Solms, Louisiana, about thirty miles south of Baton Rouge. The local postmaster said, with apparent sincerity, that it had borne twenty-seven hundred pounds. (Information, Mr. C. A. Reed, U. S. Department of Agriculture.)

In 1925 Mr. Felix Hermann went before a notary at Bexar, Texas, and swore that he had gathered twenty-two hundred pounds of pecans from a tree with a spread of two hundred and twenty feet. Commenting on this, Mr. F. W. Mally, County Agent, at San Antonio, who had not seen the tree, said, "However, I may say that while this is more or less an exceptional tree, there are a great number of very large pecan trees along the banks of the rivers in this territory. Whether they are as large as this one is not known because they have not been measured. It is not unusual for many of these large trees to produce from twelve to fifteen hundred pounds of nuts in a season, and they would probably reach a ton if they were all gathered and weighed."

is truly astounding, ranging in North Carolina from 17 pounds to 1,246 pounds per acre.[22]

It is not surprising that man should have a desire to start an industry when Nature has given such object lessons all the way from Indiana to Texas and from Texas to Georgia.

THE PECAN INDUSTRY STARTS

The pecan industry started with wild produce, and wild nuts are still marketed in large quantity, larger quantity than the produce of the grafted orchards.[23]

Texas with her millions of pecan trees is easily the leader at the present time, although Albany, Georgia, with a million

[22] Results of pecan variety test at Lower Coastal Plain Station, Willard, North Carolina.

Table 2—Yield Per Acre Per Year (Trees Planted 1906-07)
(Calculated on Basis of 27 Trees to the Acre)

Variety	*No. of Trees*	*1918-17 6-year Period*	*1918-22 5-year Period*	*1923-27 5-year Period*	*1918-27 10-year Period*
Stuart	28	19	327	386	357
Schley	19	47	68	285	177
Van Deman	17	6	56	133	95
Frotscher	20-3	145	666	1012	839
Sweetmeat	1	33	1046	1437	1246
Teddy	3	7	21	13	17
Moneymaker	2	*37*	537	1008	773

"These trees have been planted in typical soil in the particular sections and have been given good commercial orchard attention such as cultivation and cover crops but have not received commercial fertilizers." (Letter, C. D. Matthews, Chairman, Department of Horticulture, North Carolina State College of Agriculture and Engineering, Raleigh, February 4, 1928.)

[23] In the fall of 1926 one hundred and twenty carloads of wild pecans, worth $500,000, were shipped from Gonzales, Texas. They were gathered along the San Antonio River and other streams near by.

"There were more than a hundred people employed for several months this past winter and spring in picking and assorting pecans at Durant, Oklahoma.

"It is estimated that more than five hundred thousand dollars' worth of pecans were shipped out of the Red River valley last year, and that Durant handled half of the shipment from this territory." (Article on "Durant Nut Center," by John M. White, County Agent, in *The Oklahoma Extension News* published at Stillwater, Oklahoma, September, 1927.)

grafted trees of bearing age within fifty miles, is the greatest single center.

Before the last quarter of the nineteenth century all attempts at propagation were limited to planting seed, a practice that notoriously results in fruit unlike the planted seed [24] (Figs. 88 and 90). Then came the conquest of the technique of grafting and budding. This was acquired for pecans before it was for other nuts. Promptly thereafter the pecan industry started almost like a conflagration. Rundown cotton plantations were cheap and crops of cowpeas, velvet beans, and peanuts quickly restored the soil. Some of the early pecan plantations were carried at almost no cost by hogging down crops of legumes and corn and oats.[25]

Grafted and budded pecans were planted by the ten thousands during the first fifteen or twenty years of this century. Some of them were planted by near-swindlers who worked something like this:

(1) Get the record performances of individual trees such as I have quoted.

(2) Take a lead pencil and figure on a basis of the biggest yield that ever happened on the best tree on record.

(3) Let the prospectus show a similar yield for each of twenty trees to be planted on an acre of ground.

(4) Have it happen every year, beginning very early.

(5) Sell the nuts at a pleasing imaginary price.

The figures are indeed impressive if one does not see the following fallacies. The trees do not bear as early in orchards as on paper, or as often, or as much, and it is quite impossible

[24] Mr. H. Fillmore Lankford, Princess Anne, Maryland, said, "The nuts from my large tree are delicious, as I have said, but nuts grown from seedlings from this tree in some cases are as bitter as quinine, and in other cases are as sweet as the nuts from the parent tree."

[25] Careful and intelligent experimenters are working at this problem, and I believe the pecan orchard may eventually have all costs but harvest and fertilizer carried by the pig that pastures beneath and beside the pecans—one or two trees to the acre, page 211.

for twenty full-grown pecan trees to be accommodated on an acre of land. The pecan tree reaches proportions so gigantic that an orchard of trees as large as the largest reported would require more than an acre of ground per tree; yet the first planters put in twenty and often more.[26]

[26] "It is almost a universal mistake to put pecan trees too near together. Your idea of having sufficient room for the top of the tree to have sunshine is the correct one. I believe that a good idea is to put trees sixty feet apart, which will make twelve trees to the acre. When these begin to crowd, remove each alternate diagonal row and the trees will be left equally spaced with six trees to the acre. For mature trees this is enough. Furthermore, it is as much as the moisture and fertility of the soil will sustain." (Letter, Wight Nursery and Orchard Company, Cairo, Georgia, July 8, 1927—J. B. Wight. Mr. Wight is one of the leaders and pioneers in southern pecan growing.)

"The pecan is the largest-growing nut tree under orchard cultivation. The average spread of the ordinarily big pecan trees fifty or more years old, favorably located, is probably one hundred to one hundred and twenty-five feet, although maximum trees of materially greater range are not unusual." (*Yearbook,* U. S. Department of Agriculture, 1926, pp. 571-72.)

Two such trees could not stand and thrive and bear on an acre. They must have sunshine on every branch.

As long ago as 1914 some bona fide growers began planting four trees to the acre, realizing that four big pecan trees would require that much land.

"My opinion is that at twenty years pecan trees will require at least one-eighth of an acre, and more would be better; at thirty years one-fourth of an acre, and soon after that one or two trees to the acre would be quite enough.

"By cutting out every other diagonal row of a fifty-foot planting we have about eight trees left, and by cutting out the alternate trees we would have four. Later on one or more of the least desirable might be removed. I feel that we are suffering greater loss today from crowding in our older orchards than we realize." (Letter, Judson Orchard Farm, Cairo, Georgia, July 24, 1927. C. A. VanDuzee, M.D.)

As factual basis for this conclusion, Dr. VanDuzee, who has kept an amazing lot of actual tree records *(facts)* gives the following:

"The outside row (23 trees) has the adjoining field to extend its roots into and is exposed to sun and sky on that side; its roots are out in the field one hundred feet; it gave us 3,744 pounds of nuts during the last five years under my care.

"The second row, which divides the fifty-foot space between it and the first row and a similar space between it and the third row for its root pasture, gave us 1,745 pounds of nuts during the same period of time.

"These trees are of the same variety, were planted at the same time, and received practically the same treatment; each tree in the first row has occu-

THE PECAN SWINDLE

A national magazine had in June, 1910, as part of a full page advertisement the following:

"Surest Pecan Land. A pecan grove of five acres nets $2,500 yearly. No work—no worry—no loss of crop and little cost of upkeep. . . .

"The paper-shell pecan tree begins bearing at two years, produces fifty to two hundred pounds of nuts at seven years, and two hundred to two hundred and fifty pounds at ten years, increases yearly thereafter, and lives to the age of one hundred years in North Florida. Five acres will keep the average family in comfort the year round."

And the really curious part of it is that people bought their five acres with sweet and innocent faith.[27] For some actual facts of production see pages 211, 212.

It is of course not surprising that the yarns of the near swindlers' prospectus should have resulted in little but disappointment, with each of their acres with its twenty trees, a fabulous number, bearing a fabulous crop with fabulous regularity.

Indeed, figures are especially deceptive when one gets to multiplying yields per tree by a number of trees per acre. It

pied a root pasture of 6,250 square feet; the inside trees had but 2,500." (Letter, C. A. VanDuzee, Cairo, Georgia, August 11, 1927.)

In this connection I wish to suggest experiment with various stocks, for example such upland pecan stocks as are mentioned on page 202. Surely there is no shortage of heat, light, moisture, or fertility. The swamp pecan root is perhaps a poor feeder. Is there not a better stock?

[27] Another Chicago vendor of distant lands wrote me in 1912:

"From a careful investigation the following estimate seems to be a conservative one:

Age	*Per Tree*	*Per Acre*	*Per 5 Acres*	*5A. at 25c lb.*
Fourth year	1 lb.	20 lbs.	100 lbs.	$25.00
Eighth year	45 lbs.	900 lbs.	4,500 lbs.	$1,125.00
Fifteenth year	220 lbs.	4,400 lbs.	22,000 lbs.	$5,500.00
Twentieth year	350 lbs,	7,000 lbs,	35,000 lbs.	$8,750.00

is so easy to plant trees too close together both on paper[28] and on land. Individual trees perform wonders occasionally, but somehow when they are set out in rows and given a term of years, they fail to perform every year on the average as the rare genius tree does once in a while. George Washingtons really are scarce among men and among trees.[29]

Meanwhile the experts at the Georgia State Experiment Station have been sticking to it that one thousand pounds of nuts per acre would be a good average. This is a good showing at food production when compared with the results of pasture (page 268) or any other meat production or even with grain production (page 305). It is a rich agriculture, and we may expect more productive varieties in the future.

It is not yet time to say whether a well-placed northern pecan orchard can do as well as the southern. Perhaps it can.

Many foolish investors were swindled in the small-unit ab-

[28] There is no excuse for the man who takes a special tree as his basis for calculation of yield and then puts an impossible number of them on an acre.

[29] Colonel C. A. VanDuzee, Cairo, Georgia, reported at the 1912 meeting of the Northern Nut Growers' Association that the best Frotcher pecan out of four thousand trees in a two hundred and thirty-five acre plantation yielded eleven pounds in its seventh summer. I saw this orchard the next year growing great crops of cowpeas, peanuts, and corn and hogs, and the trees were in a thrifty condition.

One of the show trees of the South belongs to Mr. J. B. Wight, of Cairo, Georgia. It stands in a garden. It has all the room it can use. It has been fertilized without stint.

Dr. C. A. VanDuzee, of Cairo, Georgia, one of the keenest and best informed students of the pecan said of it (Letter, July 24, 1927):

"Mr. Wight's big Frotcher is the most fruitful tree I am familiar with. It was about eighty feet in height and breadth when I measured it a few days ago, and it is said to have given Mr. Wight a net income of over a hundred dollars on the average for each of the last ten years. It is estimated that the tree has a root pasture of two-thirds of an acre of fertile soil, and the clear space about it would average nearer forty feet than twenty."

One of the show orchards of the South belongs to Mr. Parker of Thomasville, Georgia. Mr. Parker's orchard, planted with twenty trees to the acre, of the same variety as Mr. Wight's, is in a friable soil, stuffed with cowpea humus. These are two petted prizes, a tree and an orchard of the Frotcher variety. The record of their production is furnished by the University of Georgia Bulletin, No. 82, and is as follows and gives a good sentee ownership enterprises of the southern pecan boom as they were with apples in the Pacific Northwest. That did not stop an honest and legitimate development of a large industry in the South, prosecuted by bona fide farmers who are looking after their crops as a farmer should.

This industry is of two kinds. East of the Mississippi orchards are planted. In Texas and Oklahoma bushy meadow pastures full of young wild pecans are being grafted and budded to good varieties. The pecan industry of the cotton country has reached the point where it promises crops of such large size that the great problem will be to find a market. An energetic national organization is struggling with this problem.

chance to compare the performance of the pet single tree and the trees in a pet orchard.

Mr. Wight's tree (planted 1892)		*Mr. Parker's 10-acre orchard (of 200 trees)*	
		Orchard	*Average per tree*
5th yr.	1 nut		
6th "	7 lbs.		
7th "	10.5 "	185 lbs.	.9 lbs.
8th "	13.5 "	210 "	1.03 "
9th "	27 "	1,137 "	5.69 "
10th "	16 "	699 "	3.49 "
11th "	45 "	2,698 "	13.49 "
12th "	80 "		
13th "	121 "		
14th "	131 "		
15th "	131 "		
16th "	96 "		
17th "	30 "		
18th "	169 "		
19th "	352 "		
20th "	196 "		
21St "	306 "		
22nd "	196 "		
23rd "	344 "		

According to the above quoted figures of Dr. VanDuzee, this tree is probably occupying one-half acre as effectively as four trees could. Its reach was 84 by 71 at twenty-one years of age.

Theodore Bechtel, Ocean Springs, Mississippi, reports a tree in his garden that averaged 115 pounds for the period of its 10th to 20th years and an acre *(one* acre among many) of 17 trees (success variety) 20 years and that bore 2,800 pounds in 1925.

FIG. 92. *Top*. A forest of oak (ilex) on a mountain in Majorca. One product is charcoal made by the continuous thinning and trimming necessary to keep it open as it now is for large acorn production—an acorn orchard. —FIG. 93. *Center*. A harmless-looking wash in a cotton field in the red clay hills of Georgia. Note that no cotton grows in or near it. All the top soil is gone—in a few years.—FIG. 94. *Bottom*. Close view of contour drainage ditches much used in south to stop field wash. The corn rows curve with the terraces which might with ease be lined with trees. (Photos J. Russell Smith.)

These three pictures suggest a combination of timber and grafted nut trees. The crop of timber first will make tall fruiting trees which will give maximum leaf (fruiting) surface.—FIG. 95. *Top*. Grafted chestnut tree seventeen years old assuming pole form when competing successfully with others in coppice. Man's hand is at one graft, another is just above the handkerchief on tree in the center.—FIG. 96. *Bottom Right*. Chestnut tree which had practically the pole form in 1897 but developed heavy growth of lower branches below the fork in trunk in eighteen seasons after light-robbing neighbors were removed.—FIG. 97. *Bottom L?ft*. Oak trees growing along a French roadside. Every few years the branches are cut off for firewood. Trees shaped like this and like Fig. 96 produce maximum bearing surface per unit of land. (Photos J. Russell Smith.)

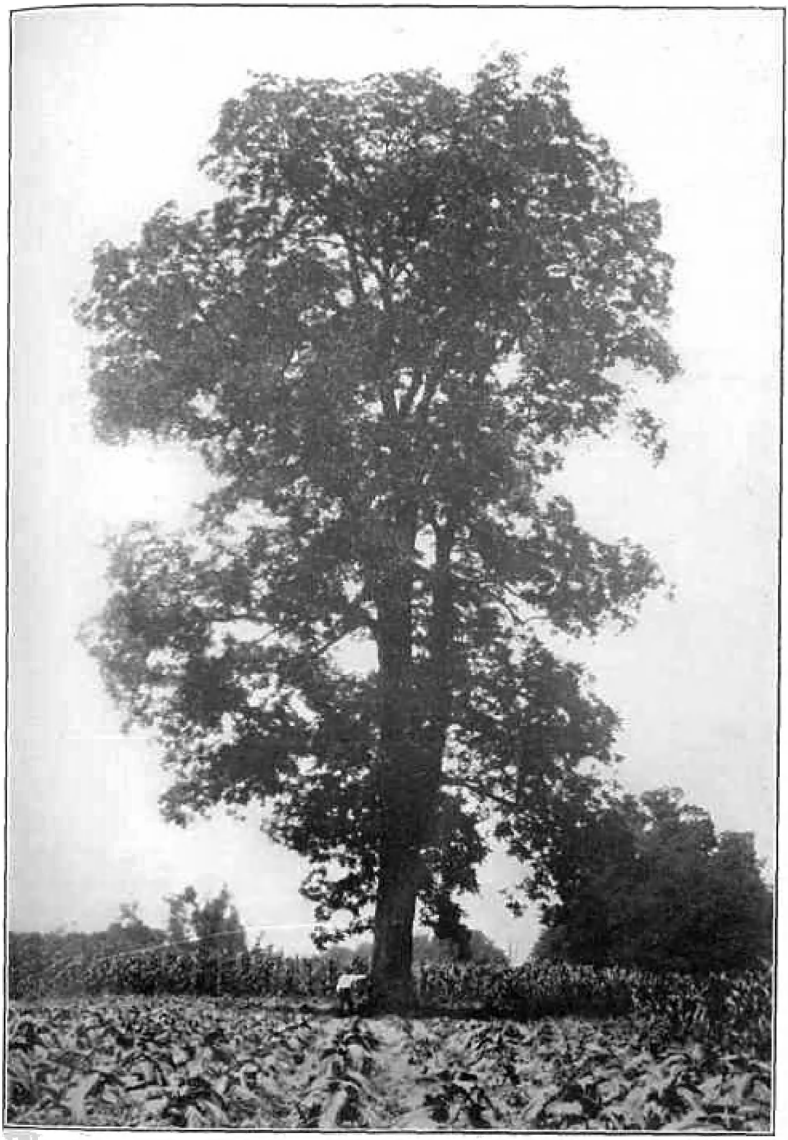


Photo J. Russell Smith

FIG. 98. This pecan tree standing in the field near Evansville, Indiana, shows the gigantic size. This tree is about 100 feet high, although there are some that are much larger. If you want your place to become a land-mark, plant pecan trees. They are good for 100-300 years.

FIG. 99. Fairbanks hickory, a hybrid (bitternut x shagbark) from Iowa, grafted to pignut, C. Ovalis. Large leaves are a part of the stock. Grafted 1918; photographed 1924; bearing good crop of nuts. Note the rocks. Blue Ridge Mountains. (Photo B. W. Gahn.)—FIG. 100. *Center.* Beaver hickory grafted on pecan, 94 inches first season. (Courtesy S. H. Graham.)—FIG. 101. *Right.* Typical wild shagbark tree; typical rocks; typical Appalachian pasture—thousands of such pastures. There might be millions more of the trees. Picture taken near Wilkes-Barre, Pa. (Photo J. Russell Smith.)

A NORTHERN PECAN INDUSTRY

The pecan industry north of the Cotton Belt is still in the pioneer stage. It had its start in the enthusiastic work of a group of tree lovers who lived down in southern Indiana, where the native pecans tower above the oak trees and produce nuts by the barrelful (page 205). These men[30] spent time and money scouring the river bottoms in search of the best tree among thousands. They have brought out half a dozen good varieties.

Another factor in the promotion of the industry has been the formation and work of the Northern Nut Growers' Association. It was started by people with an idea rather than an industry.[31]

This association has been the great repository and clearing house for information concerning nut growing in the North and any person thinking of planting more than one tree should join the association.[32]

After the Indiana pioneers had searched out parent trees of unusual merit along the Ohio and its branches, experimental grafting began. Since 1913 several nurserymen[33] have advertised grafted trees of northern origin, and the trees have been widely disseminated throughout the belt of marginal pecan territory from Connecticut through southern New York, Pennsylvania, Ohio, Indiana, Illinois, and southern Iowa and thence southward.

In almost every case these plantings have been a combination of ornament and experiment. They have proved that these

[30] Mr. T. P. Littlepage now at Bowie, Maryland, Mr. Ford Wilkinson, of Rockport, Indiana, Mr. Paul White, Mr. Robert McCoy of Lake, Indiana, the late judge Mason J. Niblack.

[31] Founded in 1910 in New York City by T. P. Littlepage, corporation lawyer, Washington, D. C.; Robert T. Morris, M.D., surgeon, New York City; W. C. Deming, M.D., Connecticut, John Craig (deceased), Professor of Horticulture, Cornell University.

[32] Henry D. Spencer, Secretary, Decatur, Illinois.

[33] Northern Nut Growers' Association has a certified list of nurseries.

particular varieties of pecan trees are hardy over most of the country where the climate is a good corn climate.

As to the bearing records, the trees of some varieties, especially the Busseron, show bearing habits that may be likened to the apple so far as precocity is concerned. Given reasonable cultivation and good soil, grafted nursery pecan trees come into bearing in from seven to ten years. Top-worked trees, where the cions are put on vigorous pecan stock, usually begin to bear in four or five years (Fig. 88). Such has been my experience with several of the Ohio valley varieties in the Philadelphia climate of northern Virginia.

The large numbers of these trees that are scattered over the middle North will tell us about the soil and climate necessary for the pecan tree. As trees, the Ohio Valley varieties, Butterick, Busseron, Indiana, Greenriver, and perhaps some others, have proved perfectly hardy at Cornell University, Ithaca, N. Y.

Unfortunately the preliminary conclusions from many of these experimental plantings may be necessarily harsh for the pecan because of its blossoming habits.

It seems true that some of the varieties, and possibly all of them, are incapable of *self*-fertilization. A tree may be wrongly condemned for sterility when it only needs a mate. In my own observation I have found that the Busseron and Butterick varieties are capable of fertilizing each other. A Busseron tree bloomed helplessly until a Butterick bloomed near it, after which both bore nuts. This seemed to indicate that experimenters should always have two varieties; and unless satisfactory reciprocal pollinating habits are known, it is better to have three.

In the light of experience people here and there are beginning to plant small orchards of northern pecans. The quality is quite as good as that of the southern and most of the varieties can be cracked by pressing them against each other in the hand.

BREEDING PECANS AND THE FUTURE OF THE PECAN INDUSTRY

In the named varieties of the pecan which we already have there are a number of great crop trees. Nearly all of these are of chance origin. But, like the walnut, the pecan is capable of improvement by breeding. Mr. E. E. Risien of San Saba, Texas, has crossed the San Saba pecan with other good pecan trees. Nuts produced from the resulting seed have shown 69 per cent. weight of meat after drying for six months.

The fact that the pecan hybridizes even in nature with several of the hickories[34] is extremely suggestive. If unaided Nature has produced such a surprise as the McAllister hiccan (Fig. 85) what may scientific breeding be expected to do? There is every reason to believe that breeding experiments can give us a much better lot of pecan and pecan hybrid crop trees for the different sections of the country.

Especially promising should be more crosses between the northern pecans and neighboring selected hickories.

PECAN REGIONS

We have four, if not five, distinct climatic areas, each of which should have its own group of pecan and pecan hybrids. First, and at present the most important because of the large commercial orchards, is the southeast of the humid part of the Cotton Belt. This region extends from eastern Texas to North Carolina. The dominant characteristic of the climate here is moisture and humidity. These are favorable to great development of fungi. Therefore, the trees for this area need to be particularly resistant to this enemy, for if the trees must be sprayed as apple trees are sprayed to keep the foliage effective,

[34] One of these hybrids, the Rockville (pecan x lacinosa, shellbark, not shagbark), native of Missouri, latitude 38° north, grew three feet on a bitternut stock in a Virginia Blue Ridge cove thicket, 1927, the year it was grafted. Another one, the Burlington, native of Iowa, has proved hardy (but not yet fruited) on pecan stock near Minneapolis.

great cost is added to production. It is time-consuming, difficult, and costly to spray a tree eighty or one hundred feet high and with eighty or one hundred foot reach.

The southwest pecan area,[35] including most of Texas and Oklahoma, has less rain, less humidity, less fungus activity, and more summer heat. Varieties may thrive here which could not thrive in the more humid East.

The northwest (Kansas, Iowa, Nebraska) section has very severe winters. Doubtless breeding from the best wild strains of that locality would produce good producing trees for 100,000 square miles of the western part of our Corn Belt.

The Ohio Valley region, which has given rise to all the varieties of pure-bred northern pecan now under cultivation, probably has better pecans in the woods than have yet been found and doubtless the proper combination of qualities, resultant from breeding, would give us many better trees than we now possess. For example, the Busseron seems to be the most precocious. Messrs. J. F. Jones, of Lancaster, Pennsylvania, and Ford Wilkinson, of Rockport, Indiana, and W. C. Reed, of Vincennes, Indiana, have repeatedly had them bearing in the nursery row the second or third year after grafting. I have had the same experience myself on the slope of the Blue Ridge Mountains in Loudoun County, Virginia. This precocity, combined with some tree that may be more productive or more regular in bearing or a more rapid grower or which ripens its nuts earlier, offers interesting possibilities.

Such improved trees have a possible area of usefulness covering a quarter of a million square miles in the large stretch of territory between the Mississippi River and the Atlantic

[35] Southern pecans have done well in the hot Southwest. Eleven Success pecan trees, twenty years old, owned by W. D. Tate, near Yuma, Arizona, have averaged one hundred pounds of nuts per year for eight years. This is on the deep and well-irrigated alluvial soil in the long hot summer with the Egyptian climate where the trees make unusually rapid growth and are thus far clear of all the enemies that beset them in the native and humid East. {*American Nut Journal,* July 1927.)

Ocean, and between the Cotton Belt and the Great Lakes, and below one thousand or fifteen hundred feet elevation.

Possibly a set of early ripening varieties of pecans and hybrids[36] can be produced in the Northeast, the section from central New Jersey and central Iowa to Massachusetts, southern Vermont, and southern Minnesota.

Who is going to breed these pecans and make these new engines for the production of fat and protein?

[36] There is Mr. Zenas Ellis's one pecan tree at Fair Haven, Vermont (page 200), waiting for the hand of the hybridizer, and also the many northern trees mentioned on page 200.

CHAPTER XX

MORE MEAT AND BUTTER TREES—THE OTHER HICKORIES

If any one knows of better nuts than some of the shagbark hickories of the northeastern United States, I beg him to write me at once and send me a few, for I wish to know this superior thing.

The hickories were food-producers of importance to the American Indian and are of great economic promise for scientific agriculture in the future. There are several reasons for this promise.

(1) There are many varieties. There are doubtless from one to five hundred varieties (perhaps thousands) of hickory worthy of commercial propagation now growing in the United States. I mean varieties in the horticultural sense, like varieties of peaches or cherries—a tree so good that an orchard like it would be valuable. I cannot prove this fact, but the following statements make it appear reasonable. Sargent[1] lists fifteen species of hickories, twenty-two varieties from a botanical standpoint and seventeen hybrids.

The truth is that the great Sargent scarcely got started on the hybrids. Mr. Willard G. Bixby, of Baldwin, New York, has more than that many hybrids in his nursery, and the J. F. Jones Nursery, of Lancaster, Pennsylvania, has rows of them which Mr. Jones made by crossing the two best trees known to him.

When one considers that there have been seven thousand named varieties of the one species of apple, my estimate of one hundred to five hundred varieties (perhaps thousands) of hickory may be too low, for we start with fifteen species scat-

[1] "Notes on North American Trees," *Botanical Gazette,* September, 1918.

tered over a million square miles and multiplied by an almost indefinite number of natural hybrids.[2]

As an elemental part in this variation the fruits of different trees vary in flavor almost as apples do. Even the squirrels race through tops of hickory trees to get to the particular one that they fancy.

The nuts vary in thickness of shell, shape of kernels, and in almost every conceivable way. Some of these wild nuts yield kernels in unbroken halves. I have no doubt that there are several thousands of such trees growing in America.[8] Some hickories bear fruit late, or sparingly, or rarely; others bear heavily and with considerable regularity. For example, the Pennsylvania hybrid tree called Weiker has a well-established record of twelve bushels at a single crop.[4]

The different varieties within the various species vary much in speed of growth, and furthermore the different species vary much in speed of growth. For example under given soil conditions a shagbark may make from three to nine inches of growth in a season while the bitternut will riot away with two or three feet and the pecan makes nearly as much as the bitternut.[5]

[2] Mr. Willard Bixby, of Baldwin, New York, perhaps the greatest authority on the horticulture of the hickory tree, reports as much as one hickory tree in thirty in certain Indiana forests to be hybrids. It was this locality that produced the McAllister (Figs. 19, 85). Every prize offered for better varieties of hickories brings forth a number of specimens which will deliver their kernels in whole halves. These are mostly shagbarks, but sometimes there are other species, and the total number of such trees in the United States even now must, I am sure, be several hundred.[3]

In 1926 the Philadelphia Society for the Promotion of Agriculture, Mr. George F. Curwen, Secretary, Villa Nova, Pennsylvania, offered prizes for the best hickory nuts and received at least a dozen that yielded kernels in unbroken halves.

[4] An Illinois correspondent writes: "This tree (a seedling of course) is the finest tree in our section of Illinois, and we have lots of bearing hickories here. This tree bears every year from three to ten bushels of splendid nuts." (Letter, C. H. Walter, Canton, Illinois, January 31, 1916.)

[5] The habit of growth among most shagbark hickories is a rush in spring. This ends with the formation of a terminal bud in about six weeks. After this no amount of coaxing or fertilization or cultivation will make it grow

(2) The hickory is a food tree of great economic promise, now that we have learned how to graft it and can make a hickory orchard just as we can make orchards of other trees.

(3) The hickory is a food tree of great promise because of the great geographic range of the genus. A single species, the delicious and beloved shagbark, grows in southern Maine, the whole of New York State, a substantial strip of Ontario, thence to southeastern Minnesota, southeastern Nebraska, eastern Texas, and eastward to the western edge of the Atlantic Coast Plain. It covers all or parts of thirty-three states.[6]

The mocker nut and pig nut, other species of hickory, cover almost the same area (page 221).

The bitternut, northernmost of all the hickories, has a range almost identical with that of the shagbark except that it reaches northward to Georgian Bay in Ontario, and to the tip of Lake Superior at Duluth in Minnesota. Sargent points out that it is common southwest of Montreal, and one of the commonest trees in the forests of western Ontario.

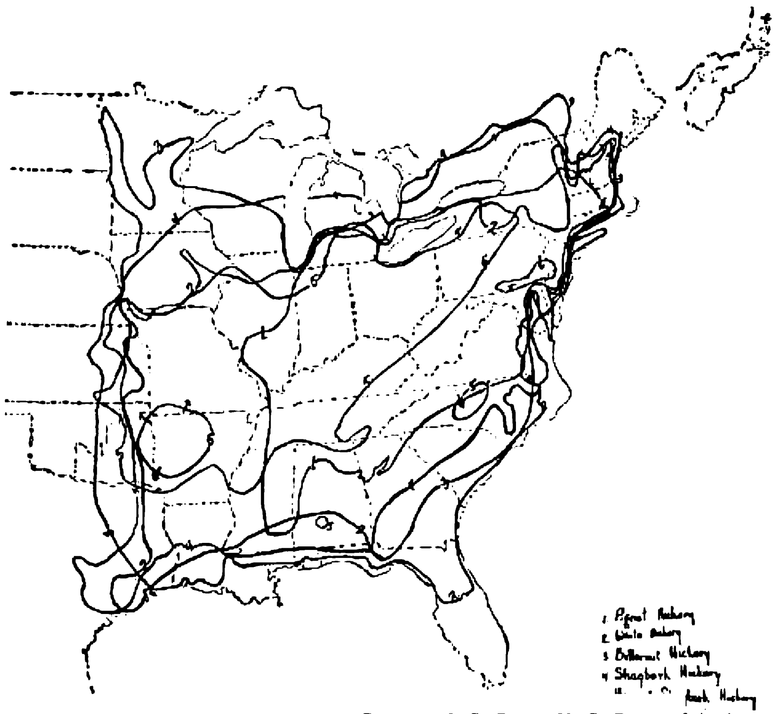
The other thirteen species of hickories grow in different parts of this territory. As a result almost any county may have from seven to ten or even more species at home, or capable of being at home, within its boundaries.

(4) The hickory tree is a food plant of great promise because of the great range of soil in which the different species can make themselves at home. Many of the species live in and

again until the next year. On the other hand the pecan species grows all summer; therefore, a horticultural disappointment results when the experimenter grafts pecans on hickories. They grow and make a nice foliage, but the pecan top is used to being fed all summer while the hickory root has the habit of doing most of its work in the spring. Therefore, the pecan top is underfed and comes through with little or no fruit or fruit of diminutive size. As a consequence the graft of pecans on hickories is of value only as a curiosity and as a means of making a quick climatic test of the variety. In some places it can be brought to fruit on an established hickory quicker than on the roots furnished it by a nurseryman. I have benefited by this fact in my own experimental work.

[8] See Forest Service Bulletin 80, *The Commercial Hickory,* pp. 23-24.

must have rich soil. But the mocker nut will grow in poor sand and gravel, and the bitternut, unwelcome because of its



Courtesy J. S. Betts, U. S. Dept. of Agri.

NATURAL RANGE OF FIVE OF LEADING SPECIES OF HICKORY

"Photostat copies of maps showing various species of hickory

1. Pignut (carya glabra)
2. White Hickory (carya alba)
3. Bitternut (carya cordifornis)
4. Shagbark (carya ovata)
5. Big nut shagbark (shellbark, carya laciniosa)

Note the extreme range of the bitternut and that the shellbark seems to avoid mountains and has outlying areas in Pennsylvania and in Carolina.

flavor, grows well on a myriad of high hills. Thus these two species offer great possibilities as stocks on which choice varieties which naturally have poor roots[7] can be grown on sand, gravel, and high hills.

(5) The hickory tree is a food plant of great promise because of the easy hybridization within the genus.

Hybridizing opens interesting and unpredictable possibilities of breeding varieties suitable for the particular needs of particular localities. Indeed, the hickories hybridize themselves with great freedom.

The hybrid is law unto itself, occasionally outdoing either parent. For example, the Weiker tree, a cross between ovata and laciniosa, has yielded twelve bushels, although a crop of three bushels is exceptional for trees of either of its parent species.

By this same independence and undependence of hybrids the tree grown from the seed of a hybrid tree is almost certain to be unlike the parent tree. The offspring tends to revert to combinations of the qualities of the two or more types that have been blended to make it, i.e., plant hybrid seed and you get the parents again. Therefore, each natural hybrid is unique and like those made by man it can only be reproduced by grafting, budding, or other vegetative reproduction.

The McAllister hiccan (Fig. 85), an Indiana hybrid with a nut often more than two inches long, raises speculation as to the wonders we may yet find in the forest or that we may produce by hybridizing, and we regret the many wonderful trees that have grown and perished and are perishing even in our day with no one to save them.

Now that grafting of nut trees has come to be a simple thing the hybrid is at our service to become the foundation tree of a particular variety, just as all the Baldwin apple trees have come from one original foundation tree. A number of these

[7] This process of getting roots to fit a particular ground condition has been tried many times. For example, the British gave up growing cinchona in Ceylon because the good variety did not thrive. The Dutch are growing it in Java with the same good variety grafted on stocks of a rank-growing but almost worthless variety of cinchona.

hybrids are growing on the grounds of experimenters, and some are for sale in commercial nurseries.

This phenomenon of hybridization opens a field of utility for the bitternut. Save for one disadvantage this bitternut is magnificent. I well remember the first one I saw. The ground beneath a majestic pasture tree was littered with large, white, plump nuts. The shells were so thin that I could crack one by pressing it between others in my hand. The rounded lobes of fat meat looked like brains in a skull.[8]

To the taste my pretty white nuts were as bitter as dead sea water; but nature alone and unaided hybridizes bitternuts and shagbarks, and some of them are sweet and very good to eat.[9]

The Fairbanks, one of these shagbark x bitternut hybrids, differs from its shagbark parent by growing much more rapidly than shagbarks usually grow and bearing much earlier than they usually bear. We may expect to wait eight to ten years for fruit from grafted transplanted shagbark.[10] I have had Fairbanks fruiting in the third year on bitternut stock

[8] I carefully weighed some of these nuts and meats and their shells and found that as they came green from the tree they were 52.4 per cent. meat. This is nearly as high as the southern pecan which ranges from 50 to 60 per cent. Mr. Bixby reports the Vest shagbark tests 49 per cent., the Kentucky 47 per cent., the Triplett 46 per cent., while pig nuts bought in the market by Mr. Edward B. Rawson, of Lincoln, Virginia, yielded 25 per cent. meat.

[9] Of one such tree, the Fairbanks, Mr. S. W. Snyder, of Iowa, ex-President of the Northern Nut Growers' Association, says, "Regarding the Fairbanks hybrid hickory, will say it is one of the best bearers to be found among the hickories, that is, as it grows here. The parent tree has had a wonderful record in the production of nuts. Mr. Fairbanks informed me at one time that the old tree had not failed in a full crop in a period of twenty years; and what is considered a full crop for it is something remarkable for a hickory tree, as it bears considerably heavier than the average variety of hickory." (Letter, Center Point, Iowa, January 19, 1927.)

[10] "I have had quite a lot of experience in grafting hickories. . . . Shagbark upon shagbark I found usually took about eight or ten years to come into bearing. The only perfect results I ever had in grafting was when I found three or four stocks along an old stone fence. These I think were from an old 'pig nut,' as one formerly stood near by. I cut the cions in early April and cleft-grafted them at once; all took and made wonderful growth

growing in an uncultivated field [11] on top of the Blue Ridge Mountain in northern Virginia. Dr. W. C. Deming reports that several pure shagbarks have borne in three, four, five, and six years when topworked on vigorous stocks.

The subject need not be expanded to one who has read this book. Searching out the best wild hickory trees now growing in America would give the basis for a profitable industry. I am sure that my two-hundred-acre farm would furnish me a competence if it had on it a full stand of mature hickories as good as the best now growing wild. With two hundred acres of such trees I could live at ease, have a servant, a secretary, and a good automobile.

By hybridizing we can get much better trees; therefore, the need is to search to get the best wild trees and then employ a staff of men to test and breed.

THE FUTURE SERVICE OF THE HICKORY TREES

The past services of the hickories suggest their future. For one thing they have helped produce the mast that has fattened the hog of the American frontiersman.[12] They might again render this service, but their excellence for human food probably puts the forage crop of improved hickories forward into a different agricultural epoch from that of the present. It is not likely that the hickory can compete with the oak

four or five feet annually. One bore nuts in the third year, and the others fourth or fifth. . . .

"I have found that by spading in some well-rotted manure and later sprinkling a few handfuls of bone meal with a little bit of nitrate of soda and extensive cultivation, one can push the shagbark along tremendously after it has once become established." (Letter, Harvey Losee, Upper Red Hook, New York, to Willard Bixby, April 19, 1919.)

[11] I do not want to stampede people into growing the Fairbanks. There are better hybrids, I think. I merely mention it to illustrate the point about breeding hybrids.

[12] "Hickory nuts have very hard shells but excellent kernels with which, in a plentiful year, the old hogs that can crack them fatten themselves and make excellent pork. These nuts are gotten in great quantities by the savages and laid up for stores of which they make several dishes and banquets." (Lawson, *History of Carolina,* p. 98, quoted in Sargent's *Silva,* Vol. VII, p. 133.)

in weight of pork per acre. We should not forget that the acorn like the chestnut is solid meat.

The past use of the hickory as food by the American Indians and colonists is still more suggestive of its future use. Hickory cream formerly made by the Indians may possibly be made again in this age of machinery. Sargent[13] thus describes it by quoting William Bartram's *Travels in North America.* "The fruit (of the hickory) is in great estimation by the present generation of Indians, particularly Juglans exaltate, commonly called shell-barked hickory. The Creeks store up the last in their Towns. I have seen above an hundred bushels of these nuts belonging to one family. They pound them to pieces and then cast them into boiling water, which after passing through fine strainers preserves the most oily part of the liquid which they call by a name which signifies hiccory milk. It is as sweet and rich as fresh cream and is an ingredient in most of their cookery, especially hominy and corn cakes."

The Indians sometimes crushed roasted sweet potatoes in this hickory milk as a kind of gravy, and hickory nut oil from the shagbark seems to have been a staple article of diet in the Virginia colony.[1*]

Partly evaporated hickory milk keeps a long time in jars, a quality of great importance for food.

We think of the hickory nut kernel as being troublesome to pick from the shell. For most wild varieties this is true, but in this day of machinery it appears to be a simple problem in chemical or mechanical engineering to work out the technique

[13] *Silva,* Vol. 7, p. 133.

[14] See Robert T. Morris's *Nut Growing.*

Further testimony—"The wild wallnut or hiquery tree, gives the Indians by boyling its kernel, a wholesome oyl, from which the English frequently supply themselves for its kitchen uses. Whilst new it has a pleasant taste, but after six months, it decays and grows acid. I believe it might make a good oyl, and of as general an use as that of the olive if it were better purified and rectified." (Thomas Ash, *Carolina, or a Description of the Present State of that Country,* p. 12, quoted by Sargent, *Silva,* Vol. VII, p. 133.)

whereby we may imitate the cider mill, shovel the nuts into a machine, crush them, extract the oil by mechanical processes, and bring the hickory oil or hickory cream or hickory butter into competition with cow's butter, olive oil, coconut oil, corn oil, lard, goose grease, tallow, margarine, et cetera, as food fats of the future.

Meanwhile hickory nuts are still delicious for eating by the fireside, for dessert, and for candies. But they cannot rival the black walnut as the standard for general cooking purposes.

For agricultural uses see Chapter XXIII.

CHAPTER XXI

SOME SUGGESTED LINES OF WORK—THE UNEXPLORED REALM

This book makes no attempt at being the last word on any topic. Its avowed purpose is to convince persons of creative intellect that there is a great field meriting scientific experimental exploration. The preceding chapters have attempted to establish with some degree of thoroughness some idea of the importance of certain fields for work. A tree crop may receive considerable space, but that does not necessarily mean that it is of more ultimate importance than some others which have received briefer treatment or have even been omitted altogether. The limitations of time and space have prevented me from covering the whole field with uniform thoroughness. Therefore, some of those which appear to have been slighted may, after a few decades of experimental work, prove to be more important than some which have received more space.

This chapter makes brief mention of a number of possibilities—mere suggestions.

I. THE BEECHNUT

The beeches (fagus) are a northern member of the mast family, as the chestnut is a southern member of the same family. In Europe the chestnut has taken the Mediterranean shores and the beech tree those of the Baltic. In America the chestnut has taken the Appalachian upland and the beech those of New England and southern Canada.[1]

[1] The beech tree like spruce and pine runs down the Appalachians with the cold climate of its high elevation.

"The people fence their wood land with woven wire and when the beech crop hits they are ready to buy hogs and turn them in about the middle of

The abundant nuts of the beech tree have helped to make the hog what he is. Beechnuts have long been important in Europe as food for the wild boar of the forest and for the semi-wild hog of Europe. The oil from beechnuts is used as a substitute for butter. The residue makes a good food element for animals.

As encouragement for those who might consider making a beech tree capable of producing a modern commercial crop I cite the following fact. The search of Dr. Robert Morris and Mr. Willard G. Bixby for beechnuts large enough to merit experimental propagation has resulted in the discovery of specimens (varieties) of the American beech varying much in size. This fact is promising for the plant breeder.

There are a dozen species or more of the beech. This fact is also promising for the plant breeder. Along with these two things we should keep in mind what has happened to the Persian walnut (see page 164) as a result of being propagated by man.

The beech tree can be grafted. This fact has given us the ornamental purple beeches. In the future it may give us wide expanses of grafted beech trees stretching over the unplowable stone-lands of New England and furnishing forage for beechnut bacon, dessert nuts for the table, and oil material for the kitchen of the future housewife.

Thus far scientific agriculture seems to have utterly neglected the beechnut.

2. THE PISTACHE

This choice dessert nut is gathered wild in southern Turkey and in other widely scattered locations, and for many years it has been an article of commerce. For a long period of time unusual specimens have been propagated by grafting and

November. In this way there are thousands of pounds of meat made in this country." (Letter, G. T. Shannon, Willow Shade, Kentucky, December 19, 1915.)

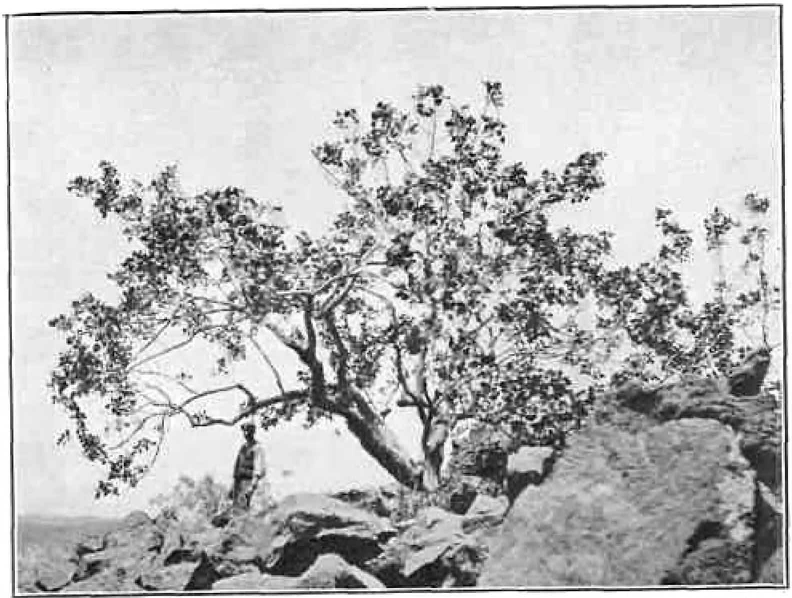


FIG. 102. *Top*. Pistache tree on the Lord Nelson estate on the slope of Mt. Etna, Sicily, growing on a tumble of volcanic bowlders where dirt is rarely visible. The occasional crops were worth $20 gold at prices for 1900-1913. (Photo J. Russell Smith.)—FIG. 103. *Bottom*. These gigantic pistache trees growing in South China, taken in combination with the growth of the tree in Turkey and Mediterranean countries and Kansas, indicate wide range and great adaptability of the species. (Courtesy U. S. Dept. Agr.)

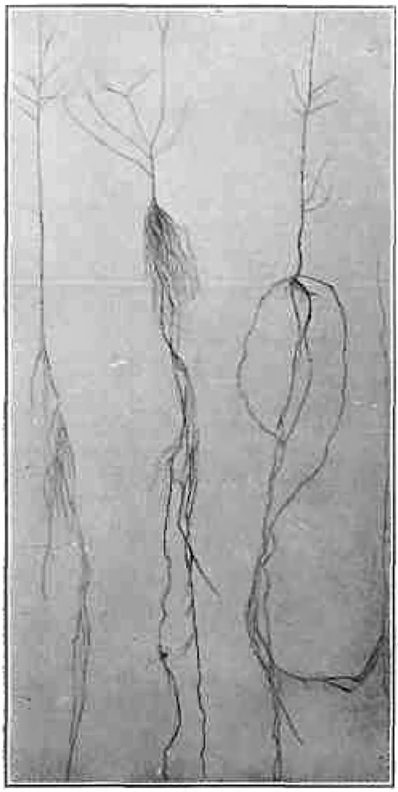


FIG. 105. *Bottom Left*. Almond seedlings nine months old. Largest top sixteen inches long. Root (11 feet) helps explain ability of this species to withstand drought. California trees often have roots 12 to 25 feet down. (Courtesy B. G. Brown, Orono, Maine.)—FIG. 106. *Bottom Right*. Byzantine filbert tree growing in park at Rochester, New York. A beautiful shade tree, also nuts. (Courtesy William C. Deming.)—FIG. 104. *Top*. Wild piñon landscape near Santa Fe, Mexico. (Photo Everett Rodebaugh.)

budding. The great superiority of these few unusual varieties of unknown origin is suggestive of further improvement of the species.

The pistache is a tree having wide climatic adaptation. Commercial varieties have been introduced in the United States from Italy, Sicily, Algeria, Greece, and Afghanistan. Other varieties have been introduced from Palestine, Syria, Libya, and France, and also from China, whose climate differs greatly from that of the other countries. The fact that the pistache comes from Afghanistan and from China as well as from Mediterranean countries[2] indicates a wide area of possible adaptation in the United States.[3] Mr. Merrill W. Isley, an American missionary in southern Turkey, told me that the tree grows wild in an area one hundred miles by one hundred miles near the northeastern corner of the Mediterranean Sea just north of the present boundary of Syria. There on the mountains the pistache tree grows wild as the scrub oak grows wild. It has survived and made profit on what perhaps is the roughest land used for agriculture anywhere in the world. (See Fig. 102.) The tree seems to thrive on thin soils, especially on that underlaid by limestone. It can cling in the crevices of rocks where there is almost no soil to be seen. Mr. Isley tells me of land in Turkey where it is so steep that only goats and men can climb there, yet the diligent Armenians had there grafted the pistache trees and were establishing valuable orchards before the desolations of the World War.

The pistache tree has two habits that are rather discouraging to the commercial planter. Mr. Isley reports that his orchard of seedling trees grafted in place required fifteen

[2] Mr. Hernando be Soto, U. S. Consul at Palermo, reported March 14, 1913, that the pistache in Sicily prefers an elevation from four hundred to eight hundred meters (1,312 to 2,624 feet).

[3] Reported thriving at Nucla, Colorado, 5,800 feet altitude, on the grounds of U. H. Walker. {*American Nut Journal,* June, 1926.) Also 40 miles west of Wichita, Kansas. (Letter, Merrill W. Isley.)

years of cultivation before producing commercial crops. This was on land good for grapes and wheat but subject to the very dry summer of the Mediterranean climate. The pistache also has very irregular bearing[4] habits. Mr. Isley states that in his Turkish pistache country the trees will be loaded with fruit once in five, six, or seven years.[5] In other years the trees commonly set full crops, but the nuts drop off. In view of the fact that the trees are male and female, it is perhaps possible that the dropping could be overcome if the planters were to provide pollen-bearing insects to fertilize the trees.

My own observation and my interviews with pistache growers on the rocky lava slopes of Mt. Etna in Sicily confirm Mr. Isley's Turkish data in every respect—wild trees in rough places; grafting to improve strains; spasmodic bearing with rarely a heavy crop.

Fortunately the nuts keep well, so well, in fact, that in Turkey before the World War the Ottoman Bank would lend heavily on bags of pistache nuts.

3. THE NUT-BEARING PINES

Dr. Robert T. Morris in his book on nut growing[6] makes some statements that give one a shock. For example, he says

[4] March 14, 1913, Mr. Hernando De Soto, U. S. Consul at Palermo, made a special consular report (unpublished, I believe) emphasizing the great irregularity of the pistache yield. He reported that well-set land would yield on the average six to twelve bushels of green pistachio nuts per acre per year, and that a fair value of this at that time was four dollars per bushel green. Each bushel yielded twenty-five pounds of nuts for which sixty to eighty cents was then the fair average value, although at times they went to higher figures. The value of such an unplowable plantation with eighty to one hundred and twenty trees per acre was put at two hundred and forty to three hundred dollars per acre. Without trees it was worth forty to sixty dollars per acre.

Mr. Edward I. Nathan, U. S. Consul at Palermo in 1927, reported (letter, September 21) that the acreage was about static and that prices that year had ranged from two to four dollars per kilo.

[5] I was told the same thing by the very intelligent English manager of the Lord Nelson estate at Bronte on the western slope of Mount Etna in Sicily.

[6] Robert T. Morris, *Nut Growing,* Macmillan.

that research has led him to place the nuts in the pine cones near the head of the list of nut food for human use. He thinks that even now pine nuts are second only to the coconut.

This statement is open to question because it is difficult to estimate the amount of crops that are consumed where produced and for which no statistical record exists. To strengthen his conclusion Dr. Morris states:

(1) That he thinks there are thirty species of nut-bearing pines to be tried out between Quebec and Florida.

(2) One species, the bunya bunya pine, produces nuts the size of the average English walnut. Others grade on down to a nut the size of a grain buckwheat.

(3) The pine trees with their wide array of species produce nuts with a wide variety of edible qualities. (See table, page 304.) Some of them are sugary and sweet.[7] Many are rich in both protein and fat.

(4) Some of them have the quality, less common among the nuts, of furnishing starch. For example, the araucarias of the southern hemispheres long furnished a starch food to the natives of South America, South Africa, and Australia.

(5) Many of the pine nuts are good when eaten either raw or cooked. Starchy varieties must be cooked. Some of the oily kinds may be covered with water and then pressed, thereby yielding a thick milky substance which can be kept for a long time and which is essentially a substitute for meat.

A few facts about one of these pines may serve to show that this genus merits the attention of the botanical creators.

The piñon (pinus edulis) of southwestern America can be seen displaying its virtues to good advantage in the vicinity of Sante Fé, New Mexico, in a climate that is hopeless for agriculture without irrigation and where pasture is of low

[7] The sugar pine (pinus lambertina), that lordly timber tree of the Pacific Coast, bears a nut rich in sugar and oil. Its sap evaporates, leaving a solid sugar.

yielding power. There the piñons raise their beautiful heads and stretch by the thousands across the landscape as far as one can see. The land may be hopeless for agriculture because of the steepness of the slope, but the piñon is perfectly at home on the hill, dry and rocky though it be. For ages the nuts have been a mainstay for the native, furnishing both fat and protein food. They are gathered chiefly by the Indians and Mexicans. When the railroad came, the Indian found a market; and now the pine nuts are shipped by the ton, by the carload, almost by the trainload. The annual value of the harvest amounts to tens of thousands of dollars.

Though the piñon is a wild product of the open forest, no one knows what might result if the best piñon tree of all the millions that Nature has already produced were chosen as parent stock. This one species of the many edible pines is scattered over a half million square miles in our own Southwest and northern Mexico. Next comes the question—what might the plant breeder do with this genus and its many species?

A private experimenter who starts a collection of the nut-bearing pine trees will add beauty to interest, for what is more beautiful than a group or collection of pines?

It is probable that a million-dollar endowment could be profitably employed for the next century on nut-pine investigations alone.

4. THE ALMOND

The almond is a cousin of the peach. The two trees are so similar in appearance as to be indistinguishable to the inexperienced. Some people claim that the peach is merely a specialized almond. Even when the fruit is nearly ripe the almond looks like a small undeveloped peach.

The world's almond crop, exclusively a product of the Mediterranean climate, is worth many millions of dollars a year. It is a well-established industry in California, Spain, Italy, Sicily, and in other locations of the Mediterranean climate, namely Chile, South Africa, and South Australia.

The fruit of the almond has already entered into the machine production stage which characterizes our present and prospective food supply. You can go to the store and buy candied almonds, salted almonds, almond meal (or paste) used to make macaroons and other cakes either in the homes or in the factories.

The tendency of the almond to early blooming is its chief limiting factor, but there are some strains, chiefly those with hard shells, that seem to survive and thrive in a climate like that of Connecticut, southern Vermont,[8] and many other parts of the eastern United States. A specimen of my own bears abundantly under the same conditions that produce a major part of the Virginia apple crop, namely a good soil plus fertilization without cultivation.

It seems reasonable to expect that breeding and selection would produce much more desirable strains suitable to the climate of the eastern United States. Apparently it might become a crop for untilled hill land, especially if supplied with water pockets for preservation of rainfall. (Page 262.)

The almond is a tree of special promise as a crop for arid lands. Indeed, most of the crop is grown on unirrigated soils in the Mediterranean lands of rainless summer. Its structure, namely a peach without juice, suggests aridity.

Some species have elaborately developed root systems, hair on leaf and fruit, and other drought-resisting characteristics. Mr. Silas Mason, Botanist, U. S. Department of Agriculture, has discovered several species that grow wild in the deserts of Nevada [9] in rainfall averaging less than ten inches per

[8] One species of hard-shell almond is living on the grounds of Zenas Ellis, Fair Haven, Vermont. It is producing fruit on the grounds of G. H. Corsan, Islington, Ontario (near Toronto).

[9] See *Journal of Agricultural Research,* Vol. I, No. 2, November 10, 1913, in which Mr. Mason describes a group of species called "wild almond" (prunus andersonii), the "wild peach" (prunus texana), the "wild apricot"

year and for some years amounting to only a fraction of that. These species await development into usable crops.

5. THE APRICOT NUT

The kernel of the apricot seed is much like that of the peach and the almond. At canneries it appears that the seeds of apricots have twenty to twenty-five per cent. kernel. In California before the World War these seeds were sometimes put through mechanical crackers. When free from the shells the kernels were roasted and sold for almonds to some confectioners. The pure food law has apparently stopped the fraudulent practice. Also in California during the World War oil was extracted from apricot kernels. It was very much like cottonseed oil and was used for cooking and as oil for canning sardines.

Under post-war conditions the cottonseed oil is cheaper, so apricot kernels are exported to Denmark and Germany in one hundred kilogram sacks and used for the manufacture of oil and acids and for a face lotion.[10] We should attempt to breed an apricot with a bigger and better seed, letting the flesh atrophy, thus specializing the apricot for a particular purpose as we do with cattle to make beef breeds, milk breeds, and ox breeds.

(prunus eriogyna), the "desert almond" (prunus fasciculata), the Texas "wild almond" (prunus minutiflora) and the Mexican "wild almond" (prunus microphylla).

They range from northern Mexico to southern Oregon. Some of them are surviving desert conditions where the rainfall in some seasons is not more than one inch a year. Mr. Mason cites an interesting adjustment. Under desert conditions they must, among other things, sprout quickly when water comes. In a week's time a greenhouse specimen had a plumule one centimeter long and a root nine centimeters long. The eleven natural hybrids listed by Mr. Mason are very suggestive for the plant breeder who would use this desert genius genus to make crops for desert lands.

[10] Rosenberg Brothers and Company, Santa Clara, California, letter, September 18, 1922. For an interesting discussion of peach, prune, almond, and apricot structure, origin, and relationship, see Bulletin 133, Bureau Plant Industry, U. S. Department of Agriculture, "Peach, Apricot, and Prune Kernels."

6. THE CHERRY TREE NUT

One of the clear-cut memories of my youth on a Virginia farm is the joyful noise of pigs as they cracked the seeds of fallen cherries beneath the trees in the orchard where the pigs pastured. This suggests developing another tree forage crop for midsummer pig pasture. Cherries come after mulberries and before persimmons.

The structure of the cherry is essentially analagous to that of the peach, a juicy pulp surrounding a kernel which contains in the center a germ carrying the food for the young seed, which also happens to be nutritious to animals. Bulletin No. 350, Bureau Plant Industry, professional paper, *The Utilization of Cherry Byproducts,* 1916, estimated that the seeds then thrown away at canneries in the United States contained 300,000 pounds of oil worth $60,000. It is true that the Mazzard cherry has a tremendous variation in size and flavor of pulp, in size of the seed, both shell and kernel. This tree is very fruitful [11] and grows absolutely wild in the eastern forest margins and along fence rows from southern Ontario to the Cotton Belt. I have seen cherry trees in northern Virginia whose trunks were two feet in diameter and from fifty to sixty feet in height.

I see no reason why breeding should not produce Mazzard cherry trees with seeds that carry enough meat to make of the fruit a profitable crop when picked up by pigs. This is a possibility worth investigation. A cherry has been crossed with the apricot and the peach.[12]

[11] I recall one tree from which I saw fifty gallons picked in one season. Then, curious as to the amount remaining, I walked around the tree estimating its burden. Upon looking up at it I could not tell where the fifty gallons had come from. I made a rough estimate of it branch by branch and concluded it must have at least two hundred gallons of fruit left as they began to rot and fall off. on the fifth of July. Estimating one-sixth for seed and one-third of the seeds for meat, we have eleven gallons of meats—call it eighty pounds—probably as nutritious as almond meats.

[12] *Journal of Heredity,* July, 1916.

7-8. FILBERTS AND HAZELNUTS

Two species of bushes, the hazels, producing nuts that are not bad, grow wild and fairly run riot in many American fields. They are considered a troublesome weed because foraging animals do not touch the leaves, and the nuts are not marketable.

The growing habit of these species is baffling to the horticulturist who would graft a good specimen. The plant becomes a clump through spreading underground stems; the clump grows on the outsides and dies in the middle. It resembles the raspberry in this respect. Therefore, the grafted specimen soon dies. Dr. R. T. Morris tried grafting one of these to the greedy European filbert. The filbert made such a demand upon the stem of the hazelnut that it kept on feeding the filbert instead of making more underground stems.[13]

At the present moment some worthy varieties of hazels and many worthy varieties of filberts are available in commercial nurseries and are ready for growth in a wide area in this country.[14]

The J. F. Jones Nursery, of Lancaster, Pennsylvania, has for sale grafted bushes of one hazel that stands still and grows—grows rapidly and bears early and prolifically.

The filbert, a cousin which hybridizes with the hazels, is an important commercial crop in the Mediterranean countries and the Caucasus, whence we import considerable quantities of nuts. Our total import is now more than twenty million pounds a year.

Professor J. A. Neilson, of Port Hope, Ontario, reports filbert trees, fifty years old, one foot in diameter, twenty-five

[13] *Nut Growing,* Robert T. Morris.

[14] Here is a sample of the complex relationships between climates and trees which shows the necessity for widespread experimentation; note the following facts: Italian red filbert winter kills at Lancaster, Pennsylvania, for J. F. Jones, while Mr. S. W. Snyder, an equally careful observer, reports it to be the hardiest he has at Center Point, Iowa, near the northern edge of the Corn Belt.

feet tall, bearing well at Ancaster, near Hamilton, Ontario, and also a plantation of European filberts eighty-five years old on Wolf Island at the mouth of the St. Lawrence River, latitude 44° 10' north.

Some European filberts blight when grown in the eastern part of the United States, but they thrive in western Oregon, Washington, and British Columbia. Several thousand acres of commercial plantings have been made, and they seem to be increasing at this time (1928).

In making some hybridization experiments (hazel x filbert) Mr. J. F. Jones, Lancaster, Pennsylvania, found that the same crossing produced nuts from which grew bushes six inches in height and ten feet in height with all the intervening heights represented. Mr. Jones produced hybrid nuts larger than those of either parent and some of his hybrids have produced at the rate of a ton of nuts to the acre.

This work of Mr. Jones is highly promising in the plants already produced and still more highly promising if more systematic work is done.

In speculating on possible results to be obtained by breeding in this group of species, the following facts should be kept in mind:

(1) Tree hazels of European or Asiatic origin, grow, bear, and are perfectly hardy at Rochester, New York.

(2) These trees have been grafted for centuries in Turkey, and Mr. Richard H. Turk reports that he is doing it at Vancouver, Washington, also.

(3) That the wild hazels are now growing in Newfoundland, Labrador, the shores of Hudson Bay, and the Peace River country of Northern Alberta.[15] They thus seem to grow

[15] Information from Professor James Neilson, Port Hope, Ontario.

"I have seen the hazelnut growing as far north as Hudson Bay, and it is very hard to distinguish it from the elm. The hazelnuts grow to a height of from twenty to twenty-five feet, and the elm comes down to about that height." Robert T. Morris, 1922 *Proceedings,* Northern Nut Growers' Association, and be adapted to the whole stretch along the southern edge of the sub-Arctic forest and reach across the continent north of the present limits of agriculture.

It is interesting to speculate upon what selection, crossing, and hybridizing from these hardy wild stocks and their good Eurasian cousins might produce in a decade or two.

9. SOAP NUT TREE

This tree produces a fine cabinet wood and a nut whose *hull* contains an excellent saponaceous principle said to make a perfect lather. Some authorities claim that it has cleansing qualities superior to manufactured soaps. The *kernel* of this nut has an oil claimed to be the rival of olive oil. It will grow in large sections of the United States.[16]

10. THE HOLLY TREE

The holly tree which grows wild near Vancouver Sound has leaves reported to have a nutrient value that rivals cereals. According to George W. Cavanaugh, of Cornell University, the analyses are as follows:

	Proteins *Per cent.*	*Fats* *Per cent.*	*Moisture* *Per cent.*	*Ash* *Per cent.*
Holly leaf	14.56	13.56	5.24	4.
Oats	11.8	5.		
Barley	12.4	1.8		
Corn	10.5	5.		
Rye	10.5	1.7		
Wheat	12.	2.		

It is claimed that simple processes can extract these fats in form suited to human consumption.

Holly grows over a wide area.

11. THE GINGKO TREE

The straight-growing gingko tree bears heavily of nuts. They have an offensive smell as the pulp decays, but the

[16] See *American Forestry,* November, 1917.

chemical qualities are suggestive of possible industrial uses. In some places the nuts are roasted and when eaten taste like roasted corn. The tree comes to us from Japan and thrives in much of the eastern United States.

12. THE PAPAW (ASIMINA TRILOBA) [17]

This is a native American tree of great beauty if given space in which to expand. Such a beautiful tree should be planted on our lawns. Its fruit is nutritious, having 435 calories per pound and being high in protein. It is liked exceedingly by some persons, disliked by others. To a very few it is somewhat poisonous.

The fruit may be found to a small extent in some markets, but it ripens in the autumn glut of foods and has small prospect of getting on the market in a large way unless experiment proves it to be good pig feed. It has large seeds much like lima beans in size and shape. They may carry most of the nutriment. Considered as forage the tree has the disadvantage of being hard to transplant, but the great advantage of having foliage that seems to be abhorred by all pasturing animals. Sheep, goats, cows, and horses apparently will scarcely touch it with their feet. It can spring up and thrive in the most persecuted pasture, and it grafts readily. Dr. G. A. Zimmerman, of Piketown, Pennsylvania, has thirty-seven varieties of papaw under test.

13. THE HORSE CHESTNUT

The horse chestnut tree, so highly prized as a beautiful shade tree, bears abundant crops of a nut which analyzes high in nutrients: [18]

Starch and starchy matters	42	per cent.
Albuminous matter	5	"

[17] See *Journal of Heredity,* July, 1916 and January, 1917. Also a mimeographed bulletin by H. B. Gould, U. S. Department of Agriculture.

[18] *The Literary Digest* for August 12, 1916.

Oil	25	per cent.
Saccharin matter	9	"
Mineral matter	15	"
Water	40	"

This nut has long been used in Europe as food for deer, for the zoo elephant, and for game, and is regularly gathered for that purpose. During the World War horse chestnuts were used to some extent for human food, but especially for forage. The bitter element was removed by boiling the crushed nuts, a method apparently similar to that used by the American Indians to remove the bitter elements from acorns.

14. THE OSAGE ORANGE (MACXURA POMIFERUM OR AURANTIACA)

This tree grows in the country once occupied by the Osage Indians, who used its wood for bows. The tree produces timber of fine quality and also bears heavy burdens of large fruit (1 to 1½ pounds) that may possibly have commercial value if processed in a chemical works of special design.

Professor W. R. Ballard, Maryland Agricultural Experimental Station, wrote me, June 14, 1916:

"Professor Norton tells me that, while at Shaw's Gardens, St. Louis, he discovered that the fruit had almost as much starch in its composition as the potato. The abundant resin has no doubt prevented its utilization for food." [19]

Careful analysis[20] shows the fruit to be rich in resins, pro-

[19] "They have a great deal of starch in them, but the resinous substances in them would interfere with use. I do not know whether this could be changed by treatment, but it is possible that more palatable varieties could be selected as well as varieties which would be more productive. I have seen trees in large hedges which were loaded with fruit, while many others were without fruit, and others bearing very sparingly close to them." (Letter, J. S. B. Norton, Maryland Agricultural Experiment Station, December 1, 1927.)

[20] Table I—Analysis of the Osage Orange (Percentages) :

H_2O in ripe fruit	80.00
Gums and resins in dry pulp (acetone extr.)	29.30
Nitrogen in dry pulp	2.81

tein, fat, and starch, and apparently well worthy of much more experimental work than has been bestowed upon it.

15. THE SUGAR MAPLE

The sugar maple is native or adapted to a large area of northeastern United States and southeastern Canada. So far as I know, neither selection nor breeding has ever been attempted as a means of increasing the efficiency of this tree. If the sugar maple is capable of being improved as the beet was improved, the results might be revolutionary for the hills from New Brunswick to Minnesota with a detour through Appalachia.

16. QUEENSLAND NUT

The Queensland nut,[21] native in Australia, produces a nut with an epicurean flavor but an almost impossibly hard shell. Some of these trees are growing in southern California. An Australian experimenter has produced one tree producing nuts with a soft shell.

Protein in dry pulp (N x 6.25)	17.56
N. in pulp after acetone extraction	3.42
Protein in pulp after acetone extraction (N x 6.25)	21.34
Oil in seed (ether extr.)	42.04
N. in oil-free meal	10.80
Protein in oil-free meal (N x 6.25)	67.50

Mineral Constituents	*Dry Pulp*	*Dry Pulp after extracting*	*Oil-free meal*
CaO	0.16	0.23	0.24
MgO	0.20	0.28	0.73
K_2O	3.82	5.40	1.32
Na_2O	0.13	0.18	0.19
P_2O_5	0.67	0.94	0.60
Ash (crude)	6.60	9.33	4.60

(J. S. McHargue, "Some Important Constituents in the Fruit of the Osage Orange," *Journal of Industrial and Engineering Chemistry,* 1915, Vol. 7, p. 612.)

[21] See U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 176.

17. THE WATTLE

This tree, whose bark contains much tannin, is cultivated to the extent of 200,000 acres in Natal. Since Natal has the climate of southeastern United States, it would seem possible to introduce the industry. Australia also has promising species of wattle.

18. THE TUNG OIL TREE

The tung oil tree (aleuritus fordii) of central China yields fruit from whose seeds is extracted one of the most valuable drying oils known in commerce. This oil is imported into the United States to the extent of forty or fifty million pounds a year and is worth several million dollars. The United States has much climate similar to that in which this tree grows.

19. WILD PLUMS, CHOKECHERRIES, AND SAND CHERRIES

This is a group of remarkably hardy natives of the northern Great Plains region. Prof. S. S. Visher says of them, "As a boy in South Dakota, I was much impressed with the value of these small trees not only for human food, but for hog food and for food of prairie chickens, bobwhites, etc."

These trees start with a great hardiness, and the previous discussion of cherries and apricots shows that they might be specialized into two groups of crops, fruit food and nut food for man or beast, especially beast.

20 — 999 ±. ???

No botanist, only God, knows how many more trees might become crop trees if man did his best with them.

Tanning materials, dye materials, fibers, rubbers, gums, medicines ? ? ?

CHAPTER XXII

A PEEP AT THE TROPICS

THE PRODUCTIVE TREES THAT ARE WAITING

The temperate zones are rich in crop-yielding trees. But many of these trees are largely untested, almost unexplored from the standpoint of economic botany. If I have succeeded in establishing that fact, what can I say about the tropics?

The vegetation of that large and little known realm is almost wanton in its productivity; and in the total of economic possibilities the trees seem to have more than their share of fruits and other useful products.[1] To advance from gathering wild produce in the forests to the systematic planting and cultivation of the tree as a crop is an easy and natural step. The process though old may, perhaps, be only at the beginning of a series of new developments. It may be seen today in the active stages of its development. Take rubber cultivation for example.

[1] "An extraordinary number of the forest trees of the Fijis furnish food for man. Such are the bread-fruit, which grows to be fifty feet high with deeply incised glossy leaves, sometimes almost two feet long. The Malay apple, or kavika (eugenia), grows to a great height and bears a delicious fruit, which when ripe is white streaked with delicate pink and most refreshing and rose-like to the taste. The cocoanut palm clusters in dense groves along the beaches, the long leaves murmuring to the sea breeze as they wave to and fro, casting their grateful shade upon the native village. Of all trees none is more useful to tropical man than the cocoanut. . . .

"Bananas and the wild plantain (fei) grow luxuriantly in the forest, as do also oranges, lemons, limes, shaddocks, guavas, alligator pears, the papaw, mango, and many other smaller shrubs and vegetables. . . .

"Famine is indeed all but impossible in the high islands of the tropical Pacific."

"A History of Fiji," by Alfred Goldsborough Mayer, *Popular Science Monthly,* June, 1915, p. 527.

A RAW MATERIAL—RUBBER—AN EXAMPLE

Rubber is the perfect example of the wild trees whose uses were quickly demonstrated, after which the technical processes were worked out with great rapidity, and manufacturing and agricultural industries created with almost magic speed.

For two generations the small need for rubber was supplied by spasmodic tapping of the wild trees of the forests. Then the bicycle and automobile made a sudden increase in demand for rubber. A few small experiments in cultivation were producing much talk by the year 1900, and by 1910 the highly profitable result of a few small plantations had started the full-fledged rubber boom with capitalistic organization, scientific prosecution, technically trained European supervisors, and thousands of oriental coolies. By 1918 the success of the growers had been so great that over-production and glutted markets with rubber at eighteen cents threw consternation into the camps of the men who had begun their cultivation on an extensive scale and had planted their trees when rubber was two dollars per pound.

At first any wild rubber tree was used. When cut-throat competition had forced intensive and scientific development, orchards were planted with selected seed rather than chance seedlings. This gave a substantial percentage increase of produce, but a severalfold increase of output is had from the orchard of *grafted trees*. Better rubber orchards now have a leguminous cover crop to feed them with nitrogen. All this development and even more has taken place in a quarter of a century.

SILT PITS IN THE RUBBER PLANTATION

We are indebted to the rubber growers for the economic large scale development of a device which in Malaya they call silt pits. This old but essentially unknown device promises to be of great value for the tree-crop agriculture of all climes.

Holes are dug in the orchard near the rubber trees. The rows of holes are connected by a ditch on contour lines. Thus the fine soil carried by running water is caught in the pits. The pits also hold surplus rain water and increase the yield of the trees. (See Figs. 18, 23, 113, 114, 115, 116, 117.)

A STAPLE FOOD—THE DATE—AN EXAMPLE

The productivity of tropical crop trees is well established by the performance of the date. Considered as human food this is possibly the king crop of world agriculture. Certain oases such as Tozeur in Central Tunis were described in the first century by Roman travelers. The oases still correspond to that description and apparently have been yielding dates every year in the intervening eighteen centuries. Crops of wheat and corn are not expected in Illinois year after year on the same bit of land. Yet these dates yield more food by far per acre than wheat or corn and have done so year after year for centuries. They are probably supported in this seeming miracle by wind-blown dust.

The foliage of the date, being feathery at the top, permits sunlight to come through and fall upon an under-orchard of olives, apricots, and figs, and beneath these beans and other leguminous crops will grow—literally a three-story type of agriculture so rich in yield that only a portion of the date oases need be worked so diligently.

THE PEJIBAYE—A WET LAND TROPIC RIVAL OF THE DATE

The pejibaye is similar in food value to the well-known date, but it is almost unknown. I doubt if 1 per cent, of the people of the United States or England have ever heard of it. But I mention it to prove the productivity of tropic trees and our ignorance concerning them. According to an article in the *Journal of Heredity,* April, 1921, this tree, which is a palm, is a rival of the date in productivity (see Fig. 109). The fruit is more productive than the banana, but it differs from the date in having starch instead of sugar for its main constituent. For months at a time the pejibaye is the chief food supply of the native peoples of southern Costa Rica and the lowlands of Colombia, Venezuela, and Ecuador. It was mentioned by the early Spanish travelers, has been in use ever since, and yet we have not even heard of it.

A RAW MATERIAL—KUKUI OIL—AN EXAMPLE

In the attempt to establish the idea of the fecundity of the tropical tree I have already mentioned a staple raw material, rubber, a staple food of the Old World, the date, and one of the New World, the pejibaye. Now I cite another industrial commodity, a paint oil, which we might make from the kukui or candlenut tree, whose oleaginous seeds make a brilliant flame that lighted Polynesia for an unknown period of time before the Standard Oil can brought a cheaper illuminant.

This tree grows or will grow, in many wet tropic lands. It has been officially reported[2] to produce five tons of nuts (analyzing 19.5 per cent. oil) per acre. It is a paint oil with

[2] "Kukui (aleurites triloba, or a. moluccana) is generally distributed throughout Polynesia, Malaysia, Philippines, Society Islands, India, Java, Australia, Ceylon, Bengal, Assam, China, Tahiti, Hawaii. It has been introduced into the West Indies, Brazil, Florida, and elsewhere. The tree has wide-spreading branches, attains a height of forty to sixty feet, and is characterized by large, irregularly lobed leaves of a pale green color and nuts about two inches in diameter containing one or two seeds. In Hawaii kukui is common on all the islands, being the dominant native tree of the lower mountain zone and easily recognizable at a distance by the pale color of its leaves.

"Every one knows that the ground under kukui trees is literally covered with nuts of which few are used for any purpose at present.

"At two hundred pounds of nuts per tree and eighty trees per acre there would be a yield of eight tons of nuts per acre. It has been found that algaroba yields from two to fourteen tons of beans per acre. A good stand of kukui will give a larger product per acre and a conservative estimate would be five tons of nuts. On 13,000 acres the annual crop of nuts would thus be 75,000 tons.

"We may probably assume 15,000 acres as a safe estimate of the kukui in Hawaii.

"From our experiments it appears easy for a man, woman, or child to pick up five hundred pounds of nuts per day. The nuts are, of course, to be

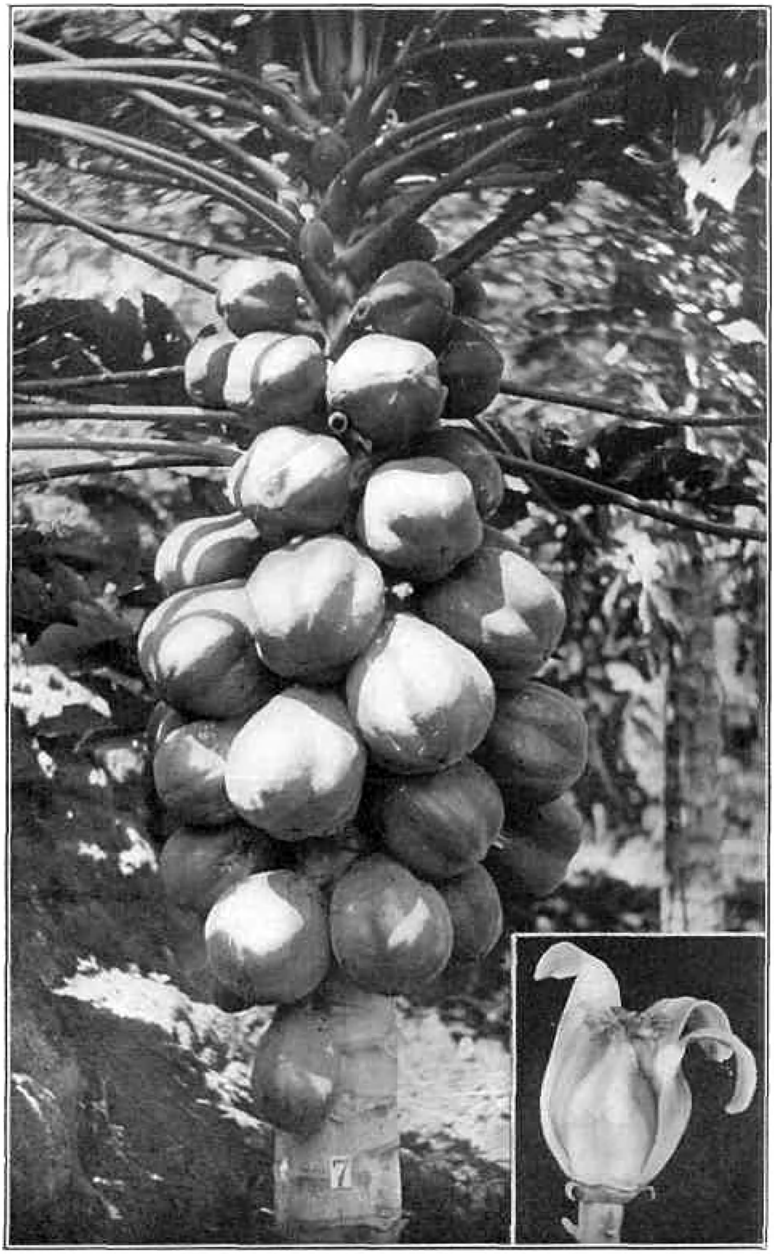


FIG. 107. This Hawaiian papaya tree, with fruit 7 inches long and 6 inches in diameter, illustrates the fecundity of tropical tree crops. (Courtesy J. E. Higgins, Honolulu, and Paul Popenoe.)

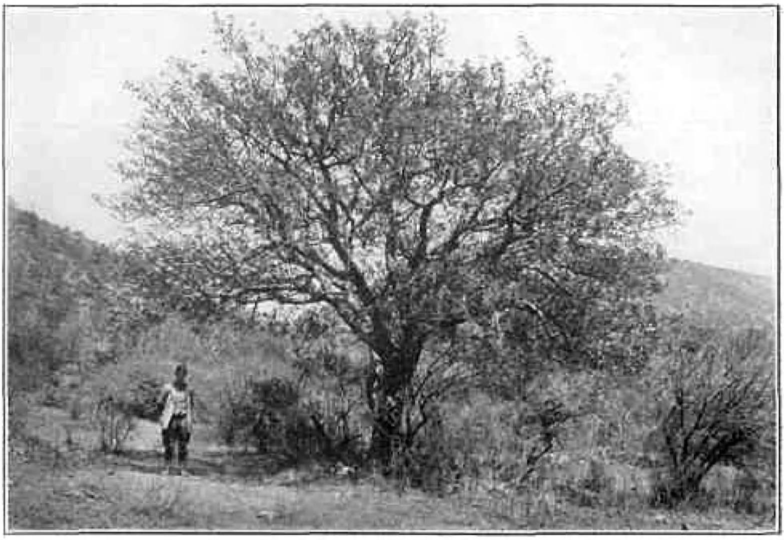


FIG. 108. *Top.* Dr. Shantz.)—FIG. 109. *Bot-* Central Congo, Egyptian Sudan, near Laurenzo Marquez, Mozambique; in Northern Rhodesia. ill Northern Transvaal, dry agricultural grasslands; agreeable fruit, oil-giving kernel; final value unknown. (Courtesy H. L. Shantz saw this tree in *torn.* A bunch of fruit of the pejibaye. Grows from Nicaragua to Ecuador, from sea level to 5000 feet; seedless, indicating culture for ages; main food supply of many peoples. Our complete ignorance of it is suggestive of undeveloped tropical resources. See *Journal of Heredity,* 1921. (Photo Wilson Popenoe.)

use and price like that of linseed oil. Small quantities of this oil have been imported into the United States for seventy-five years. No one is making large commercial use of it at present, but it seems to be a remarkable waiting resource.

PALM OIL [3]—BOTH FOOD AND RAW MATERIAL—A SUGGESTIVE METEOR OF COMMERCE

The meteoric rise of the African palm-oil trade is one of the miracles of recent commerce. The oil palm widely scattered in the forests of western and central Africa produces a big fruit with an oily pulp surrounding a hard nut containing an oily kernel. For ages the African native has been boiling this fruit and skimming off the oil for butter fat.

About the beginning of this century some of this palm oil reached Europe. It attracted the attention of manufacturers, and Lord Leverhulme, English soap magnate, father of Sunlight Soap, sent scientific explorers to investigate the

gathered free from the soft outside husk. Only an extremely small percentage of the nuts spoil or turn rancid even after lying two years on the ground. The spoiled nuts float in water and may thus be easily separated from the sound ones. At thirty cents per one hundred pounds the laborer would receive one dollar and fifty cents for five hundred pounds, a day's work. The average oil content of the meat or kernel is sixty-five per cent. The kernel equals thirty per cent. of the weight of the nut. About 19.5 per cent. of the nut is therefore oil. In the Sunda Isles where kukui oil is an important article of export, experiments have shown that ninety per cent. of the oil is obtained by commercial methods through the use of presses. The oil recoverable by commercial methods would thus amount to 17.5 per cent. of the weight of the nuts. From one hundred pounds of nuts 17.5 pounds of oil would be obtained, or a value of one dollar and seventy-five cents at ten cents per pound.

"Kukui oil has been shipped from various islands of the Pacific to the United States for the past seventy-five years for use in making soap, paint, varnish, and artists' oil. The market price is the same as or slightly higher than that of linseed oil and varies with the price of the latter." (Hawaii Agricultural Experiment Station, Honolulu, Hawaii, Bulletin, No. 39, issued February 8, 1913, *The Extraction and Use of Kuhui Oil,* by E. V. Wilcox and Alice R. Thompson.)

[3] The palm is said to be second only to the grass family in the number of its species. When one considers its present productivity as resulting chiefly from unscientific chance, it opens interesting speculation as to what it might produce after a few decades of selection and breeding.

commercial possibilities. Their reports sounded almost too good to be true, so this lord of soap checked up their accounts with personal journeys. As a result he established large plantations of oil palms in western Africa. This was very-easy to do, for the trees stand many to the acre over large areas of wild forest. The trade shot up, and Europe now imports hundreds of thousands of tons of palm kernels and palm oil.[4] This industry has sprung up almost as quickly as the rubber industry.

Oil palm gives three distinct kinds of oils:

1. The edible oil boiled from the fruit.
2. The inedible oil pressed from the fruit.
3. The oil of the kernel. The kernel has long been extracted from the nut by the African women working with two stones. A cracking machine now does the work.

Meanwhile, this tree is running wild in Brazil, having been brought there by the early importations of negro slaves. However, Brazil is not solely dependent upon the African oil palm, for it has one of its own, babassu, growing wild over a large area about the latitude 5° south and now in the process of being introduced into commerce.

WHAT HAPPENED TO THE COCONUT

The ancient and well-known coconut with its rich oil and myriad uses need not be here expanded except to point out one fact that may revolutionize the economics of almost any kind of vegetable oil. Chemical researches have recently turned the strong liquid coconut oil into a sweet-flavored tallow-like substance which now graces millions of European and some American tables in place of the more expensive butter.

[4] In 1911, the United Kingdom imported 25,000 tons of palm kernels. In 1919 it was 317,000 tons. In 1926 Europe imported over half a million tons of kernels.

SOME OTHER TROPIC TREE CROPS

Save for sugar most of the other standard tropic exports are tree crops—cacao, coffee, and tea, cinchona, spices, and Brazil nuts.[5]

I must mention two important tropical tree-foods that have not yet entered commerce. One is the papaya, a fruit resembling a cantaloupe but which grows in huge clusters from the upper part of the trunk. The other is the avocado or alligator pear, and this tropic delicacy offers an interesting dare to the commercial genius of man. The fruit is as large as a Bartlett pear, sometimes even twice or three times as large, and has a thick buttery meat which analyzes from fifteen to thirty per cent. fat. Porto Ricans sometimes chop it into little cubes and mix it with their rice as we might mix butter with our rice. This makes the rice (dietetically) into bread and butter. As a constituent for salad avocado furnishes the oil.

The avocado tree thrives from sea level to six thousand feet in Guatemala. A few are growing in California and Florida. But the real problem is to extract the oil so that it will keep—dry it or can it—or find some means of handling it fresh.

In giving brief mention to this long list I make no attempt to be complete. I wish merely to try to suggest the riches of the tropics in tree-crop possibilities.

Messrs. Dorsett, Shamel, and Popenoe[6] list twenty fruits in Brazil which they describe as little known. They have little doubt but that there are several hundred trees native to the tropical world and producing an important fruit not now of

[5] The Brazil nut of our market grows in a wild tree that towers above the Amazon forest, as the pecan towers over the oak tree of Indiana. These nuts go to waste by the millions of bushels. Only a small fraction of the crop is gathered and sent to the market. There are many other trees in these forests producing edible or oil-giving nuts.

[6] In Bulletin 445, Bureau of Plant Industry, U. S. Department of Agriculture.

commercial utilization, but capable of it, and at the same time capable of improvement through plant breeding.

TROPICAL NEEDS AND THE EROSION PROBLEM

Certain parts of the tropical world are in need of having tree crops developed even more extensively than at present. In a large part of the tropical world the main food supply of native peoples is some cereal. The system of production is to burn the forests, plant a crop or two of corn, and after harvest let the thicket grow again while another piece of land is cleared and burned to make a fresh field. This method destroys the forests. It devastates the soil. If a permanent field is made, the destruction is often even more sure and final. The torrential character of most tropic rainfall lifts field erosion to the plane of an economic terror.[7]

The soil destruction in India and Central America described by the papers just referred to shows that the tropic denizens are destroying their lands almost as rapidly with cereals as we are destroying ours in the southern part of the United States with corn, cotton, tobacco, and gullies, and like ourselves they are in need of development of tree-crop agriculture if the lands are to continue to serve the race.

TREE CROPS AND TROPIC FAMINE

On both sides of the equator in latitude varying from six to ten or twelve degrees, the rainfall is concentrated into one season, and as a result the forest gives way to open parklike country called savannah, where trees are scattered over the grasslands. As distance from the equator increases, the rainfall, trees, and grass diminish until finally the desert prevails.

[7] See (1) Bulletin of Agricultural Research Institute, Pusa, No. S3, Calcutta, 1916. "Soil Erosion and Surface Drainage." Albert Howard.

(2) "Afforestation of Ravine Lands in Etawah District, United Provinces," E. A. Smythies. Indian Forest Records, Calcutta, 1920.

(3) *Proceedings* of the Second Pan-American Scientific Congress, Section 3, Conservation of Natural Resources. O. F. Cook, p. 573. "Possibilities of Intensive Agriculture in Tropical America."

(See map, Fig. 136.) This grassland zone of the rainy season and the dry season is a latitude of famine for the reason that the tropic rainfall is the most unreliable in the world. An examination of the distribution of rain by months (Fig. 135) shows how difficult is the problem of growing a cereal, which is at the present the chief dependence of the people. When should they plant it? The rainfall is so unreliable that they may plant two or three times and fail. But an established tree can wait for rain and use it when it does come and therefore has a better chance of harvest than an annual crop like sorghum, millet, and corn. Especially would this be the case with an extensive use of water pockets such as are used in connection with the rubber in Malaysia. (Pages 244-245.)

FORAGE CROPS—BEANS (GRAIN SUBSTITUTE)—SOME EXAMPLES

There are many tropical trees producing beans whose forage value and use are much like the honey locust and keawe. For example, babul is the most widely distributed tree in India. I saw babul trees in my first moments in India as I landed on the coasts of Coromandel from Ceylon. They were growing in white sand. I saw them at the foot of the Himalayas clinging to rocky slopes and again at the extreme west as I neared the port of Karachi.

Everywhere the goat herder leads his flocks to these trees. Often he cannot wait for the beans to fall, but with a long hook he cuts down branches that his wards may eat the beans and also the leaves of the tree. In a year of bad drought these trees will be thus beheaded by the million. Often they stand in land too dry for dependable agriculture.

The gigantic saman tree of India yields sugar beans greedily eaten and said to improve the quality of milk.

In Cuba the guasima is left when pastures are being cleared exactly as persimmons are left in the pasture fields of Georgia.

The bean is greedily eaten by all farm stock,[8] but I can get no measure of its actual productivity per unit of area.

H. J. Webber, Professor of Sub-tropic Horticulture and Director of Experiment Station at Riverside, California, gives me the following facts. They are illuminating as to the possibilities of native trees and suggestive as to the possibilities of introducing them from other places.

"I found the carob in a few places in Rhodesia and in the Transvaal, and there are some references to the production of carobs in the Department of Agriculture reports from the Transvaal, and also from the Department of Agriculture of southern Rhodesia. Mr. Walters of southern Rhodesia issued a bulletin on the carob which was published by the Department of Agriculture. I had not been in Africa long until I was impressed by the very large area in the central part of the country in the high plateau region where it appeared to me

[8] "In my section of the country in eastern Cuba, specially in Camaguey province, the cattle country of Cuba, the 'guasima' tree and the 'algaroba' are considered as valuable trees on account of the fruits that they bear in the dry season when the pastures are exhausted; in winter both fruits constitute a valuable food for the stock. Horses, cattle, mules, and hogs eat them. A great value is given to the fruit of the 'guasima' because the native farmer considers that fruit is specially adapted to feed the horse. Our cattle man, our native 'guajiro' collects the fruit of the 'guasima' and feeds his best pony on it because his animal will grow on a fine coat of hair." (Letter, Dr. Emilio L. Luaces, Santiago de las Vega, August 25, 1916.)

"The guasima tree is a native of Cuba but also of all tropical America and the species guazuma tomentosa is a native of Java too. Two species are known in Cuba as guasima. Guazuma ulmofolia, lam., and guazuma tomentosa, H.B.K. of the natural order sterculiaceae. Both are equally common and produce pods eaten by cattle.

"The guasima is perhaps the most vastly distributed tree over the Island. It is found in all kinds of soils even in the heights, except in the very arid savannahs.

"It is a quick grower and begins to produce after the fourth year.

"The guasima is used in Cuba mostly to feed the pigs, for which purpose when the forest lands are cleared up the only tree that is left is the guasima and sometimes the ceiba.

"The 'portreros' (pasture land) in Cuba are characterized by the abundance of the guasima tree under which the cattle find shade and some food." (Letter, Republica de Cuba, Secretaria de Agricultura, Comercio y Trabajo, Estacion Experimental Agronomica, Departamento de Botanica, Agosto 25 de 1916, Juan T. Roig.)

the carob would be an ideal crop. Few trees exist, however, in the country at the present time. I found a group of twenty or thirty trees on a plantation south of Untalli in Eastern Rhodesia where the trees were about fourteen or fifteen years of age and of fairly good size. I was told that they produced pods in abundance and that the cattle came to the trees regularly to get the pods and this was evidenced by the fact that the ground was trodden down all around under the trees. The owner of the plantation was convinced that the planting of carobs in that section would be of very great value.

"There are a number of legumes native to South Africa that have pods similar to the carob, some of which are actually thicker and might be even more valuable if cultivated or if planted on good lands. I have not yet had opportunity to determine the identity of these trees. I saw one in the forest near Victoria Falls that produced a square solid pod about the length of the pod of the carob and an inch square practically each way."

This passage from Dr. Webber needs pondering—especially when one remembers that there are several million square miles of semi-arid tropic lands on which such trees might grow.

THE OPPORTUNITY FOR TROPICAL TREE RESEARCH

The tropic lands have great crop possibilities in their trees.

The tropic lands have great need for a more dependable crop than the grain crops of today.

The tropic lands exceed the temperate zone in the possibilities of tree-crop development through government agencies. Appropriations do not depend so much upon elected legislatures as they do in the temperate zone. Suppose the Director of the Experiment Station of Maine, Minnesota, Arizona, or Alberta should want to do big work as outlined in this book. I know that some of them have tried and have almost eaten their hearts out in running up against obstacles.

If the Director of Station in Rhodesia, Sumatra, or the Punjab has a big idea, he may need but to convince a small council of intelligent men who are not politicians and who do not have to get reflected by a popular majority.

PART THREE

ECONOMICS, FARM APPLICATIONS, AND NATIONAL APPLICATIONS

CHAPTER XXIII

TREE CROPS AND FARM MANAGEMENT

I. A TREE FARMER'S FARM

R. 0. Lombard, gun in hand, crept softly through the thick forest in a Georgia swamp. He was hunting for wild turkeys. He heard a cracking sound. Peering around a clump of bushes he spied some hogs crunching acorns beneath a water oak. They were miles from any house. They were fat, ready for the shambles, and it was all of their own doing. The hogs had fattened themselves on swamp produce.

As Mr. Lombard quietly watched the hogs, a thought struck him. "If they can feed themselves out here on the swamp, why can't they do it on my farm? Here they pick up a living in the fall when acorns are ripe. If I were to raise other tree crops on my farm, why could they not pick up their living the rest of the year too?"

For the rest of his life Mr. Lombard (now unfortunately no longer living) had fun working out the idea of tree-crop farming, where pigs harvest the crops. When I saw him, he had two hundred everbearing mulberries, two hundred hog plums, two hundred wild cherries, three varieties of red haws, and mock oranges.[1]

[1] "This plant is found growing in South Carolina to Florida and Texas. It begins to bloom in February and lasts until April. The small fruit which ripens in late summer is retained throughout the winter." (Letter, P. J. Berckman's Company, Augusta, Georgia, August 21, 1915.)

Mr. Lombard thought them very fine winter hog feed. He also had a few trees of cudrania.

"The name of the plant which you desire is cudrania tribola, No. 352, introduced by Professor Wilson of the United States Department of Agriculture.

"We do not think this tree has been used to any extent by the people here

The native persimmons, as they sprang up in his fields, were grafted to a productive variety of native American persimmon, and in September when I saw them, the trees were bending down with unripe fruit. He had a large number of water oaks scattered about the place, and had been planting them systematically for years.

As an exhibit at the county fair he had printed slips numbering twenty-six crops[2] which were growing either wild or cultivated on his place. Some he said were of small value, but they were there.

He had three hundred acres of fenced pasture. One-quarter of it was swamp. Some was hopeless-looking sand which Mr. Lombard said was "hardly worth the hole it filled up in the

in the South, and we know of only two trees near our city and these are across the river in South Carolina. One of these trees bears a full crop every year, while on the other one the fruit drops before maturity." (Letter, Fruitland Nurseries, successors to Berckman's, Augusta, Georgia, July 5, 1923.)

[2] 1. Mulberries (Downing), April 20th to July 20th (dates of use).
2. Mulberries (Hix), April 26th to July 20th.
3. Mulberries (White), May 4th to June 26th.
4. Huckleberries (Frog Eye).
5. Huckleberries (large high bush), June 1st to July 1st.
6. Huckleberries or Blueberries, June 5th to July 5th.
7. Huckleberries (hog or ground), June 10th to July 20th.
8. Wild Cherries, June 10th to July 20th.
9. Blackberries (highland), May 26th to June 30th.
10. Blackberries (swamp), June 5th to July 10th.
11. Hog plum, June 20th to August 20th.
12. Gooseberries, July 1st to August 15th.
13. Haws, August 15th to September 30th.
14. Haws, August 25th to September 30th.
15. Haws, August 15th to September 30th.
16. Muscadines, September 1st to October 15th.
17. Dogwood berries, September 15th to December 30th.
18. Black gum berries, September 10th to December 30th.
19. Acorn (water oak), September 15th to April 1st.
20. Acorn (post oak), October 1st to April 1st.
21. Persimmons, September 15th to December 30th.
22. Hickory nuts, October 1st to April.
23. Pecan nuts.
24. Chestnuts.
25. Chinquapin nuts.
26. Hazelnuts.

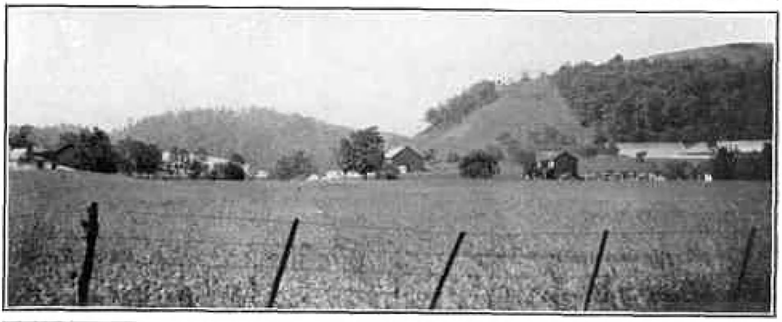


FIG. 110. *Top*. Majorca. Heavy trees in the foreground, grafted oaks; feathery trees, almonds. The heavy trees on the steep hill at the back are oak (ilex), thinned out to make acorns for hog-fattening.—FIG. 111. *Center*. An Appalachian valley in Central Pennsylvania. The steepness of the hillside field is submitted as evidence of widespread agricultural insanity.—FIG. 112. *Bottom*. A grove of locusts (Robinia Pseudacacia) whose nitrogenous roots support a good stand of bluegrass on a shaly Allegheny Ridge in Central Pennsylvania where grass is rare. (Photos J. Russell Smith.)

Courtesy E. A. Smythies, Indian Forest Service

FIG. 113. Bare eroded lands on the upper Jumna were quickly reforested by digging these pits to catch rain water and irrigate the trees. Pits increased water penetration several fold, from 6 inches to 40 inches. Pits dug by famine relief funds.

earth." Some of the farm was in Bermuda grass. When I was there in early September, Mr. Lombard had a small field of cowpeas in some of the sand. The pigs harvested these as they did all the crops which grew on the trees. He reported keeping forty hogs all the time. Acorns, he said, kept his hogs fat for five months in winter, and mulberries did it for three months in summer.

II. THE VISION OF THE HILL FARMS

I venture to enlarge Mr. Lombard's vision. I see a million hills green with crop-yielding trees and a million neat farm homes snuggled in the hills.[3] These beautiful tree farms hold the hills from Boston to Austin, from Atlanta to Des Moines. The hills of my vision have farming that fits them and replaces the poor pasture, the gullies, and the abandoned lands that characterize today so large a part of these hills.

These ideal farms have their level and gently sloping land

[3] My friend, Dr. Deming, sees this farm (in part) thus:

"I am going to ask you to look forward a quarter of a century or so and visit with me in imagination an ideal farm not too far from Hartford (Connecticut), owned by a farmer of unusual vision.

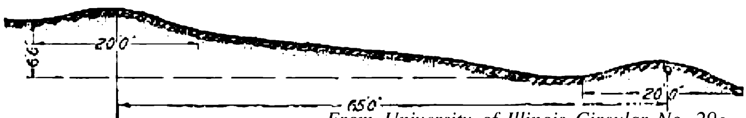
"We find the public road skirting his land bordered on both sides with high-headed Stabler black walnut trees, beneath whose pendant feathery foliage we get unobstructed views of the fair surrounding fields. These trees yield annual crops of nuts which have the peculiar merit for a black walnut of shedding their kernels in unbroken halves when the nuts are cracked. The kernels readily fetch from eighty cents to a dollar a pound in the market and the cracking helps give winter occupation to the farmer's hands, which, by the way, he employs the year around.

"The drive leading to the farmer's house is bordered with grafted Japanese heartnut trees with their huge semi-tropical leaves and luxuriant growth. Their nuts find a ready market uncracked or fetch a larger return for the labor of cracking out the easily removed kernels.

"In favored places near the house and barn are a few English walnut trees whose dark green, fragrant foliage has an exotic charm and which furnish nuts enough for home use with an occasional surplus for market.

"Around the ample kitchen garden is a sheltering hedge. Half of this hedge is composed of European filberts in interpollinating varieties that yield good annual crops of nuts. The other half of the hedge is of chinkapins loaded in September with clusters of burs, each with its small, round, sweet nut, the joy of children. The chinkapins show the chestnut blight in places but nevertheless keep on bearing year after year."

protected by mangum terraces (Fig. 120) and are intensively cultivated—rich in yields of alfalfa, corn, clover, legumes, wheat, and garden produce. This plow land is the valley bottoms, level hill tops, the gentle slopes, and flattened terraces on the hillsides. The unplowed lands are partly shaded by cropping trees—mulberries, persimmons, honey locust, grafted black walnut, grafted heart nut, grafted hickory, grafted oak, and other harvest-yielding trees. There is better grass beneath these trees than covers the hills today. The



From University of Illinois Circular No. 290

Cross-section of two mangum terraces, 65 feet apart, on a 10 per cent. slope.

crops are worked out into series of crops to make good farm economy.

It will take time to bring this miracle to pass. It will take time to work it out. First of all a *new point of view* is needed, i.e., *that farming should fit the land.* The presence on the land of the land owner is also needed. This is not a job for tenants. Let the tenant go down to the level land which carelessness cannot ruin so quickly. Not his the beautiful home in the beautiful hills.

This is the place for the man who has the insurance point of view. Fortunately, insurance is now becoming one of the characteristics of this age. One of the best kinds of farmer's insurance is for him to build his hill farm over gradually to the tree-crop basis.

How shall the hills be turned into tree farms, since otherwise they will be ruined sooner or later by plowing? The question really is, how can the unplowable lands be made to yield richly through trees? Before answering these questions emphasis should be made upon three new pieces of agricultural technique:

1. Nitrate instead of cultivation,
2. Irrigation from rain-fed water pockets,
3. Hogging down the crops.

III. A NEW TECHNIQUE—CULTIVATION BY NITRATE

At the mere suggestion of an uncultivated tree the devotees of the plow will rise up and say that trees need to be cultivated. I will agree with them and quote back for their comfort a statement given me in France that the Persian walnut tree in the pasture bears only half as much as the tree that is cultivated.

The orthodox defenders of the plow and of cultivation were telling us twenty years ago that an apple orchard *had* to be cultivated. For the most of the clay lands of eastern United States this statement is now known to be merely a kind of fetishism, as some millions of Virginia and other eastern American apple trees yearly attest. The apple trees are *fertilized.* The theory of cultivation is that it increases the available food supply. I accept the theory. Facts seem to prove it. The same theory underlies the use of the commercial fertilizer. Experiments at numerous farms, and numerous experiment stations such as those in Ohio and Virginia, show apple trees that will bear two or three bushels in uncultivated, unfertilized sod and will bear perhaps ten, fifteen, or twenty bushels if given a few pounds of fertilizer, preferably nitrate of soda.

With an established tree in many soils and locations you may cultivate or you may fertilize, but in most naturally forested sections of the United States it is not necessary to do both. I claim that tree-crop experimenters can use fence rows and corners of land to grow trees without cultivating them, but please do not quote me as saying they can do this without fertilizing the trees. Furthermore *young* trees, if not cultivated, must be protected in the first years by mulch. I have proved in many cases, to my sorrow, that grass can rob a little apple tree and kill it, whereas three feet of mulch plus nitrate of soda will cause it to grow like the green bay tree of Scripture and bear more apples, alas, than I can sell. Experimenters growing nut trees and other crop trees can plant them in almost any kind of place if they will give the trees a smothering coat of grass mulch three or four feet from the trunk, and in addition give fertilizer and other attention that a cultivated tree should have. Guaranteed this treatment, most species will react as the apple does. When the top is large enough to shade the ground around the trunk, the trees can usually fight it out and make steady growth if abundantly fertilized. This statement is made for the naturally forested areas of the eastern United States. I do not know how far west it holds true. It is probably not true for the Great Plains.

IV. AN ALMOST NEW TECHNIQUE—FERTILIZING WITH LEGUMES

Legumes of grass size, bush size, or tree size can sometimes be made grow beside the crop-yielding non-leguminous tree and fertilize it with nitrogen (page 65). These possibilities have been as yet but little explored in the temperate zones.

V. A NEW TECHNIQUE—IRRIGATION BY RAIN-FED WATER POCKETS

Fig. 23 shows a method of making a pocket in the earth so that the water will remain upon the square rod where it falls. The effect of this is like that of cultivation or fertilizer because it increases available moisture and increases the available food supply of the plant. Irrigation by water pockets should be one of the devices of the agriculture of the future, particularly the tree agriculture. Once the pit is made the rains will automatically fill it, and the tree will irrigate itself for years with very little attention save an occasional cleaning out of the pit or ditch or terrace. Otherwise the forces of nature would gradually tend to level the pockets.

This method of irrigation seems to have been invented independently in several parts of the world. Unfortunately it has been used but little in any of them until this century.

1. It was invented at an unknown time by the Arabs of North Africa. These people still build banks around their olive trees so that no rainfall will escape. Sometimes they let a rill from a nearby hill run into the catchment basin.

2. Something of the same sort was invented by the late Colonel Freeman Thorpe of Hubert, Minnesota, who reported that it made Minnesota's black oaks grow twice as fast as their nearby neighbors that had missed the benefit of such watering.

3. A hole catching water and irrigating trees was devised by the late Dr. Meyer of Lancaster County, Pennsylvania. He had a gully in his orchard. He put a dam of trash across it. Water collected behind this dam. The doctor observed that the trees near it grew better than the rest. This caused him to keep men at work in odd times digging holes near his apple trees. The trees prospered and Dr. Meyer thought that it was profitable.

4. A horizontal terrace holding rainfalls to irrigate trees was invented by Mr. Lawrence Lee, a graduate engineer and orchardist of Leesburg, Virginia. On his steep Piedmont clay hills, he says, "nine-tenths of the water of a summer thunder shower runs away." Aiming to reduce this, he put rows of apple trees across the hill at equal distances apart. He laid off one row on the absolute level. The others were thirty feet apart up or down the hill from this base row. As a result every furrow along the row planted on the absolute contour held water, whereas it drained away from the others because they sloped a little. In a few years Mr. Lee observed that the trees of the contour row which had the water lying above the trees at every rain were distinctly the largest in the orchard.

He took the hint. He planted another orchard where every row was on the contour, the exact level. Then he used a Martin grader (made in Owensboro, Kentucky) with tractor, and made horizontal terraces that would hold water above every row of trees. Mr. Lee reports that there was no run-off from this orchard for several years. His orchard was called to my attention by an expert apple grower who saw it from a distance and asked what had made the trees grow so much more rapidly than those in another orchard just across the road and which had been planted at about the same time.

5. I have seen pits dug as big as a barrel to catch trash and water in coffee plantations on Porto Rican hills. When the pit is full of leaves and silt, they plant a young tree in this beautifully prepared seed bed. I am told that this practice is common also in Central America.

6. These catchment pits have reached their most systematic development, and they are most extensively used under the name of silt pits in the tea plantations of Ceylon and rubber plantations of Malaya (Fig. 18), where they serve the double purpose of water-saver and soil-saver and have been dug by cheap coolie labor in thousands of acres of plantations. They are probably used in other parts of the Far East, but I have not seen them.

7. Water catchment pits have been effectively used by the Indian Forest Service.* On steep, eroded land the rainfall penetrated *six inches* without water pockets and *four feet* with water pockets.

8. This idea has had its most suggestive development in

[4] The effectiveness of these water pockets in the afforestation of denuded and gullied lands in India (along the Jumma, Chambal, and other rivers, especially in the Agra, Etawah, and Jalaun districts of the United Provinces) has been little short of miraculous. Centuries of overgrazing by cattle, goats, camels, and ponies had destroyed protective vegetation with the result that half a million acres of alluvium had become a net work of ravines. The normal rainfall of fourteen inches rushed away so rapidly that it wet the soil but six inches deep. After the digging of water pockets water penetrated to a depth of more than four feet, and reforestation was surprisingly successful. Babul trees reached a height of twenty feet in four years. (Information from E, A. Smythies, of the Indian Forest Service, Dec. 28, 1923.)

North Carolina where Mr. Lee, an engineer of Charlotte, North Carolina, has developed a fairly satisfactory *engineering technique* to do this thing in the mechanized American way that we like to call modern. He makes the pits on a large scale on the cut-over pine land with no other object than that of saving water for his company's (Southern Power Company) power plants and increasing the growth of the timber. He calls them "terrace with back ditch." This is essentially the same device as that of Mr. Lawrence Lee (No. 4 above), although the men are unknown to each other.

The water-holding terrace is merely a slight modification of the old drainage terrace so commonly used in the cotton fields of the South. (Figs. 23, 114, 115.)

The terrace type of land management has the great drawback of dividing a tract of land into small fields of irregular boundaries because the plows and cultivators cannot cross the terraced banks. However, tens of thousands of American cotton fields have been worked that way for decades. Any other way meant speedy ruin.

Note the excellence of this terraced field for one who would convert his farm to cropping trees. His customary farming method can go on undisturbed while young trees grow on the terrace banks. It was in such a place that Governor Hardman had planted some of the honey locusts in his almost unique honey locust orchard. (Page 65.)

The Small Terraced Field and the Tractor

The man whose mind happens to be molded in the level land farming idea is usually much shocked by the idea of modern agriculture in the little narrow strip of land of varying width between two terraces. Unquestionably it is awkward, and the cost per acre for working it is more than for working a wide flat area. Perhaps good management can make this pay. If we can only get out of the land-robbing philosophy and into the land-building philosophy, the little terrace may come into its own. The sloping field with natural drainage almost always declines in fertility. The little hillside terrace does not lose its good soil, but gets better and better. With care it can be made to yield fifty or seventy-five bushels of corn instead of the fifteen or twenty of the slopes. You can turn many corners for that difference. The increased yield made possible on terraced land can make it compete in cost with the wide rolling unterraced lands.

If we get the concept of making the farming fit the land and then examine this little terraced strip we see the following facts. Its chief disadvantage appears when crops like corn, cotton, and tobacco are cultivated in rows. On these terraces there must be much winding back and forth of man and team. This disadvantage almost disappears if the land is sown to a broadcast crop such as alfalfa, oats, and other small grain, millet, cowpeas, etc., or soy bean or other legumes. Most of these can be harvested with the mowing machine and the hay rake, which require only a small amount of turning. Best of all, these crops can be harvested by the animals which bring us to the third new technique.

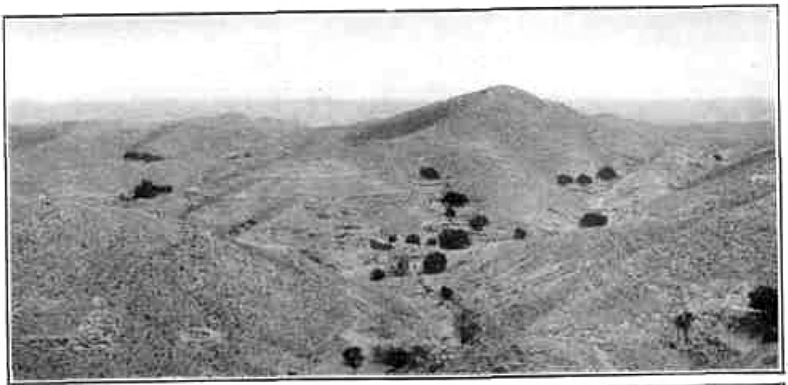
VI. A NEW TECHNIQUE—HOGGING DOWN CROPS

The chief invention in agricultural economics in the past quarter of a century has been the harvesting of crops by the pigs. It has now gone far beyond the experimental stage.[6] Each year in this country millions of acres of corn and hundreds of thousands of acres of clover, soy bean, cowpeas, peanuts, wheat, and other crops are not touched by human hand or by machine. The pig walks in and harvests the crop without cost and with much joy to himself.

I would lay especial emphasis on the suitability of the hog for harvesting crops on the little winding strip of tilled land

[5] Two counties in southwestern Wisconsin hogged down twenty-seven per cent. of the corn crop in 1926. (W. J. Spillman, U. S. Department of Agriculture.)

FIG. 114. *Top.* Mr. Lawrence Lee's great invention—a water-holding terrace made on absolute contour with Martin grader. Trees, very small in picture, planted just below edge of ditch. They are growing admirably with *no* cultivation in an old worn field. *It works.* This is not mere theory. (Photo Lawrence Lee.)—FIG. 115. *Center.* Terracing cotton-fields, South Carolina. Water follows the gentle winding slope of the black lines. It would interfere with no machinery if rows of trees stood on the edge of these terraces. (Courtesy U. S. Dept. Agr.)—FIG. 116. *Bottom.* Apple orchard planted on contour by M. B. Waite (U.S. Dept. Agr.), with irregular spacing of trees and short rows, but soil is saved though cultivated. (Photo J. Russell Smith.)



Photos J. Russell Smith

FIG. 117. *Top*. Gulch irrigation of olive trees by the Matmata tribe of Berbers in Central Tunis. Rock dams have been built across the narrow valleys in limestone plateaus. Silt collects behind them. Every rain wets it all. The finest olive trees I have ever seen. Rainfall of 7 inches per year. FIG. 118. *Center*. Bank between two rows of Tunisian olive trees to prevent run-off of surface water. Rainfall 7 to 8 inches. Trees 70 feet apart. Increase of trees gives no increase of fruit.—FIG. 119. *Bottom*. Dr. J. H. Meyer, of Pennsylvania, at left, standing in a typical pit dug near an apple tree in bis orchard to catch surplus water.

between two terraces. With hogging down of non-tilled crops there is only soil preparation and seeding to be done on the winding little terraced fields (see Fig. 115)—another reduction of the handicap.

Hogging down also permits a variety of foods to be eaten by the pig, which has a distinct advantage.[6]

If crop trees are on the terrace edge, hogging down permits trees to have the benefit of cultivation if the owner so desires and permits part of the hillsides to be cultivated. All parts can be profitable because that which is not cultivated can be covered by the trees and grass.

These new techniques—nitrate instead of cultivation, fertilization by legumes, irrigation from the rain-fed reservoirs on the spot, and hogging down, taken in combination with ordinary pasture suggest an entirely new era of heavier productivity of the unplowed and unplowable lands of the American farm. This is fortunate because over a large section of our country the greater part of the land as now arranged (page 10) can be regularly plowed only to its ruin.[7]

A Possible New Technique

The year after the Portuguese cork farmer strips his oak trees, the trees yield an enormous crop of acorns. Stripping the bark off injures the tree enough to scare it into yielding a big crop but gives no permanent bad result. This matter of crop stimulus through controlled injury is like whipping a horse. Its possibilities are for most crops unknown, but certainly

[6] See Farmers' Bulletin 441, U. S. Department of Agriculture, *Feeding Hogs in the South.*

[7] "In nearly every county in the Southern states there is from 25 per cent. to 75 per cent. of the land not in cultivation. Much of this land is of a character suitable only for the growth of grass and trees that would yield some revenue through stock feeding." (Archd. Smith, Professor, Mississippi Agricultural and Mechanical College, Agricultural College, Mississippi, letter, May *30,* 1913.)

worth experimental study. It may permit substantial increase of fruiting on many kinds of trees. (See page 12.)

VII. UNPLOWED LAND AND ITS YIELD IN PASTURE

At the present time orthodox agriculture in America recognizes but two uses for unplowed land—forestry and pasture of grass and leaves.

This book finds its chief reason for being in the fact that pasture is a very low-grade use for land—low in return. Because of the low return of pasture, man appeals to the plow and causes ruin. Much semi-poetic stuff has been written about the beautiful blue grass of Kentucky. It is beautiful, and it is good poetry stuff, but it is open to question if it is any more productive than good blue grass in adjoining states where careful test shows such pasturage produces the paltry harvest of but one hundred and fifty to two hundred pounds of live meat per year.[8] The same is true of the rich and beautiful pastures of England. And there are millions of acres of rough pasture in the United States east of Kansas and north of the Cotton Belt which will not make over fifty pounds of beef or mutton in a year.

These figures are little short of appalling when we remember that this meat is half waste. It is much less nutritious pound

[8] See Virginia Agricultural Experiment Station, Bulletin 204. "The Management of Blue Grass Pastures." This bulletin is in agreement with the following statements:

"Two acres of good average grazing land in Missouri will furnish feed for one thousand pound steer for a grazing period of seven months. The steer will gain from 350 to 400 pounds." (University of Missouri, Columbia, October 8, 1913, F. B. Mumford.)

"The most reliable figures are quoted in Henry's *Feeds and Feeding,* taken from a large number of cattle in three of the most important Corn Belt states. The yield of beef per acre as quoted here is as follows:

	Yearlings	*Two-year-olds*
Missouri	141 lbs.	159 lbs.
Iowa	144 lbs.	156 lbs.
Illinois	135 lbs.	156 lbs.

(Letter, E. F. Ferrin, Ames, Iowa, September 30, 1913.)

"Data have been gathered at this station and corroborated by the Illinois, for pound than most of the wild nuts that we store in the attic or permit to lie in the woods.

The unplowable lands can be classified as:

(1) Steep lands,

(2) Rough lands,

(3) Odd corners of lands including farm windbreaks,

(4) Overflow and wet lands.

VIII. UNPLOWABLE STEEP LANDS

1. These lands belong naturally in grass and trees and water pockets. If not too rough or too steep much of this kind of land can be cultivated in strips with water pockets and trees as above mentioned. In places that are too steep to be cultivated the water pockets can still be used to save the land and nourish the trees. On land too steep to have water pockets that are large enough to hold all of the rainfall, small ones may be used for getting trees established and for partial irrigation.

2. Rough pasture land. Here is one of the greatest wastes in land utilization in America.

The low yield of these hilly pastures has just been mentioned (page 268). Nearly all such areas have undergone cultivation by plow until by the processes of erosion most of the loose top soil has been removed, often to the depth of

Iowa, and Missouri stations showing that the average gain per steer on grass without grain is approximately fifty pounds per month for the grazing period of six months. It. takes very good land to graze one two-year-old steer for each two acres, thereby making the yield of beef on good land 150 pounds per acre. On cheap land where it requires more than two acres to furnish pasture for a two-year-old steer the yield per acre would necessarily be less. There are some parts of this state where it would require ten acres of land to furnish pasture for a two-year-old steer during the summer (30 lbs. of steer per acre per year) and there are very few parts of the state where a two-year-old steer can be grazed on as small an area as an acre and a half." (Purdue University, Agricultural Experiment Station, Lafayette, Indiana, October 18, 1913, letter, F. C. King, Associate in Animal Husbandry.)

Similar figures, namely 150 pounds per acre, were found to be the mutton yield as a result of careful weighing and measurement of English grass yields by William Somerville, Professor of Rural Economy at Oxford University, England.

many inches.[9] Under these distressing conditions the yield diminishes until finally the place goes back to pasture. The amount of this loss in one or two decades will astonish one who looks up the facts.

Using the Leguminous Tree as Source of Nitrogen

I am sure that many of these pastures would have their productivity as pastures increased if they could be thinly covered with a planting of some leguminous tree whose roots would gather nitrogen from the air and leave it in the earth where the grass roots could share it. I cannot prove that statement statistically, but on the other hand I believe that it is also true that there are no experiment stations in the United States that have data to disprove it or to prove it. Such data would be very valuable and reasonably easy to secure.

My opinion is derived from observing that good grass grows under locust (robinia) and honey locust trees in pastures, sometimes in places where nearby lands are desolately bare. I have seen conspicuous examples of this on some of the shale hills of Bedford County, Pennsylvania. Certainly my opinion is backed up by an editorial in the *Breeder's Gazette* (1926).

I believe the owners of such pastures in natural blue grass country would get more grass if their fields had compact clumps of about twenty-five yellow locust trees set one hun-

[9] See the very illuminating and discouraging article in *American Forests,* June, 1927, in which Mr. Hugh Hammond Bennett, United States Bureau of Soils, states, "On the watershed of the Potomac River the writer recently checked the amount of soil wastage over some of the mountainous country from whence comes the water supply of the national capital. It was found even on the smoother plateaus that from five to eight inches of top-soil had been removed from most of the cleared land. This condition obtained in many places where crops had been grown only fifteen or twenty years, and the exposed subsoil of clay and rock was so infertile that poverty grass was the principal plant seen in many pastures and abandoned fields. Remaining patches of original forest with their undisturbed virgin soil served as an index to what has happened."

FIG. 120. *Top.* A mangum terrace. Man at left stands upon its crest. Man at right shows where water flows away across field. (Courtesy Agr. Ex. Sta. Univ. of Ill.)—FIG. 121. *Center.* This typical Old World terrace from the Apennines of Italy prevents erosion at the price of much hand labor. Machinery can cross the device shown in Figs. 114 and 120. (Photo J. Russell Smith.)—FIG. 122. *Bottom.* Black Belt of Alabama. Shallow soil, one of best in the world, washed away to bedrock of white limestone in a few decades. (Courtesy U. S. Dept. Agr.)

FIG. 123. *Top*. Top of Appalachian shale hill. Soil too shallow to plow, yet supporting grass and trees, because roots penetrate the cracks.—FIG. 124. *Center*. Sorrento peninsula, Italy. Background, olives; foreground, walnuts. Every tree grafted. Most of the land utterly unplowable.—FIG. 125. *Bottom*. Central Tunis. Rainfall less than 10 inches. Olives, as far as the eye can see. Tree agriculture is the best of desert agricultures.

dred feet apart. The roots would run under all the grass in . the field and nitrate it. The honey locust trees (Chapter VII), besides feeding nitrogen to grass (page 65), would yield beans.

If such pastures had an open planting of honey locust interplanted with grafted walnut trees or grafted hickory trees, the honey locust could furnish nitrogen[10] for the nut trees. If the run-off went into water pockets so that trees and grass could share all the water that fell, it would certainly result in a substantial increase of grass, wood, and tree crops. The water pocket would also catch and hold the fine earth particles which the rain would ordinarily carry away. Thus fertility would be increased, and the land would be built up. It should be remembered that both locusts and the black walnut have open tops letting much light through.

IX. THE ROUGH AND STONY LANDS

These differ but little from the steep land except that they are usually in better condition because they have escaped the scalping by a plow-mad race.

The Rocky Knolls of Limestone

Under the heading of rough lands mention should be made of the hundreds of thousands of fruitless trees now standing in the rough limestone fields of the great Appalachian Valley which extends from southern New York to northern Alabama. In certain sections, such as the Cumberland Valley, Shenandoah Valley, and the valley of east Tennessee, which have long been famous for a rich agriculture, the traveler is amazed by the great amount of outcropping limestone making patches where farm machinery cannot go. Here the good soil makes good grass, and often good trees have sprung up without the aid of man.

This is prime walnut land, and the walnut is thoroughly

[10] This practice is much used in coffee, tea, and rubber plantations, but they have not yet used a harvest-yielding legume.

at home. Here the present system of agriculture may remain absolutely intact, but supplemented by many million bushels of Persian walnuts and American black walnuts or hickory nuts or honey locust beans or acorns produced by trees standing in spots of land that the plow cannot touch.

X. FENCE ROWS AND ODD CORNERS OF LAND

Every farm even in the flattest, blackest prairie of Illinois has some corners of land that are not cultivated and where the tree lover can make a few trials without interfering with the main business of the farm. There is the lawn. The beautiful (but worthless) elms, the fruitless sycamores and boxelders and the maples—oh, Lord! how many are the maples that throw down worthless leaves upon our pathways! To ornament the home nothing is more beautiful than the hickories and the pecans, and the various walnuts certainly rank high in esthetic value. They all have the additional charms of intellectual interest and a probability of nuts.

Then also there is the roadside. In France and Germany tens of thousands of roadside walnut trees and roadside plum trees belong to the local government. The annual crop is sold on the tree, and a substantial saving of taxes results. Since in America the roadside land belongs to the owner, this is a possible source of income or a place of experimentation for those to whom land is scarce.

The fence rows within the farm are even better than the roadside for experimental planting. On thousands of American farms the fence rows are almost lined with trees. In sections of northern Virginia, where I lived as a boy, it is not at all uncommon for farms of two hundred acres to have from fifty to two hundred trees scattered along their division fences and roadsides or even standing in the fields. Many of the trees are almost worthless, although some are the post-giving locust.

A square farm of one hundred and sixty acres has two miles of boundary fence. If divided into four fields, it has at least

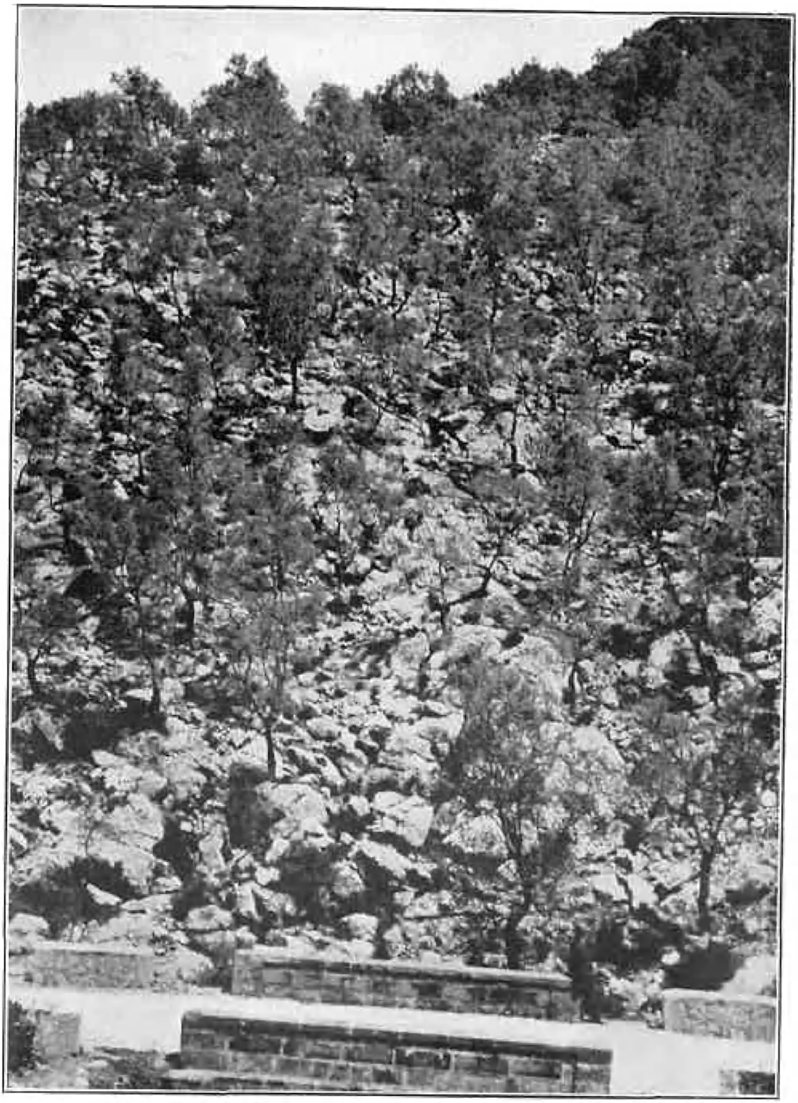


FIG. 126. The fissured limestone on this mountain top on the Island of Majorca leaves almost no earth visible. But wild olives grow in the crannies, send their roots far down into the fissures, look healthy, are grafted to good varieties, and yield well. There are also some small pickings for sheep in the same enclosure, which was so fenced with thorn that I could not enter. (Photo J. Russell Smith.)

FIG. 127. *Top*. These three magnificent chestnut trees, now dead with blight, suggest the effective use that can be made of millions of odd corners of land on our American farms. Indeed, millions of such places are now occupied by brambles, bushes, and other worthless or almost worthless vegetation and might just as well be occupied by some noble tree yielding nuts or other useful crop. (Photo J. Russell Smith.)—FIG. 128. *Bottom*. The windbreaks around the prairie farmstead invite the tree breeder to discover trees that produce crops as well as wind-resistance. (Courtesy U. S. Dept. Agr.)

one mile of inside fences. Crop-yielding trees along these fences will not interfere with the machine agriculture in any way. Of course the trees should not be there if they cannot pay with their own crops for the reduction of crops they make in the field. In a recent journey from New York to St. Louis, and thence to San Antonio, Texas, I was struck by the great number of fruitless trees standing in the midst of fields that were prime for machinery.

Tens of thousands of farms have an uncultivated corner across the gully, beside a stream bank, or a chopped-out bit of woods. In all these places trees will grow. If the land is not pastured too hard, the seeds of walnuts and hickories and many others will grow up ready to be grafted in a few years by him who would experiment.

The Windbreak

"Oasis agriculture in the Sahara, Arabia, and other tropical desert regions is made possible, principally, by date palms, which act as windbreaks and as shade for tender plants beneath, while drawing the wherewithal for a valuable fruit crop from the basement stories of the soil.[11]

Several hundred thousand square miles of the middle western United States are so level that the wind fairly combs the grass because there are no hills or forests to prevent or disturb its close approach to the earth.

In this region the farmers have planted windbreaks about their houses and farm buildings and now the agricultural scientist has found the windbreak is a needed protection to the grain field.

"Measurements made in fields of small grain indicate that the crop gain in the protected zone is sufficient to offset fully the effects of shading and sapping. In a wheat field protected by a dense windbreak the gain amounted to about ten bushels per acre where the protection was most complete, and grad-

[11] R. C. Forbes, ex-Director Arizona Station,

ually grew less as the distance from the windbreak increased. The total gain was about equal to the amount of grain which could have been grown on the shaded ground near the trees. The season in which the measurements were taken was not of high winds nor did it lack moisture. It would appear, therefore, that in a windy year when evaporation was high the total gain for the field would much more than balance the loss." [12] This statement ignores the value of wood or crop produced by the trees of the windbreak.

That means that Illinois, Iowa, Kansas, Nebraska, Minnesota, the Dakotas, and other states and other similar regions in other continents need to have thousands and tens of thousands of miles of long rows of trees. Perhaps they might be fruit- or nut- or bean-yielding trees [13] while stopping the wind and making wood. "Alfalfa grows almost to the base of honey locust trees." [14]

XI. THE OVERFLOW LANDS

From Maine to Kansas and from Minnesota to Texas and Alabama there is much land which is uncultivated because it is threatened with overflow from some flooding stream at some time during the growing season. Therefore, the plow crops are unsafe and cannot be depended upon. Therefore, this, the best of land, usually remains in pasture. From Ohio and Iowa southward and southwestward this is the homeland

[12] *The Windbreak as a Farm Asset,* Farmers' Bulletin 788, United States Department of Agriculture, Carlos G. Bates, Forest Examiner.

See also U. S. Department of Agriculture, Farmers' Bulletin, No. 1405.

"I have long had in mind that we might some day protect one-quarter section by cutting it into ten- and twenty-acre fields and protecting each field with red cedar or other windbreak." (Letter, Albert Dickens, Horticulturist, Manhattan, Kansas, August 3, 1916.)

[13] The element of overhead expense should be emphasized here as a profit aspect. It seems to be established that the farmer should have a windbreak for its own sake as a windbreak. Therefore, every dollar of profit from fruit, nut, bean, or wood is a dollar of clear profit. Overhead expense as a business factor has not been sufficiently appreciated in American agriculture.

[14] Farmers' Bulletin, No. 1405, *The Windbreak as a Farm Asset,* p. 6.

of the pecan and the big nut shellbark hickory. This is also the home of several other hickories and of the black walnut.

These very fertile meadows, these little Nile valleys, are the natural home of a two-story agriculture, pasture beneath, tree crops above. Owing to the high water level from the nearby streams, the moisture supply is usually abundant. Owing to the overflowing of muddy water, fertility is so abundant that the high-headed pecans, hickories, walnuts, honey locusts, oaks, or other trees can bear their maximum crop[15] without causing much diminution of the grass at their feet. I venture to suggest that enough pecans to supply the world's market for the next thirty years can be grown on such unplowable overflow lands in the proved homelands of the pecan. (Chapter XIX.)

XII. STARTING THE TREE FARM

Suppose some one wishes to start a tree-crops farm. How shall he begin? The answer is plain. Begin gradually. One thing this book is most emphatically *not:* it is not a recommendation to the business interests of the United States to plant out a large tract of any crop-yielding tree. Such one-crop-gambling enterprises have overhead charges which usually eat them up. A farm on the contrary already carries its overhead charges and an intelligent farmer can start experimenting with trees with no element of additional overhead—no purchase price of land, special tools, or anything but the trees themselves and the few things that may be directly used with the trees.

To one who is now farming and wishes to try tree crops, the thing to do is to go on with his farming as before. Start some trees in a small way. Try a few of several species or varieties. Experiment with them. Let the business grow in the light of experience. In due time the farm can be made over as things prove themselves. It can be done gradually in the same

[15] This land has the lowland disadvantage of frost, but this is mitigated by the low (or absent) cost of trees that care for themselves.

way that annual payments build up a life insurance investment. Men regularly pay life insurance so that their widows and orphans may have an income in later years,—in very much later years we all hope as we do it. We regularly lay aside money to be used after we are dead. With this point of view in mind, I wish to point out that the hickories, for example, offer tens of thousands of farmers an opportunity that probably beats five per cent. bonds as a means of adding to the estate. Page 279 shows a suggested ultimate objective.

Wherever there is a piece of rough land naturally set to hickory and suitable for pasture, the hickory timber can be cut down. The stumps will often throw up suckers, which grow with much speed for a few years. Cattle will not eat them, and the suckers can soon be grafted. At the height of six or eight or ten feet, the new-set graft is safely out of the reach of pasturing animals. After it is grafted, a little care for a few seasons, such as tying in the grafts and painting the wounds, will see them safely healed over. Two or three prunings in the winter time suffice to completely establish the graft and give it a monopoly of the root. After this you can forget (unless you love trees) your investment of twenty-five or fifty cents. Then after five or ten years more or less, your graft will probably begin to pay one hundred per cent. or more on the cost every other year and will keep it up for several generations. Meanwhile the field has always been a good pasture and you have been going on with your farming, while Nature, slightly aided, has been turning your pasture into a valuable property.

If the tree grower wishes to begin by starting with nursery trees, he can buy grafted trees of the following species[16] to be used as human foods:

1. Northern pecans and southern pecans—many varieties.
2. Shagbark—several varieties.
3. Hybrid hickories.

[16] See H. D. Spencer, Secretary, Northern Nut Growers' Association, for list of nurserymen.

4. Hickory-pecan hybrids.
5. Black walnut—several varieties.
6. Persian walnuts—several varieties.
7. Japanese walnuts (heartnut) several varieties.
8. European filbert—many varieties.
9. American hazelnut—several varieties.
10. Hazel-filbert hybrids—several varieties now are or soon will be available.

He can probably secure now or soon a few Chinese seedling chestnuts from the Department of Agriculture, or he can buy any year some Chinese chestnut seed.[17] By the time his trees are large enough to graft he can probably secure cions of some blight-proof oriental chestnut or hybrid.

For forage crops he can secure grafted mulberries, grafted persimmons, both native and oriental, honey locust seedlings, or honey locust seed from which to grow trees to be grafted in place a little later when good varieties are known.

The best producing oak trees within ten miles of the place of residence of most people of the United States will make interesting grafting experiments.

Interplanting Different Species

Interplanting of different species will be an important device in tree-crop farming. To provide early returns quick-maturing species can be alternated with slow-maturing.[18]

To secure fertility leguminous and non-leguminous trees may be interplanted so that the non-legumes may derive nitro-

[17] Yokohama Nursery Company, Woolworth Building, New York City, will fill your order if placed early enough.

[18] The mulberry tree is a promising filler crop. It grows rapidly, bears young, and is unusually resistant to shade.

"The mulberries are in general quite tolerant of shade. This is shown not only by the fact that the trees bear fruit throughout the crown and even in quite dense shade, but also in the fact that the young seedlings are able to grow for a long time under the shade of other trees." (Letter, George B. Sudworth, Dendrologist, U. S. Department of Agriculture, Jan. 23, 1923.)

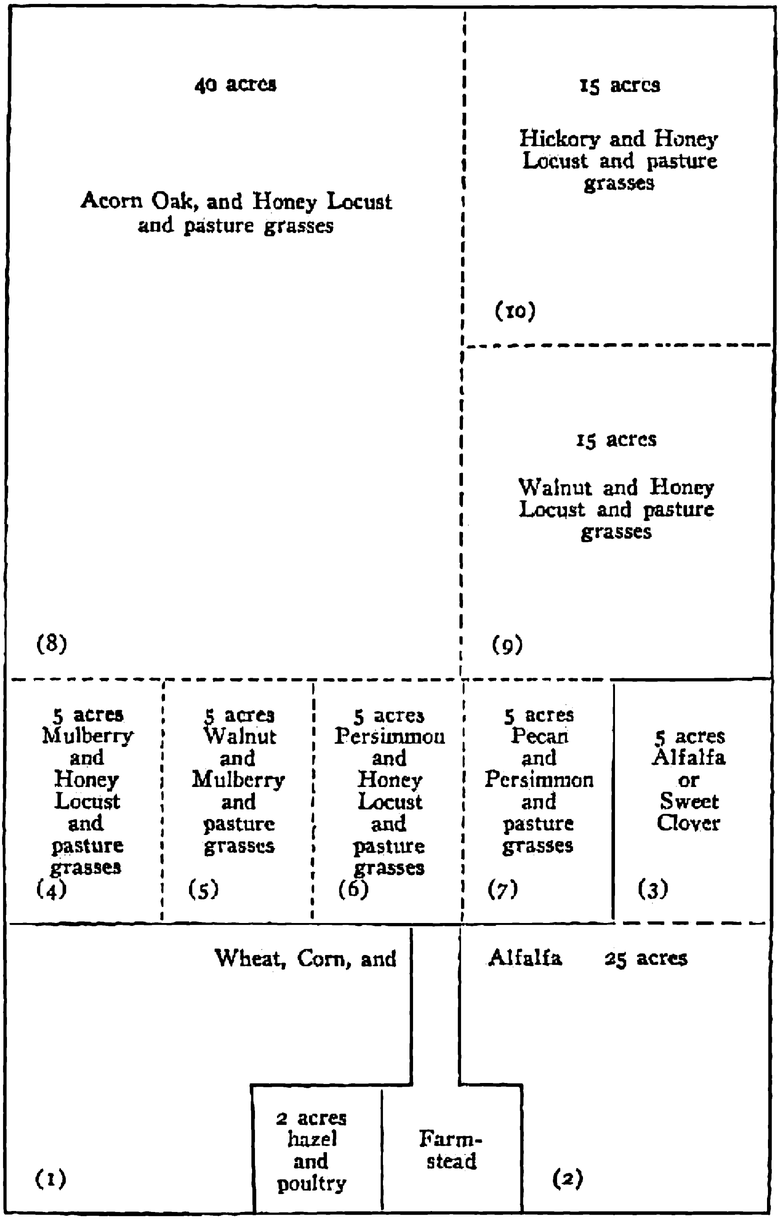
Therefore, every third tree in every third row in a mulberry orchard might be a pecan ninety to one hundred feet from its nearest pecan neigh-gen from the legumes. Thus nut trees, including oaks, might be permanently interplanted with the leguminous honey locust.

XIII. TREE CROPS FOR THE DRY FARMER

Tree crops have unusual merits for agriculture in some lands too dry for plow farming. If a competition were opened for the driest farmers in the world, I should enter as promising contestants the Berbers who live in the Matmata section of central Tunis. Their average rainfall is about eight inches a year It is often less than this, yet they are the owners of the finest olive trees I have seen in my journeys through Spain, Portugal, Algeria, Tunis, Italy, Palestine, and Syria. These trees are of record-breaking excellence though growing in a climate of record-breaking aridity. Why? The Berbers build dams of dry stone wall across gullies in a limestone plateau (Fig 117). At every sudden shower, water rushes down the gullies sweeping a certain amount of loose soil. This catches behind the dams. Olive trees are planted in this soft earth. Every shower that produces a run-off in the gullies soaks this evergrowing mass of collected top soil so that one-half inch of rain may give these trees in the rich gully pockets the equivalent of six, eight, or ten inches of rainfall because of the thorough soaking of the collected soil mass.

This practice of gully-shower irrigation could be used in the arid parts of America and every other continent. In a certain modified sense, it has already been copied in America. A Montana bulletin describes the building of barrages and the

bor The pigs as they pasture the mulberry would hardly miss the ninth tree which was a pecan Gradually the towering pecan would overspread the low-topped mulberries, paying for their scalps with nuts. Similarly every fourth tree in a mulberry orchard might be a grafted black walnut, grafted English walnut or grafter hickory. As these crowded out the mulberry fillers to nurse along the orchard which would be paid for almost from the be ginning by the automatic harvest of the neighboring filler trees. The precocious and bush-like hazels, filberts, and hybrids thereof have interesting filler possiblities.


40 acres
Acorn Oak, and Honey Locust and pasture grasses
(8)
15 acres
Hickory and Honey Locust and pasture grasses
(10)
15 acres
Walnut and Honey Locust and pasture grasses
(9)
5 acres Mulberry and Honey Locust and pasture grasses
(4)
5 acres Walnut and Mulberry and pasture grasses
(5)
5 acres Persimmon and Honey Locust and pasture grasses
(6)
5 acres Pecan and Persimmon and pasture grasses
(7)
5 acres Alfalfa or Sweet Clover
(3)
Wheat, Corn, and Alfalfa 25 acres
(1)
2 acres hazel and poultry
Farm-stead
(2)

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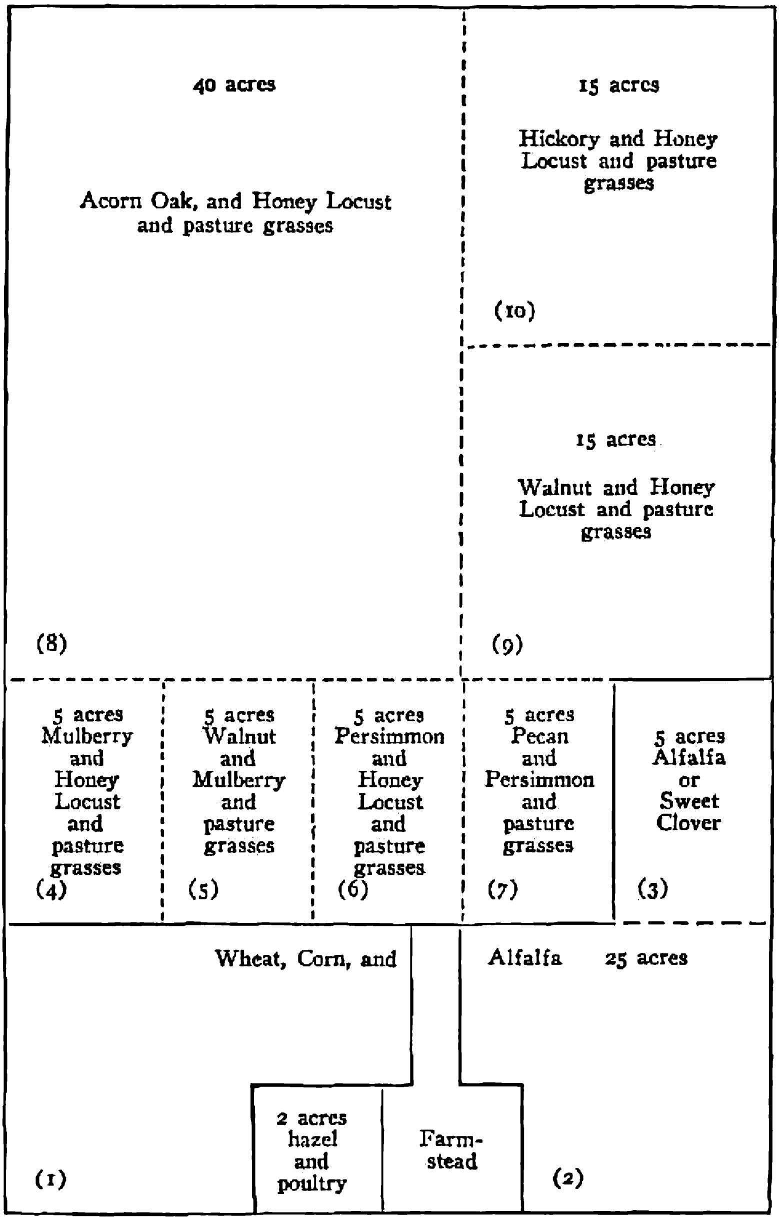
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(1)
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(2)
2 acres hazel and poultry
Farm-stead

impounding of run-off gully water in grain and alfalfa fields to the great improvement of the crop.

This device, however, has much wider possibilities with trees than with grain and hay for the reason that grain and hay require wide areas, while a tree can stand at the bottom of a gully in a ravine.

Here is an interesting possibility for the million or more square miles of arid lands between Kansas and California, and between northern Alberta and southern Mexico. At present millions of arroyos (gullies) waste their rushing waters at the time of occasional rains. These gullies might become rows of useful trees fed and watered by the gully itself.

Perhaps the water of gullies could be led into long horizontal trenches or field reservoirs reaching long distances across the face of the slope and lined with the fruit-yielding trees which would be watered every time the gully flowed. This practice would be closely akin to the one common in parts of Shansi, a Chinese province southwest of Peking with scanty rain. There in the agricultural villages one of the common sounds of summer nights is the booming of the temple gong as the priests walk through the streets awaking the people to the fact that there has been a shower on the hills and the gullies are running. The population scurries out armed with shovels and diverts water from gully to field.

I have seen these fields months in advance all prepared, the field banked around, and gullies with dams so that when the first rain came it would irrigate field number one. Shovel out the dam, and the water would flow down and irrigate field number two; and so on.

May not the use of cement, accurate leveling devices, road-scraping machines, tractors, and dynamite in America put rain-catching devices on a basis that is not only mechanized but almost automatic, so that the gully water might fill our field reservoirs while we slept?

Plant breeders might produce hardy and productive strains of almond, olive, apricot, oak, mesquite, honey locust, walnut, or other fruiting trees which could be planted out in the arroyos of the arid Southwest so that the sheep ranches of our own country might be dotted with productive trees in a manner identical to that of the Berbers who have dotted their sheep and goat ranches with olive trees and date palms. Enough of this has been done in Kansas to merit much more attention than it has received.[19]

Examination of the map will show (Fig. 136) that every continent has large areas of grass land or scrub land on which this is about the only possible form of agriculture.

The world needs immediately eighteen or more experiment stations whose staffs are experts in the breeding of desert trees.[20] Each of these stations would have on the average a million square miles of land to serve. Each station would possibly increase the productivity of at least fifty thousand square miles or thirty-two million acres. Suppose five dollars[21] per

[19] "Taking advantage of run-off water in order to give trees an increase in moisture over the natural fall is, as you doubtless conjecture, an old and common method. The Experiment Stations at Colby and Tribune have taken advantage of this, and it is quite the common thing in the parks. The park at Colby was planted for this purpose, and the trees have made very satisfactory growth. . . .

"The past twenty years I have visited every county in the state, and the forty western counties would have from five to twenty units and the average perhaps fifteen. The area would be harder to estimate. Probably a couple of acres for each location.

"The value of trees has been more from ornamental and esthetic points of view than from production of food. The mulberry and apricot are quite generally grown in the dry territory and produce some food. The black walnut is generally planted more for the production of nuts than for timber. Mulberry of course is not a high-class food, but it attracts the birds and is quite commonly planted." (Letter, Professor Albert Dickens, Horticulturist, Kansas State Agricultural College, Manhattan, Kansas, March 24, 1927.)

[20] In Alberta, Texas, Arizona, Mexico, Argentina, Brazil, Russia, Turkestan, northwest China, India, eastern Palestine, Turkey, Sudan, Rhodesia, Cape Colony, North Australia, and South Australia. See map. (Fig. 136.)

[21] These trees would have to be scattered over wide areas. This would enhance their value exactly as the value of the irrigated land of western North America is enhanced by the fact that it is scattered. As the irrigated land is chiefly in alfalfa, the haystacks scattered over a million square

acre per year were added to this thirty-two million acres—a rather large result to follow from an endowment of one or two millions.

The variation of plants of the same species has received frequent mention. One more point needs to be presented in connection with the idea of breeding desert trees. They sometimes vary fifty per cent. or more in the amount of water required to produce a given result. This variation *within the species* suggests an interesting line of experimentation with different species and strains,[22] to find the most efficient for particular places.

XIV. TWO-STORY AGRICULTURE FOR LEVEL LAND

Lastly I wish to submit the thesis that the trees now unused or little used as crop mediums may be the best kind of crop for some of our levelest and most arable lands. I have in mind a two-story agriculture with tree crops above and tilled crops beneath. By analogy I would recall the French practice (page 166) of scattering walnut trees all over the farm while going on with the farming. This does not sound alluring to the machine-using American, but let us consider it. Suppose you had a farm on the sandy plain somewhere between New York and Galveston. You are growing hogs and letting them

miles combine with the adjacent range land to support animals and the family in a way that could not result if all the irrigated land were in one block.

Similarly millions of scattered fruit, nut, and bean trees in the ranch country would meet their greatest need in helping to feed both the family and the flocks, with occasional small surpluses or specialties for export. The chief cash value would reach the world market in form of meat and wool and hides in exchange for an infinitude of manufacturers.

[22] See "Water Requirements of Plants as Influenced by Environment," L. J. Briggs, and H. L. Shantz, *Proceedings,* Second Pan-American Scientific Congress, Washington, 1915.

The variety of wheat having highest water requirement was eighteen per cent. above the lowest, corn thirty-one per cent., vetch thirty-five per cent., alfalfa forty-eight per cent., sorghum sixty per cent., and millet seventy per cent. I regret that Messrs. Briggs and Shantz did not test trees. I should expect similar results among them.

FIG. 129. *Top.* A hillside pasture made doubly fruitful by grafting suckers of chestnut trees in a clearing.—FIG. 130. *Bottom.* Tall-headed pecan trees planted by owner in cow pasture of rented dairy farm. The two stakes support the tree. The barbed wires keep the cows from rubbing the stakes. The pieces of old rubber hose by the man's finger protect the tree from the stakes. This invention is freely given to the public. The trees were mulched and manured. They are thriving in the *pasture* of a *rented farm*. No overhead cost. The latest improvement in this technique in land too rough to do as in Fig. 23 is to dig a two-bushel hole above tree, plow furrows leading water to it for shower irrigation. Try it. (Photo J. Russell Smith.)

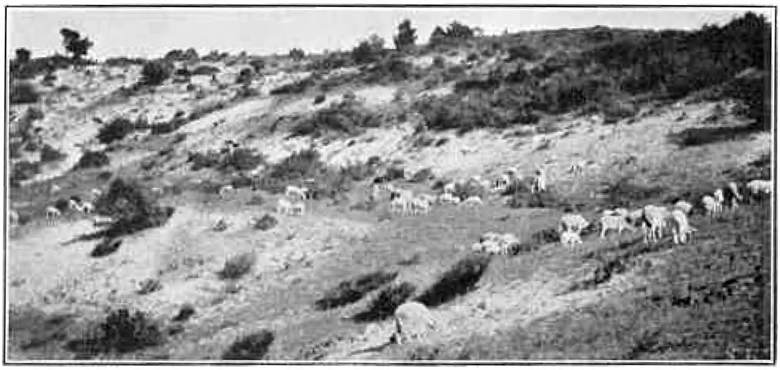


FIG. 131. *Top.* Northern Algeria. Rainfall, 20 inches. Pasture land scattered with wild olives.—FIG. 132. *Center.* Same locality as Fig. 131. Hill which was like Fig 131 has had all its trees grafted to become like Fig 124.—FIG. 133. *Bottom.* Abandoned farm buildings. Abandoned house. Abandoned Pennsylvania hills. The level land agriculture would not pay.

harvest a series of crops with, perhaps, cotton in the series as a cash crop. You plant out most of your farm with pecan trees in rows two hundred feet apart, fifty or one hundred feet apart in the row. This is not much of an interference with plowing, harrowing, planting, or tillage. Save for the cotton and probably some corn you have no harvesting operations; the pigs do that and little trees do not interfere with them. Little trees do not interfere with harvesting cotton or corn.

After you have planted your pecans, walnut, hickory, honey locust, grafted oak, or other large-growing productive trees as just described, you go on with the hogging-down crop rotation. Gradually the trees grow to gigantic size and maximum productivity, meanwhile the hog farming goes on beneath the trees to the benefit of the trees, but the crops from the trees more than make up for the reduction in the forage and cotton crop series.

Concerning this two-story agriculture it is a little-used fact that some plants do not require full sunshine for maximum growth. Mr. H. L. Shantz of the United States Department of Agriculture states[23] that experiments with artificial shading showed that when the light was so decreased as to range from one-half to one-seventh of normal illumination a general increase in growth resulted in potato, cotton, lettuce, and radish. Corn made its best growth in full light.

When we know more about this subject, we may be able to work out a crop rotation that will actually do better when taken from full sunshine to the partial shade made by some kinds of crop-yielding trees, especially in our southeastern area of abundant rain—Cotton Belt and Corn Belt.

[23] Bulletin, No. 279, Bureau of Plant Industry, United States Department of Agriculture, *Effects of Artificial Shading on Plant Growth in Louisiana*, H. L. Shantz.

CHAPTER XXIV

PLAN OR PERISH—TREE CROPS. THE NATION AND THE RACE

A NEW PATRIOTISM IS NEEDED

Considered from the standpoint of permanent resources a large part of the United States is on the road to economic Hades, going rapidly, by way of gullies, and few there are who seem to realize the significance of the catastrophe.[1]

The idea that a foreign country might get possession of some little island on the coast of Maine or Florida or Texas would bring thousands of Americans to their feet willing to fight and perhaps to die that this speck of land should not pass to the possession of another nation.[2] Yet these same men who would fight to prevent change in national ownership of a piece of land have little compunction about destroying land in their own country. By neglect they are often destroying an acre or two in a season. Thousands of them *are* doing it *yearly, now.* In a single generation each of tens of thousands of Americans destroys enough land to support a European farm family for unknown generations of time.

These land-wasters think that they are patriotic citizens. We need a new definition of patriotism and a new definition of treason.

[1] For example, the hillside shown in Fig. 5 is within one hundred miles of Washington. It is fairly typical of thousands in the whole Piedmont area that reaches from New York to Alabama. The County Demonstration Agent in the county where that picture was taken seems never to have heard of the mangum terrace (Fig. 120), and his chief, the state Chief of Extension Work, tells me that he did not know there was need for such a thing in that area which is typical of thousands of square miles of rolling hills impoverished and gullied by erosion.

[2] If it did pass to some other national ownership, it would still be the same piece of land. It would still have the same good for humanity that it had before the fight. It would even continue to be the private property of its previous owners.

THE DEAD NEIGHBORHOOD

Take as an example the hills of New England and the Appalachian hills and ridges. This area has one of the most wholesome climates in the world, a climate that helps man to be healthy and vigorous both in mind and body.

It has one of the most agriculturally dependable climates in the world. The land is not visited by the droughts and famines that are so often and so feelingly referred to in the Old Testament and which desolate so vast an area of South America, Africa, Australia, and Asia. These American hills have one of the best of climates to feed man's body with food and his mills with raw material.

These American hills are variegated with beautiful flowers in spring, clothed with green in summer. The glory of autumn foliage, its red, brown, yellow, and gold set off by the evergreens, makes one of the most beautiful landscapes in the world, fit to inspire man's spirit and lift it above the prosy but useful bellyful of nuts that lies beneath the falling leaves. Yet this wholesome, dependable, and beautiful land is in agricultural decline. Much of it is desolated and abandoned. The old agriculture of the level land has been tried upon the hills, tried and found wanting.

The hills are gullied. The fields are barren. Tenantless houses, dilapidated cabins, tumbledown barns, poor roads, poor schools, and churches without a pastor—all are to be found in too many places. No wonder that whole townships are for sale and at a cheap rate. But these neighborhoods might be transformed through tree-crop agriculture.

"One phase of the rough land situation which has interested me greatly here in southern Indiana is the present hopelessness of the economic condition of the people who try to make a living there by the use of 'flat land methods.' They can't be good American citizens—they are too poor. Your program affords hope for such people and regions." [3]

[3] Letter from Stephen S. Visher, Indiana University, May 18, 1928.

TREE CROPS AND TENANCY

The tree-crop agriculturist must be a home owner, not a shifting tenant. A half million square miles possessed by land-owning small farmers is a greater basis of national strength and endurance than the landless and roving crowds of humans who, in the cities, shift from apartment to apartment and surge back and forth on the trolleys, subways, and elevated railways.

WHO WILL DO THIS WORK?

And this transformation of the hills cannot come about through the action of *government* in any democracy unless it be some small, compact, economically patriotic, well-educated, and intelligent one like Switzerland. Government may possibly be able to do it in countries governed from above like a tropical colony of a European power, but there is no use in waiting for government in the United States of America. In America it depends chiefly upon private enterprise; probably it can come only through private endowments skillfully managed.

THE GAME PRESERVE

What a game preserve a collection of good crop trees would make! The trees would both shelter and feed the animals. This job is worth doing for that purpose alone by a naturalist and big-game hunter of great means.

WORLD APPLICATIONS

An examination of the world regions map (Fig. 136) will show that every type of climate that is found in North America recurs in other continents. Some of them recur in every continent. Therefore, this book is one of world-wide application. Since I am an American and have spent only two and one-fourth years in foreign lands, my philosophy is naturally illustrated chiefly with American facts. But the *philosophy* is of world-wide application. The regional map shows in what parts of the world a given tree has some chance of thriving. Con-

FIG. 134. The maple trees down the lane with their sap buckets produce a toothsome and wholesome sugar. They are suggestive in their income, and suggestive in the fact that they have not yet been subjected to scientific improvement. (Courtesy H. R. Francis, N. Y. State College of Forestry.)

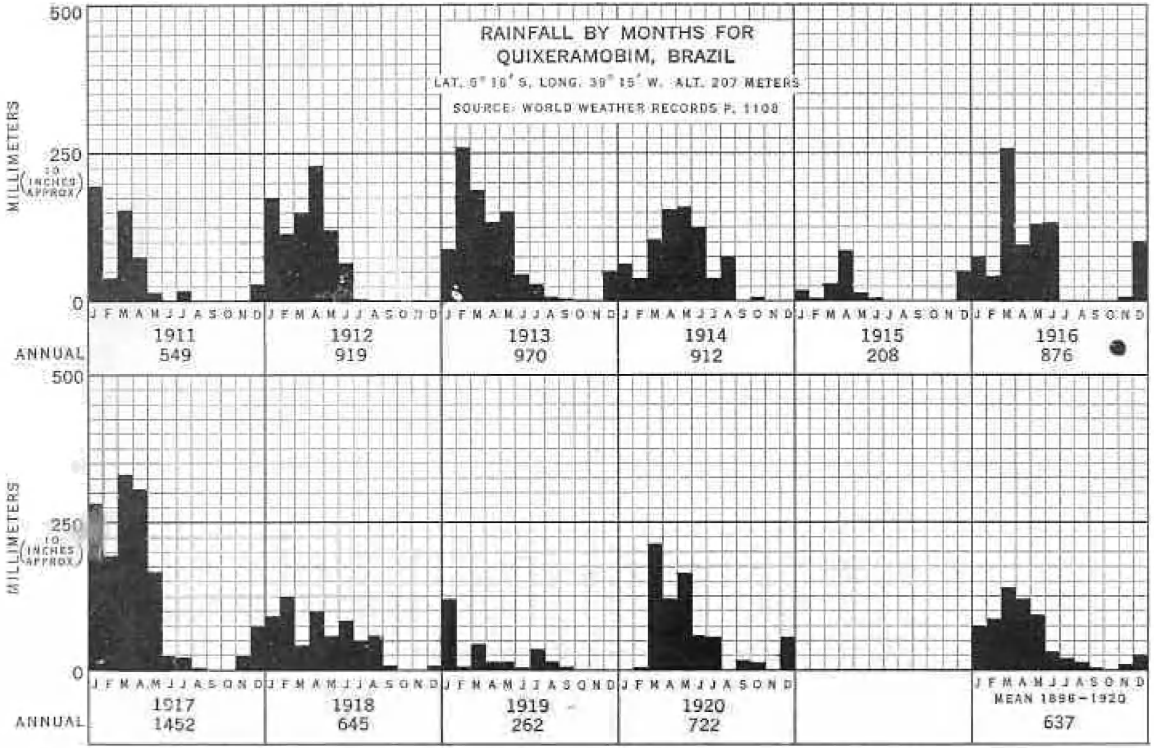


FIG. 135. This graph shows a very undependable rainfall. There are many such places, especially in the tropics. Can grain agriculture survive such irregularities? The answer is probably negative. Can tree crop agriculture do better? The answer is probably affirmative. This book is written in the hope that tests will be made to increase our knowledge.

versely it shows the parts of the world in which we have a chance of finding trees that are likely to thrive in a given area within the United States.

In most cases a crop that is a success in one continent has several more continents in which to spread itself. For example, experiments by government agriculturists[4] in India seem to indicate that mesquite seeds from California and Hawaii have been planted in several localities in India with apparent success. Since most of India suffers from drought, this is a fact of vast significance. The chapter on the tropics gave some inkling (page 252) of the valuable but unused tree crops that Nature has already developed in arid lands.

Suppose we should work out a tree-crop agriculture along lines indicated and suggested by this book. What might it mean for the United States?

TREE CROPS CAN INCREASE CROP AREA

This table[5] shows that in 1925 less than one-fifth of Massachusetts was improved land in farms and less than one-eighth of the land of the state was in crop; that West Virginia has

	Total harvested crop land		*Total crop land and pasture land other than woodland*	
	Acres (thousand)	Per cent. of area	Acres (thousand)	Per cent. of area
Massachusetts .	**625**	**12.1**	1,072	**20.8**
New York	**8,290**	**27.1**	**12,467**	**40.8**
West Virginia .	**1,677**	**10.8**	**5,304**	**344**
Ohio.	**10,703**	**41.05**	**17,979**	**68.9**
Iowa.	**21,466**	**60.3**	29,505	**82.9**
Illinois.	**19,755**	**55,07**	**26,700**	**74.4**
Tennessee	**6,209**	23.2	**10,922**	**40.9**
Oregon.	**2,592**	**4.2**	**10,385**	**16.9**
California———	**5,723**	**5.7**	**21,045**	**21.1**

[4] Kunhikannon, K. (Department of Agriculture, Mysore). *Agricultural Journal of India,* Vol. XVIII, Part 88, pp. 144-147, 1 fig. Calcutta, London, 1923.

[5] From *Yearbook,* U. S. Department of Agriculture.

even less of her land in crop; while Iowa, a state blessed with much level land, has four-fifths of her land improved and three-fifths actually in crops.

Now the soil and climate of Massachusetts and West Virginia are such that certainly ninety-five per cent. of their land area would grow crop-yielding trees of some profitable variety. Therefore it seems fair to assume that tree crops may easily increase by five- or six-fold the crop-yielding area of New England and of the Appalachian region of which West Virginia is a type.

When one adds to this the large amount of rolling land, too steep for permanent agriculture of the present type, to be found in the non-mountainous parts of eastern states and the rolling sections of Ohio, Indiana, Illinois (Fig. 4), Iowa, Wisconsin, Missouri, Kansas, and other states, it seems a conservative statement to say that tree crops by utilizing steep, rough, and overflow lands could double the crop-yielding area of that part of the United States lying east of the one hundredth meridian.

By utilizing the same sort of land in the foot hills of the Rockies, the Sierras, the Cascades, and the Coast Ranges it would seem probable that tree crops could double, perhaps more than double, the present crop-yielding area of the Rocky Mountain and Pacific states. Note the California figure, only 5.7 per cent. of her area in harvested crops. This use of crop trees on the slopes of mountains in semi-arid lands (Fig. 132) indicates that there are many tens of thousands of square miles waiting in the arid parts of the United States, Mexico, Central America, South America, Asia, Africa, and Australia.

USE OF TREE CROPS IN ARID LANDS

If the gully water that now runs away in arid regions should be utilized for isolated crop trees in the manner indicated in the last chapter (Fig. 117), at least one million square miles of semi-arid land west of the one hundredth meridian in the United States might possibly have its productivity doubled.

THE WOOD SUPPLY

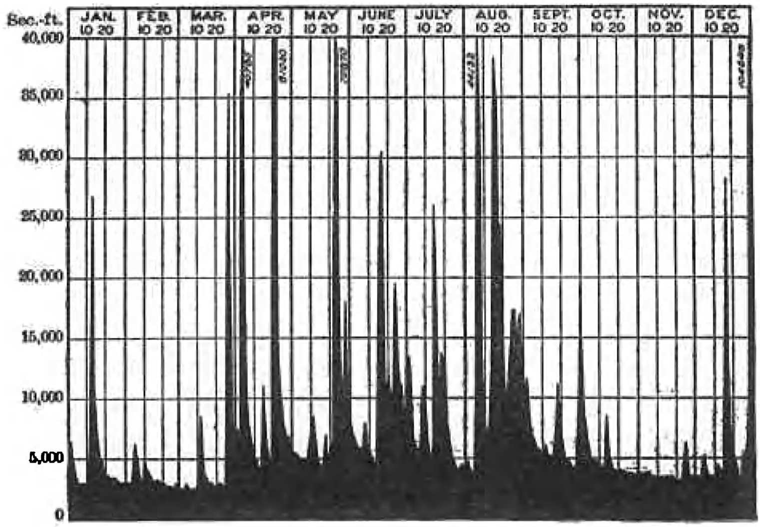
The continuance of geological surveys and technical invention seems to reveal unexpected supplies of some of the mineral resources, especially oil (from shales), but no credible estimator finds an explanation of our declining lumber output other than declining timber supply. In other words our western civilization with its vast use of raw material seems to be inevitably moving into a shortage of wood and timber. In our present civilization the refuse of the grain agriculture is straw, almost worthless and quite generally wasted. In contrast to this the tree crops, once established, will leave a substantial annual by-product of wood. Only a little of it will be saw timber, but this fact is of declining importance in this period when the use of wood in the form of pulp, paper, carton, and even paper board is increasing rapidly.

TREE CROPS, THE WATER SUPPLY, AND NAVIGATION

Suppose that four-fifths of the hill lands east of the one hundredth meridian were in crop trees whose productivity made it profitable for the farmers to cover their lands with water pockets or terraces with back ditch (Fig. 23). This would mean a greatly increased amount of water held in the ground from rainy season to dry season. This would make decreased flow in the spring of the year with many streams carrying in the minimum period several times their present flow. This would mean improved water supply for cities and for river navigation.

TREE CROPS AND WATER POWER

We are entering the age of almost universal distribution of electric power. To make this power we are rapidly building reservoirs to store mountain water for power purposes. And these reservoirs are being filled up by silt, at a rate which promises an untimely end. Reservoirs built in Algeria by the French have been completely filled. Most of this silt in eastern America is produced by wastage of fields through a pre-



DISCHARGE OF YADKIN RIVER AT SALISBURY, N. C, 1901

This graph shows (in part only) the actual amount of water day by day for a year in a small North Carolina river. In this particular year the maximum discharge per second was 104,640 cubic feet; the minimum was 2420; the average was 8636. Suppose masonry reservoirs had raised the minimum to 6000, while water terraces raised it to 7500 and protected the masonry reservoirs from filling—at the same time that they doubled the agricultural output and quadrupled the agricultural valuations.

ventable erosion. The tree-crop agriculture with field water pockets would keep most of the silt on the land where it is needed. This would greatly prolong the life of reservoirs. The storage of water in little field reservoirs would increase the minimum stream flow and therefore minimum water supply and therefore power output at minimum seasons. Since this low peak in power development is a very damaging factor, these water pockets would have a very great influence on the capital value of power installations. It should be remembered that it has been done already for its power and timber value alone (page 265) and for its agricultural value alone (page 263).

TREE CROPS AND FLOOD CONTROL

If four-fifths of the hill lands east of the one hundredth meridian had water pockets large enough to store all ordinary rains, the flood problems on our rivers, including the Ohio [6] and the mighty Mississippi, would possibly be so much reduced in size as to cease to be a serious economic menace to property situated in their flood plains.

Every continent can use these advantages. America has no monopoly on these possibilities of increasing the proportion of crop land, the usable resources of wood, of water, of navigation. Other continents also may mitigate the extremes of high and low water in their rivers by detaining the rain upon their uplands in water pockets and terraces with back ditch.

TREE CROPS AND THE WORLD'S FOOD

The ability of tree crops to increase the world's food is suggestively shown in a table invented by W. J. Spillman (see page 305).

[6] After the great flood of 1907 Pittsburgh created a Flood Commission. The Commission investigated and recommended a series of reservoirs in the mountain defiles upstream from Pittsburgh to hold flood waters until the flood danger had passed. These expensive reservoirs, if built, are destined to rapid filling, if the short-lived mountain farming of the present type continues with its gullies. But if the agricultural land were in water pockets, these would catch the silt which otherwise fills the reservoirs, would hold back much more water than the reservoirs themselves held back. It would thereby increase the available resources of flood control, of water power, of navigation, and would benefit every town from Pittsburgh to New Orleans. Too bad some Pittsburgh millionaire does not make a demonstration of this on a few thousand acres.

APPENDIX A

LIST OF ARTICLES IN WHICH THE TREE CROPS IDEA HAS BEEN BROADCASTED

American Breeders Magazine, 1910, "Breeding and Use of Tree Crops"

American Forestry, April, 1917, "Food Producing Trees"

Atlantic Monthly, Aug., 1914, "The Agriculture of the Garden of Eden"

Century, July, 1914, "Two Story Farming"

———May, 1916, "Dry Farmers of Rome"

———Dec, 1916, "New Farmer and His New Water Supply"

Everybody's Magazine, Sept., 1912, "Making Trees and Plants to Order"

Harper's, Jan., 1913, "The Agriculture of the Future"

———May, 1914, "The Real Dry Farmer"

Harper's Weekly, Sept. 12, 1914, "Avocations that Counted"

Review of Reviews, March, 1916, "Farming Appalachia"

Science, June 12, 1914, "Tree Crops as a Control of Erosion"

The Country Gentleman, June 28, 1913, "The Doctor's New Job"

———July 5, 1913, "Nut Farming for Tomorrow"

———Nov. 8, 1913, "Nut Trees That Bear Dollars"

———Dec. 6, 1913, "Pecans and the Patient Waiter"

———Dec. 27, 1913, "Pigs, Peas, and Pecans"

———Jan. 24, 1914, "Propagating Chestnuts"

———Jan. 9, 1915, "Neglected Northern Pecans"

———Oct. 8, 1915, "Riehl Fun from Nuts"

———Dec. 4, 1915, "A Georgia Tree Farmer"

———Jan. 8, 1916, "Shade Trees That Bear Nuts"

———Jan. 22, 1916, "Grafting Walnuts and Hickories"

———June 17, 1916, "English Walnuts in the East"

———Mar. 22, 1924, "Hog Feed on Trees. (A Georgia Tree Farmer.)

The Farm Journal, April, 1925, "New Light on Nut Growing"

The Geographical Review, Jan., 1916, "Oak Tree and Man's Environment"

The Journal of Heredity, Feb., 1916, "The Persian Walnut, a Type Problem"

The Saturday Evening Post, July 10, 1909, "Plows and Poverty"

APPENDIX B

BIBLIOGRAPHY ON SOIL EROSION AND ITS PREVENTION

I. BULLETINS AND BOOKLETS ON EROSION

Soil Erosion a National Menace. H. H. Bennett and W. R. Chapline. U. S. Dept. Agr. Circular No. *33*.

Is the United States a Permanent Country Like North Europe- Arthur J. Mason. Homewood, Ill.

These two are perhaps the most important in this collection and merit the attention of all thinking persons.

Erosion and Denudation in the Southern Appalachians. W. W. Ashe. U. S. Dept. Agr.

Soil Erosion. W. J. McGee. U. S. Dept. Agr., Bureau of Soils. Bulletin No. 71.

Washing of Soils and Methods of Prevention. J. G. Mosier and A. F. Gustafson. University of Illinois, Agricultural Experiment Station. Bulletin No. 207.

Gully Control. M. R. Bentley. Agricultural and Mechanical College of Texas.

Keep Our Hillsides from Washing. A. R. Whitson and T. J. Dunnewald. Agricultural Experiment Station of the University of Wisconsin. Bulletin No. 272.

Controlling Surface Erosion of Farm Lands. F. L. Duley, University of Missouri Agricultural Experiment Station. Bulletin No. 211.

Range Preservation and Its Relation to Erosion Control on Western Grazing Lands. Arthur W. Sampson and Leon H. Weyl. U. S. Dept. Agr. Bulletin No. 675.

Soil Erosion in the South. R. O. E. Davis. U. S. Dept. Agr., Bureau of Soils. Bulletin No. 180.

Soil Erosion in Iowa. E. E. Eastman and J. S. Glass. Iowa State College of Agriculture and Mechanic Arts. Bulletin No. 183.

Gullying and Its Prevention. F. H. H. Calhoun. Clemson Agricultural College, South Carolina Agricultural Experiment Station. Circular No. 20.

The Washed Lands of Indiana: A Preliminary Study. M. L. Fisher. Agricultural Experiment Station, Purdue University. Circular No. 90.

Soil Improvement for Worn Hill Lands of Illinois. C. G. Hopkins and J. E. Readhimer. Agricultural Experiment Station, University of Illinois. Bulletin No. 115.

Soil Erosion. George Roberts, J. B. Kelley, and E. G. Welch. College of Agriculture, University of Kentucky. Circular No. 129.

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The Prevention of Soil Erosion—Filling the Large Ditch. Iowa State College of Agriculture and Mechanic Arts. Extension Bulletin No. 77.

The Removal of Mineral Plant-Food by Natural Drainage Waters. Kentucky State Agricultural Experiment Station. Bulletin No. 237;

The Soil Saving Dam. Missouri College of Agriculture. Circular No. 14.

Timely Soil Topics, The Control of Soil Erosion. Ohio State University. Bulletin No. 40.

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Forests and Water in the Light of Scientific Investigation. Raphael Zon. U. S. Dept. Agr. Forest Service.

The Removal of Mineral Plant Food by Natural Drainage Waters. J. S. McHargue and A. M. Peter. Kentucky Resource Bulletin No. 237, 1921.

Our Waste Lands, a Preliminary Study of Erosion in Mississippi. E. N. Lowe. With an appended address on Mississippi's agricultural potentialities by Dr. W. J. McGee, Washington, D. C. Nashville, Brandon, 1910. 23 pp.

II. ARTICLES ON EROSION

"Erosion and Floods in the Yellow River Watershed." W. C. Lowdermilk. *Journal of Forestry,* Vol. XXII, No. 6, October, 1924, pp. 11-18. This article is peculiarly appalling.

"Erosion Control in Japan." W. C. Lowdermilk. *Oriental Engineer,* Vol. VIII, No. 3, March, 1927, pp. 3-13.

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"Soil Erosion of Soybean Land." F. L. Duley. *Journal of the American Society of Agronomists,* Vol. XVII, pp. 800-803, 1925.

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APPENDIX C

ANALYSIS OF FEEDS FOR FARM ANIMALS

Feed	*Moisture*	*Ash*	*Crude Protein*	*Crude Fiber*	*Nitrogen Free Extract*	*Fat or Ether Extract*	*Digestible Protein*	*Digestible Carbohydrate Equivalent*
Barley [1]	9.6	2.9	12.8	5.5	66.9	2.3	10.4	63.8
Corn [1]	12.9	1.3	9.3	1.9	70.3	4.3	7.1	74.8
Wheat [1]	10.6	1.8	12.3	2.4	71.1	1.8	9.8	63.3
Wheat bran [1]	9.6	5.9	16.2	8.5	55.6	4.2	12.5	48.7
Cottonseed meal (good) [1]	7.3	5.8	36.8	13.5	30.0	6.6	30.9	42.1
Alfalfa hay [1]	8.3	8.9	16.0	27.1	37.1	2.6	11.5	42.0
Alfalfa [1]	72.0	2.6	4.7	8.0	11.0	0.8	3.6	12.8
Potatoes [1]	78.9	1.0	2.1	0.6	16.3	0.1	1.3	16.3
Turnips [1]	90.6	0.8	1.3	1.2	5.9	0.2	1.2	7.4
Honey Locust [2]								
U.S.D.A. Grounds	4.1	3.7	13.4	16.3	61.3	1.2		
New Mex. Agr. Col. [3]	5.20	3.58	4.50	14.56	69.94	2.22		
Carob: Entire Bean [2]								
Italian	11.3	2.9	5.1	6.0	74.4	.3		
Portuguese	8.3	3.1	4.3	7.9	76.1	.3		
Algaroba or Keawe [4, 7]								
Sample No. 1	....	2.14	10.84	26.48	56.40	.77		
Sample No. 2	....	....	9.88	31.29	53.13	.62		
Mesquite Beans [5]								
Hawaii: 5 samples	12.3	3.3	9.0	23.4	51.4	.6		
Arizona: 4 samples	6.3	4.5	12.7	24.5	49.5	2.5		
Calif.: 2 samples	11.4	4.0	9.7	22.6	51.3	1.0		
New Mex.: 1 sample	4.8	3.4	12.2	32.0	45.1	2.5		
Texas: 7 samples	6.9	4.4	12.4	25.7	47.9	2.7		
N. M. Tornillo beans	5.1	3.0	9.8	19.3	61.8	1.0		
Mesquite Tree [5]								
No. 1343 [8]	7.25	4.31	12.48	25.67	55.51	2.03		
No. 1345 [1, 10]	6.21	5.24	14.12	22.17	54.80	3.69		
No. 1313 [10]								
Pods, 70%	5.48	5.71	5.70	30.70	55.46	2.40	*Sugars*	
Seeds, 30%	7.69	3.38	37.54	5.75	46.89	6.45	*Reducing*	*Sucrose*
Carob Bean [6]								
Pods and Seeds [7]								
1704	11.91	1.67	7.96	5.60	44.96	1.00	12.94	13.96
Minimum	9.12	1.67	3.26	4.98	26.99	1.00	3.25	6.39
Maximum	19.81	3.46	15.22	17.42	43.57	3.82	18.69	41.56
Average	13.28	2.57	6.75	9.29	39.80	2.17	11.08	19.44
Pods without seeds								
2200	12.27	2.50	3.77	9.96	40.28	2.64	6.88	21.70
2201	18.08	2.39	3.33	8.24	37.54	2.86	20.54	7.02
2371	5.70	3.87	3.40	13.62	18.36	3.08	13.04	8.93
2493	8.21	2.71	7.18	4.73	24.48	.71	8.36	43.62
Minimum	3.70	1.76	2.02	3.14	24.48	.22	3.00	7.02
Maximum	24.70	3.87	7.18	15.31	48.36	4.02	20.54	43.62
Average	11.50	2.72	4.50	8.78	36.30	2.37	11.24	23.17

[1] United States Department of Agriculture, Bureau of Animal Husbandry. The carbohydrate equivalent shown in the last column of the table is the sum of the digestible crude fiber and nitrogen-free extract, plus 2.25 times the digestible fat.
[2] United States Department of Agriculture, Bulletin No. 1194.
[3] Analysis No. 12053 Misc. Div. United States Department of Agriculture, Bureau of Plant Industry, Washington, D. C., of an unusually broad-podded variety of honey locust pods obtained near grounds of New Mexico Agricultural College, Mesilla, New Mexico.
[4] Hawaii Agricultural Experiment Station, Bulletin No. 13, Edmund C. Shorey, chemist.
[5] Composition of Entire Mesquite Beans. Analyses from "The Mesquite Tree" by Robert H. Forbes, Bulletin No. 13, Arizona Experiment Station.
[6] Bulletin No. 309, University of California, "The Nutritive Value of the Carob Bean."
[7] Prosopis juliflora: Entire beans.
[8] Gathered August 1 on Rillito River.
[9] Sample furnished by N. R. Powell of Pettus Bee Company, sent by W. J. Spillman.
[10] Gathered October 7, on Santa Cruz River.
[11] It should be noticed that these maximum and minimum figures refer to a particular element in a number of different samples. They are not complete analyses of one sample like Nos. 1704, 2200, 2201, 2371, and 2493.

APPENDIX D

FOOD VALUE OF THE PERSIMMON AND OTHER FRUITS

From Farmers' Bulletin No. 685 U. S. Department of Agriculture

COMPARATIVE ANALYSES OF FRESH FRUITS, SHOWING THEIR FOOD VALUES IN PERCENTAGES OF THE WEIGHT OF THE FRUIT.[1]

Fruit	*Total Solids*	*Ash*	*Protein*	*Sugars*	*Crude Fiber*
	%	%	%	%	%
Apples	13.65	0.28	0.69	10.26	0.96
Blackberries	13.59	.48	.51	4.44	5.21
Cherries	22.30	.65	.81	11.72	.62
Currants	15.23	.72	.51	6.38	4.57
Dates[2,3]	66.86	1.20[4]	1.48[5]	56.59[6]	3.80[7]
Figs	20.13	.57	1.34	15.51	....
Grapes[8,2]	21.83	.53	.59	17.11[9]	3.60
Oranges (Navel)	13.87	.43	.48	15.91	....
Peaches[7,2]	10.60	.40	.70	5.90[6]	3.60
Pears	16.97	.31	.36	8.26	4.30
Persimmons[10,2]	35.17	.78	.88	31.74[9]	1.43
Plums	15.14	.61	.40	3.56	4.34
Raspberries	13.79	.49	.53	3.95	5.90
Strawberries	9.48	.60	.97	5.36	1.51

[1] Data, with exceptions as noted, from Bureau of Chemistry Bulletin, No. 66, pp. 41–42.
[2] Dry matter.
[3] Average of eleven analyses. See "Chemistry and Ripening of the Date," Arizona Agricultural Experiment Station Bulletin No. 66, p. 408.
[4] See "Principles of Nutrition and Nutritive Value of Food," Farmers' Bulletin No. 142, p. 18.
[5] Adapted from the two publications mentioned in footnotes 3 and 4.
[6] Fats and carbohydrates.
[7] See "Use of Fruit as Food," Farmers' Bulletin No. 293, p. 14.
[8] See "The American Persimmon," Indiana Experiment Station Bulletin No. 60 (1896), p. 52.
[9] Nitrogen-free extract.
[10] Average of six analyses in "The American Persimmon," Indiana Experiment Station Bulletin No. 60 (1896).

AVERAGE COMPOSITION OF NUTS AND OTHER FOODS [1]

Kind of Food	*Refuse*	*Edible Portion*						
		Water	*Protein*	*Fat*	*Carbohydrates*		*Ash*	*Fuel Value per Pound*
					Sugar, Starch, Etc.	*Crude Fiber*		
Nuts and Nut Products:	%	%	%	%	%	%	%	*Calories*
Acorn, fresh [2]	17.80	34.7	4.4	4.7	50.4	4.2	1.6	1,265
Almond	47.00	4.9	21.4	54.4	13.8	3.0	2.5	2,895
Beechnut	36.00	6.6	21.8	49.9	18.0		3.7	2,740
Brazil Nut	49.35	4.7	17.4	65.0	5.7	3.9	3.3	3,120
Butternut	86.40	4.5	27.9	61.2	3.4		3.0	3,370
Candle Nut	.....	5.9	21.4	61.7	4.9	2.8	3.3	3,020
Chestnut, fresh	15.70	43.4	6.4	6.0	41.3	1.5	1.4	1,140
Chestnut, dry	23.40	6.1	10.7	7.8	70.1	2.9	2.4	1,840
Horn Chestnut, or Water Chestnut	.....	10.6	10.9	.7	73.8	1.4	2.6	1,540
Cocoanut	34.66	13.0	6.6	56.2	13.7	8.9	1.6	2,805
Filbert	52.08	5.4	16.5	64.0	11.7		2.4	3,100
Ginkgo Nut (seeds)	.....	47.3	5.9	.8	43.1	.9	2.0	940
Hickory Nut	62.20	3.7	15.4	67.4	11.4		2.1	3,345
Peanut	27.04	7.4	29.8	43.5	14.7	2.4	2.2	2,610
Pecan	50.10	3.4	12.1	70.7	8.5	3.7	1.6	3,300
Pine Nut, Piñon	40.6	3.4	14.6	61.9	17.3	...	2.8	3,205
Pine Nut, Spanish, or Pignolia (shelled)	.....	6.2	33.9	48.2	6.5	1.4	3.8	2,710
P. edulis [3]	.....	3.1	14.8	60.6	18.7 [5]	1.8 [4]	2.8	....
P. pinea [3]	.....	4.2	37.0	49.1	5.5 [5]	1.0 [4]	4.2	....
P. gerardiana [3]	.....	8.7	13.6	51.3	23.4 [5]	0.9 [4]	3.0	....
Pistachio	.....	4.2	22.6	54.5	15.6		3.1	3,250
Walnut (Persian)	58.80	3.4	18.2	60.7	13.7	2.3	1.7	3,075
Walnut (Amer. Black)	74.1	2.5	27.6	56.3	11.7		1.9	3,105
Almond Butter	.....	2.2	21.7	61.5	11.6		3.0	3,340
Peanut Butter	.....	2.1	29.3	46.5	17.1		5.0	2,825
Malted Nuts	.....	2.6	23.7	27.6	43.9		2.3	2,600
Cocoanut, desiccated	.....	3.5	6.3	57.4	31.5		1.3	3,125
Chestnut Flour	.....	7.8	4.6	3.4	80.8		3.4	1,780
Cocoanut Flour	.....	14.4	20.6	2.1	45.9	10.1	6.9	1,480
Hazelnut Meal	.....	2.7	11.7	65.6	17.8		2.2	3,185
Other Foods for Comparison:								
Meat, Round Steak	.....	65.5	19.8	13.6	....	....	1.1	950
Cheese, Cheddar	.....	27.4	27.7	36.8	4.1	....	4.0	2,145
Eggs, boiled	11.20	65.0	12.4	10.7	....	....	.7	680
Wheat Flour, high grade	.....	12.0	11.4	1.0	74.8	.3	.5	1,650
White Bread	.....	35.3	9.2	1.3	52.6	.5	1.1	1,215
Beans, dried	.....	12.6	22.5	1.8	55.2	4.4	3.5	1,605
Potatoes	20.00	78.3	2.2	.1	18.0	.4	1.0	385
Apples	25.00	84.6	.4	.5	13.0	1.2	.3	290
Raisins	10.00	14.6	2.6	3.3	73.6	2.5	3.4	1,605

[1] Unless otherwise stated, from "Nuts and Their Uses as Food" by M. E. Jaffa, Professor of Nutrition, University of California, U. S. Dept. Agr. Farmers' Bulletin, No. 332. In studying the column marked "refuse" it should be remembered that many of the nuts are based on poor, wild produce of the present markets rather than selected strains or improved strains which can be grown.

[2] For further acorn comparisons, see pages 151 and 144, 162.

[3] Information from Frederick V. Coville, U. S. Department of Agriculture.

[4] Fiber.

[5] Carbohydrates plus fiber.

APPENDIX E

FOOD VALUES OF CROP AND LIVESTOCK PRODUCTS PER ACRE

Food Products	*Yield per Acre*		*Calories per Pound*	*Pounds Protein per Acre*	*Calories per Acre*	*Acres to Equal One Acre of Corn*
	Bushels	*Pounds*				
Field						
Corn [6]............	35	1,960	1,594	147.0	3,124,240	1.00
Irish Potatoes [6]....	100	6,000	318	66.0	1,908,000	1.64
Wheat [6]...........	20	1,200	1,490	110.4	1,788,000	1.75
Dairy Products						
Milk [6]............	....	2,190	325	72.3	711,750	4.39
Cheese [6]...........	....	219	1,950	56.7	427,050	7.32
Meat	(live lbs.)	(dressed)				
Pork [6]............	350	273	2,465	22.7	672,945	4.64
Beef [6]............	216	125	1,040	18.5	130,000	24.00
Poultry Crop [6]						
Meat and Eggs....	66 lbs.	111 eggs	....	27.5	149,000	21.00
Nut Crops		*Pounds*				
Chestnuts (fresh)...	....	1,600	1,140 [7]	....	1,824,000	1.71
Persian Walnuts...	....	1,000 [1]	3,075 [7]	....	1,266,900	2.47
Black Walnuts.....	....	1,000 [2]	3,105 [7]	....	776,250	4.03
Hickory Nuts......	....	1,000 [3]	3,345 [7]	....	1,672,500	1.86
Pecans............	....	1,000 [4]	3,300 [7]	....	1,650,000	1.89
Acorn.............	....	1,400 [5]	1,265 [7]	....	1,455,762	2.12
Keawe [8]...........	....	....	....	....	....	....

In comparing these nut crops with corn it should be remembered that the figures for the nut crops are supposed to be annual averages, whereas corn, even on the best of land, is almost always put in rotation; and therefore there is rarely less than one crop in three years, often one crop in four or five years. Page 282 shows that many of these tree crops *might* have side crops also.

[1] Based on California production (page 173). Edible portion see page 304.

[2] Quantity is estimated yield. Calories are for edible portion (p. 304). Assume 25 per cent. edible. See 1919 report Northern Nut Growers' Association for tests of weights, also 1927 report of same. Some yield more than 25 per cent. kernel.

[3] Yield estimated by Dr. W. C. Deming for full stand grafted trees. Calories for edible portion. Assume 50 per cent. edible. See 1919 report Northern Nut Growers' Association where many nuts were more than 50 per cent. edible.

[4] Quantity, Georgia Experiment Station Estimate. Calories for edible portion. Edible portion estimate 50 per cent. Some yield more than 50 per cent. kernel.

[5] Quantity, author's estimate. See chapters on the oak. It is probable that the figure for yield is too low. Edible portion taken from p. 304.

[6] From U. S. Department of Agriculture, Farmers' Bulletin No. 877: *Human Food from an Acre of Staple Farm Products*, by Morton O. Cooper and W. J. Spillman, from whom the idea came.

[7] Analysis on page 304.

[8] Counted as calories and considered as stock food it outranks corn. See Chapter V.

APPENDIX F

HOW TO GRAFT NUT TREES

Grafting trees is an old art. It is known that the Romans did it in at least nineteen different ways, and Cyrus, king of Persia, weary of the cares of empire, abdicated and had some years of peaceful pleasure, grafting trees in his garden.

Grafting takes advantage of the fact that the common fruit and nut trees do all of their growing in the cambium layer. Cambium is the slippery gelatinous substance that we find under the inner bark of a rapidly growing tree in the season when it is putting forth shoots. In this thin layer the tree grows all of its wood and all of its bark.

Grafting merely puts a piece of one tree (the cion) into another (the stock) so that the cambium of the cion can connect with the cambium of the stock, grow fast to it, be fed by it, and grow from it. The cion, thus fed by the cambium of the stock, grows, but keeps its own character. Thus we can make a million trees like the one fine tree that furnishes the original cion wood.

Grafting nut trees is fun. It appeals to the creative instinct, as well as the instinct for beauty and for profit.

Grafting *nut trees* in the United States is a new art. For a long time people tried to do it as they do apple trees and they failed.

The following pages attempt to illustrate and explain for beginners some of the most thoroughly proved methods of grafting nut trees that have been used in the United States north of the Cotton Belt.

1. SPLICE GRAFT: FIG. A

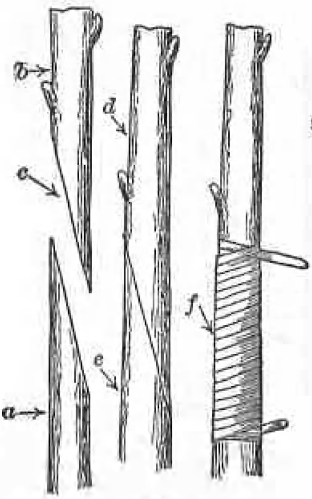

FIG. A

1. Have cion *b* same size, or about same size, as the stock *a*.
2. Cut them as shown—one plane flat surface on each.
3. Fit these two, the cion and stock, together, so that all their flat surfaces touch each other and their inner barks meet. Wrap them tightly with moist raffia as far as the cut surfaces extend. Tuck the end of the raffia in. Do not tie any knots.
4. String will do if you are *sure* to cut it off before it cuts the growing tree.
5. Now cover all of the raffia or string and all of the cut part of the stock and all of the cion—every bit of it—with grafting wax. This prevents death by drying and seems to be one of the big secrets of success.

This method makes the most perfect of all unions; in a year or two you may forget that the tree was grafted if you are not careful to mark it.

II. SIDE GRAFT: FIG. B

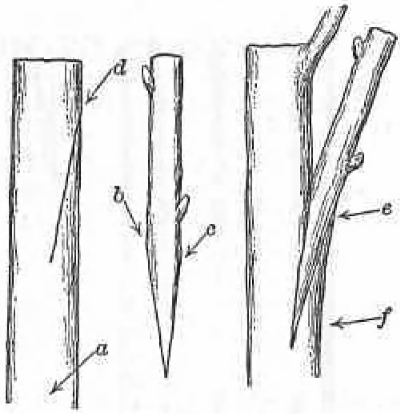

FIG. B

This method can be used when the stock and cion are the same size or when diameter of stock is two or even three times that of the cion.

1. A diagonal downward cut *d* is made in the stock *a*. The cut must be straight, and this is hard to do. It requires a very sharp knife, and it can not be made by a straight down push of the knife. You start with the point of the blade and slide the knife forward slowly, finishing with the heel of the blade. In doing this, some people put one hand on the back of the knife blade.

The beveled blade (see III, 2) is more effective for this than the ordinary blade.

2. The straight cut *b* on one side of cion is a little longer than on the other side *c*.

3. The cion is pushed in with the long cut edge next to the stock and the short cut edge next to the flap. See that the cion fits the cut as to length and that the cambiums meet on one side of the cion or both sides of cion.

4. Wrap with raffia or string from *e* to *f*.

5. Wax all cuts and all of the cion.

6. Tying of new shoots is required when they grow long, to prevent blowing out. Wind is a great enemy.

7. Most of the top of the stock above the place of grafting should be cut off before grafting time. Seven or eight days in advance seems best in Pennsylvania.

III. THE BARK SLOT METHOD: FIG. C

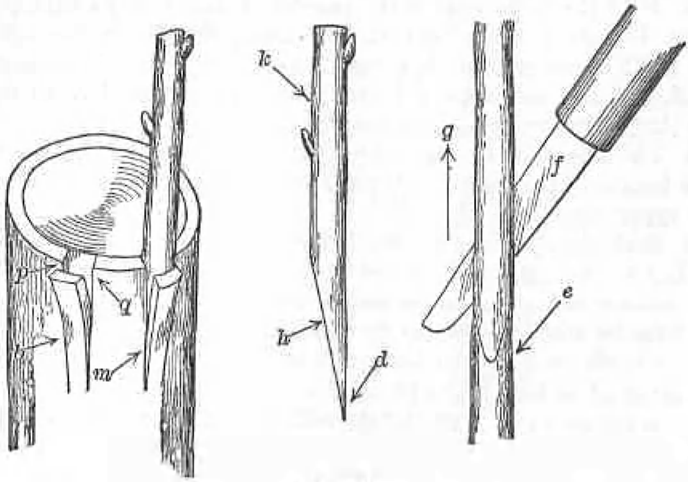

FIG. C

This method is explained at length by Dr. Robert T. Morris in his book, *Nut Growing*. It is for stocks that are considerably larger than the cion, say three-quarters of an inch in diameter and larger.

1. The cion *k* is trimmed with a straight, clean cut. All the cutting is on one side except that a little tip of the bark is cut off at *d*.

2. Be careful that the knife-cut *h* is *straight,* as shown in the figure. This is important in all cion trimming. To make this straight cut you must cut away from yourself. Make the whole cut at one stroke. This can be done much—very much—more easily if the knife *f* is held at an oblique angle to the length of the cion *e* as shown in Fig. A. The arrow *g* shows the direction of the cut. This gives a kind of saw effect which makes cutting much easier. The cut is a sharp, quick motion from the elbow. Do it quickly enough to make the shavings fly. The wise grafter will practice this for an hour or so a few days before he is ready to graft. Do not waste good cions learning this. Some experts think that the straight cut can be done much more easily if the knife is ground on one side so that it is beveled like a chisel. For cross section of beveled knife blade see *g* in Fig. A. The beveled edge touches the shaving, and the flat edge touches the cion. You cannot buy knives with beveled edges. In any case the grafting knife must be sharp, very sharp, and kept so. It is a great

waste to try to graft with a dull knife, a waste of time, of cions, and of your chances of success.

3. With the knife-point make two cuts *p* and *q* in the bark of the stock. Let the distance between the cuts at the top be the same as the width of the graft or cion when its cut surface is held against the stock. Let the cuts approach each other slightly as they go down. See this in the tongue of bark below *p* and *q*.

4. Let these cuts be the same length as the cut part of the cion. The tongue of bark *b* between these two cuts can now be loosened at the upper end.

5. Stick the cion into the slot behind the tongue of bark, with flat surface of cion against the wood of the stock. Push it down until the cut surface of the cion is concealed and the cion fits snugly in place with the tip sticking down in the cambium.

6. Cut off the tongue of bark outside of the cion. Cut in at *m* about a quarter of an inch above its lower end.

7. Wrap cion and stock tightly with raffia or string. Raffia is preferable.

8. Cover cion and raffia completely with wax and also cover every cut surface of stock with wax.

9. It is well to put in two cions opposite each other if stock is over three-quarters of an inch, and if very large put in three to aid the growth of bark over the cut end of stock.

In the drawing, the slot without cion and the one with cion are shown near each other merely for convenience in exposition. Grafts should not be put so close together as these two slots in the drawing.

10. It is not commonly desirable to saw off for grafting a tree or limb more than two inches in diameter, although some grafters have a three-inch limit.

11. The bark slot graft grows rapidly because the stock is big and it is apt to blow out unless carefully tied in and watched after it makes a good growth.

12. This is probably the easiest kind of grafting to do, and beginners are strongly urged to begin with it.

In all of the three kinds of grafting mentioned above it is well to leave a small limb near the graft. It seems to encourage growth of graft.

IV. MODIFIED CLEFT GRAFT: FIG. D

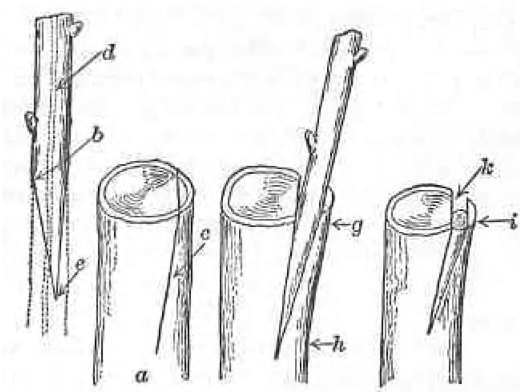

FIG. D

This is the method used in nurseries where grafts are set by the thousand. It should not be tried by beginners the first year of their grafting experience.

1. Owing to the pith *d* in the center of most of the cion wood of the nut trees, it is better to trim the cion *b* on one side clear through the pith so that the point *e* ends in solid wood.

2. This cion with the large cut on one side and the small cut on the other fits the stock *a* much better if the stock is cut at *c*, one side of the center.

Most experts think they get better success if the cut in the stock is made at a slant as in *a*. This is hard to do. The knife *must* be beveled. It must be pushed across and down like a saw, with the beveled edge toward the narrow wood. The knife must not be pushed straight down and the whole cut should be made at one stroke. Some one has said that you are not a grafter until you have cut yourself a few times. Here is one of the places you may do it.

Start this cut with a very little bit of solid wood on one side of the cut.

3. Always keep both hands above the knife edge in cutting stocks as well as in trimming cions.

4. The trimmed part of the cion and the split part of the stock should be of the same length.

5. Push the cion into the split or cleft until the cleft is full.

6. In this form of graft the cambium layers of cion and stock meet each other unusually well.

7. Wrap with raffia from *g* to *ft*.

8. Here is one refinement of technique that is used by some, but it is not necessary. It is used when the cion is smaller than the stock. The top view of the stock after cion *i* is set and cut off level with top of stock (merely to enable one to see) shows the open part of cleft *k*. Fasten a small piece of paper to the stock with the raffia used in wrapping the graft. Do it in such a way that the paper will keep wax out of the side and top of the cleft beside the graft. If you succeed with this the growing graft will fill up the cleft with wood much sooner than if it is filled with wax. Then there will be less danger from blowing out.

By using this method the nurserymen can get black walnut grafts to grow from two to six feet the year that they are grafted and to heal over so completely that they can be sold at the end of the year in which they are grafted.

9. Cover with wax every bit of cut surface of the stock, all of the paper, and every bit of the cion.

10. Nursery trees the size of your finger or thumb are usually cut off for grafting a few inches above the ground. On such short, firm stocks it is easier to make the diagonal cut in the stock.

Care After Grafting

All shoots but one should be rubbed off of the stock every three days after grafting for at least five times. The one that is left should have the end pinched off to keep it from taking too much strength away from the cion. The tree prefers its own buds. If the graft starts to grow, all shoots on the stock should be rubbed off and kept off. Strings should be removed at the end of three weeks.

Some experts put a paper bag over the graft to shade it and cut a hole on north side to keep it from getting too hot inside the bag. Others do not think this necessary. It depends somewhat upon the heat and the natural shade. The beginner should try some with and without the paper bags. The bag can be removed as soon as it is in the way of the growing graft.

Cions

1. Cions should be cut in cool weather when the temperature is above freezing, before any start of growth whatever has been made

and before the sap has begun to flow. They must be kept dormant until grafting time.

2. Cions keep well on a *cool, damp earthen* floor of an unheated cellar, in frosty climates, if covered with two or three layers of burlap. Don't try it on cement. Cement is dry. Earth is damp. Some experimenters now say that they keep better if entirely coated with melted paraffine wax. I have not tried this yet, but expect to do so.

3. Cions from a rapidly growing tree are better, much better, very much better, than from a slow-growing tree. The end twigs of an old bearing tree are therefore not as good as the shoots that grow out where a limb is cut off or when the tree is heavily fertilized.

4. The thin pithy outer end of a twig is poorer than the butt end.

Stocks

Thrifty, fast-growing stocks are better than slow-growing stocks. It is a waste of time to graft the little runty trees in a row of seedlings. The time to graft is just as trees are shooting buds and the cambium can be scraped up like jelly on your thumb nail. In the first three methods above mentioned, the stock can be cut off when grafted. If there are open places within the graft, as *k* in Fig. D, they may fill with sap and ferment and the cion may die. To avoid this, stocks that are to be grafted by the method shown in Fig. D should have stocks sawed off about a week in advance of grafting. It is no use to graft them while the sap is running out of them. It is time to graft as soon as the sap stops running after the sawing off. Sawing off tops before grafting causes less waste of the tree's energy. Therefore it seems to be a good thing to do when grafting by methods shown in Figs. B, C, and D.

Wax

If you are only going to set a dozen or two of grafts, you can use old-fashioned grafting wax. It is the simplest.

1 part tallow
2 parts beeswax
4 parts rosin

Melt them all together. Pour into a tub of water. Before it is hard, work it like dough in greasy hands. Wrap in oiled paper. It will keep for years. It may need a little warming in sun or warm room before using. It works like putty. When using it carry along a piece of fat meat to grease your hands, to keep wax from sticking. Since greasy hands may grease the dons you are trimming and kill them, you should have an assistant do the waxing.

Dr. Robert Morris uses pure melted paraffine put on with a ten-cent paint brush. The paraffine is kept hot in a special alcohol lantern, very convenient to use, sold by E. C. Tyson, Flora Dale, Pa.

One nurseryman adds a small amount, two or three ounces each, of beeswax and rosin to each pound of paraffine to make it less brittle. Others mix in one-fifth of crude pine sap secured from Glen Saint Mary Nursery, Glen Saint Mary, Florida.

Two very successful nurserymen use a black wax, as follows:

8 lb. rosin
3 lb. beeswax
½ pint linseed oil boiled
¼ lb. lampblack

This is all melted up, stirred, and put into small vessels ready to melt and put into the grafter's melter. This melter is sold by J. F. Jones Nursery, Lancaster, Pa. It burns charcoal. The chief advantage of the black is that you can see so much better what you are doing.

Knives

Maher and Grosh, Toledo, Ohio, a mail-order house, have a good assortment of grafting-knives, but be sure to test every knife well before using it. Many knives will not hold the necessary sharp edge. A dull grafting knife is a crime.

Success

Nut grafting is not certain. There are some things we do not know about it yet. The beginner who gets five per cent. should not be discouraged, and he who gets forty per cent. should think it great luck, but there are some who have much better success than that.

The grafter will do well to keep record of date, weather, and condition of stocks each time he grafts. He may learn something.

Painted wooden labels with copper wire will keep a pencil record two seasons. They are sold by Benjamin Chase, Derry Village, N. H. Copper labels with scratched writing last for many years. These are sold by Ball and Socket Manufacturing Co., West Cheshire, Conn.

One of the first things the hickory grafter should do is to learn the different species. Some will not grow on others, but shagbark will grow on shagbark, and most of the others also will grow on shagbark, and all grow on the pecan.

It is well in our present state of knowledge to try a little early grafting and a little late grafting. Any one expecting to do anything with nuts north of the Cotton Belt should join the Northern Nut Growers' Association, H. D. Spencer, Secretary, Decatur, Ill. This organization is the clearing house for information which is being rapidly collected. The beginner should also see sample copies of the *Nut Journal,* Rochester, N. Y., and *The Nut Grower,* Downingtown, Pa.

In preparing this description of technique and practice I have drawn upon my friends, Dr. Robert T. Morris, Dr. William C. Deming, Mr. John W. Hershey, Mr. Willard Bixby, and the late J. F. Jones, from whom I have learned nearly all I know about nut grafting.

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