# THE CORK OAK:
## Past, Present and Future on the Pacific Coast

by

Stuart W. Heintzelman

A Thesis

Presented to the Faculty

of the

School of Forestry

Oregon State College

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science

June 1940

Approved:

_____

Professor of Forestry

CONTENTS

# LIST OF FIGURES

# INTRODUCTION

The thought behind this paper is to set forth the possibilities of cork oak production in the United States. As a background to this, the past, present, and future of the tree are set forth.

Beyond these inherent factors, the author wishes to incite more interest in silvicultural research on the Pacific coast which closely resembles the cork oak's native land in latitude, soils, and climate. From the rather inadequate sampling which has been done up to the time of this writing, it can be seen that cork oak definitely has a place in this land.

Like so many other good things, the study of cork oak has been conducted half-heartedly up to this time because of the unbelievers who will not give a good thing a fair trial. Since the first cork oak acorn was planted in a tawdry California mining town more than 80 years ago, various plantings have been set out both in single trees and plantations, only to relapse more or less into desolation and oblivion.

What has caused this? Publicity and advertisement so necessary in developing any product have just not been present. No industrial product ever attained prominence without an intelligent introduction to the potential users, and so it is with this tree.

Now let us look at the possibilities of the tree

in our country. Physical factors agreeable for a new home are similarity of climate and soil to those of its original habitat. On the economic side, undoubtedly the most important factors are industrial needs and more efficient land use.

Industrial needs are of primary interest. A glance at the attached graphs and tables will indicate the importance of the cork oak market to this country. The United States by far is the world's best customer of cork oak bark. At present, war is having a definite effect on the price of this natural product grown commercially only in southern Europe. By growing her own cork, America would benefit both labor and many industries. America can just as well be independent and grow at least part of her own supply. Producing cork oak would benefit the cheap transient labor which now picks cotton and fruits and floods the areas most suitable to the tree's growth with an over-supply of labor. The cork industry could also get its cork bark at reduced prices because of lowered freight costs. Even if all the home production would not satisfy the market it would cause healthy competition which is necessary to good business. Another feature is efficient land use. Cork oak adapts itself readily to multiple use. The present American property owner needs more than one source of revenue which is best solved by multiple use lands. Such lands permit a fairly constant revenue regardless of the idiosyncrasies of the market. Hogs fatten well

on cork oak acorns; cattle find good grazing beneath the trees; and the plantation owner still gets an unspoiled crop of cork bark.

In the main, studies of the problem have been scarce, and many have fallen "by the board." Most of this has been from lack of financial interest both by the government and individuals. A few have lapsed because of planting injury or planting in too strenuous a climate.

The studies which are definitely known about but are not necessarily being continued are as follows: The state of Oregon had one plantation on the Umpqua National Forest which was sponsored by a retired railroad executive. At the same time plantings of several trees each were scattered along the Pacific coast at various forest district ranger stations of the Siskiyou National Forest. In the state of California are found the remaining studies. There are plantings consisting of one or several trees in the cities of Napa, Biggs, Oakville, Los Angeles, and Marysville. Other plantings are in Campo Seco, Calaveras County; Tuttletown, Toulmne County; and Santa Monica Forestry Station, Los Angeles County. There are three plantations: one at Chico; another at Angels Camp, Calaveras County; and the last on the University of California campus at Berkeley.

My method of procedure in this work was first to consult certain professors on possible lines of approach and then go through library reference indexes on periodical

literature and books. After gathering all the library material together, it was abstracted and carefully indexed according to priority of material.

Meanwhile armed with contemporary references, the author wrote to each asking for any information on cork oak. All were very kind and answered promptly. Much of the information gained this way was overlapping, but it served to clinch the truth of many statements which were of doubtful authenticity. Those references used were cork using companies, professors of colleges and universities, forest service men, the United States Department of Agriculture, and others directly or indirectly connected with cork oak bark or trees.

The author received well-organized material in answer to his letters. From the United States Department of Agriculture and the United States Department of Commerce came very comprehensive bulletins on the subject. However, the Department of Agriculture bulletins had been published before the last decade.

After the initial research was completed, book references on thesis and research paper writing were consulted. From the knowledge thus gained, it was possible to compose a paper according to generally accepted standards.

# CHAPTER I

## HISTORY AND CHARACTERISTICS

The cork oak tree, Quercus suber or Q. occidentalis (two species of doubtful differentiation), has been known as a highly desirable species of oak to civilized man for over 2300 years. There are 150 distinct uses for the tough, bouyant, insulating bark. It is the only evergreen oak of the Latin lands remaining green while hot simoons or sirroccos twist north from southern Mediteranean lands. All plants have a layer of cork in addition to the ordinary bark but this particular tree develops cork to the greatest extent in nature (9).

Historically the tree bears "....the hallmark of approval of 2000 years." (2). Theophrastus, the Greek philosopher, mentions the tree in the fourth century B. C. as a very useful tree and a native of the Pyrenees Mountains. Decades before the previous literary reference, Horace, a Roman poet, writes of cork stoppers for wine bottles in twenty-five B. C. Pliny, the Roman naturalist and author, describes (first century A. D.) the use of cork for buoys and bungs of casks. Plutarch, the Greek biographer and moralist of the first century A. D., refers to cork jackets which are better known now as life preservers (2).

The native habitat of this little-publicized but important tree forms a comparatively narrow border along

the shores of the countries of southern Europe (Figure 1A) and northern Africa. Specifically, the countries of optimum growth are Spain and Portugal. In Spain the provinces of Andalusia and Estremadura to Catalonia are most important. Following these lands, come Algeria and Tunisia, then southern France including Corsica. Next in order are the provinces of Sardinia and Sicily in Italy (11).

The total area occupied by the tree is approximately 5,000,000 acres, making a yearly production of about 50,000 tons. These figures are not too exact because of the poor methods of inventory and the passive attitude of the cork interests toward foreign probing into the matter. The major production, however, goes to the United States, England, France, Germany, Austria, Denmark, and Sweden arranged in order of amounts imported (2).

Cork derives its name from the Latin word cortex meaning bark (4). Growth of the oak is in a tortuous, gnarled pattern. The average tree being rather small and the tendency of the tree to grow in somewhat open stands gives the cork oak forest the semblance of an ill-cared-for apple orchard on the stony soils of certain familiar regions of the United States.

To be more specific in reference to growth, the oak's size is usually twenty-five to fifty feet tall with a dense, spreading crown. The diameter is from eight to eighteen inches, measured at breast height, with a clear

trunk of twelve to fifteen feet. Occasionally a tree is found to be sixty feet high and four feet in diameter. Since the average stand per acre amounts to only thirty or sixty trees at a maximum (5) under natural conditions, it can be seen that the forests are very open.

As yet there have been no extended attempts at artificial reproduction. A good part of this will be explained later under nursery work. The oak is very slow-growing and requires thirty to sixty years before optimum production is reached. Some cork, of course, is harvested before this time but not the finest grade. The age runs from 100 to 500 years, and during this period of maturity the tree will continue producing merchantable cork (5).

The land best suited for the forests is that on the dry, lower slopes of mountains usually that with a southern exposure. Agreeable soils are those which are poor and rocky--too poor for any profitable agriculture. This statement does not necessarily mean that the best growth is found under these conditions but the best cork production results. The best growth, most vigorous, occurs in rich, deep, loose soil (5).

Botanical characteristics of the tree are as follows: Small yellow flowers are produced in April or May. These in turn give birth to acorns in the late fall. (2). To diverge for a moment, the acorns are excellent for hog food and are responsible for the famous flavor of Spanish hogs. This enterprise is bad from another side as

it halts natural reproduction while it is being carried on.

Except for the bark, the layman might become confused between our native live oaks of the United States and the cork oak. The bark develops a thickness of one inch in twenty years. Any damage to the phellogen, mother bark, results in a permanent scar at the point of injury; no more cork will be produced where there is a scar. Care has to be taken both in procedure and in time of removal of the bark. If a hot, dry wind occurs soon after bark removal, the tree is very likely to die. (2).

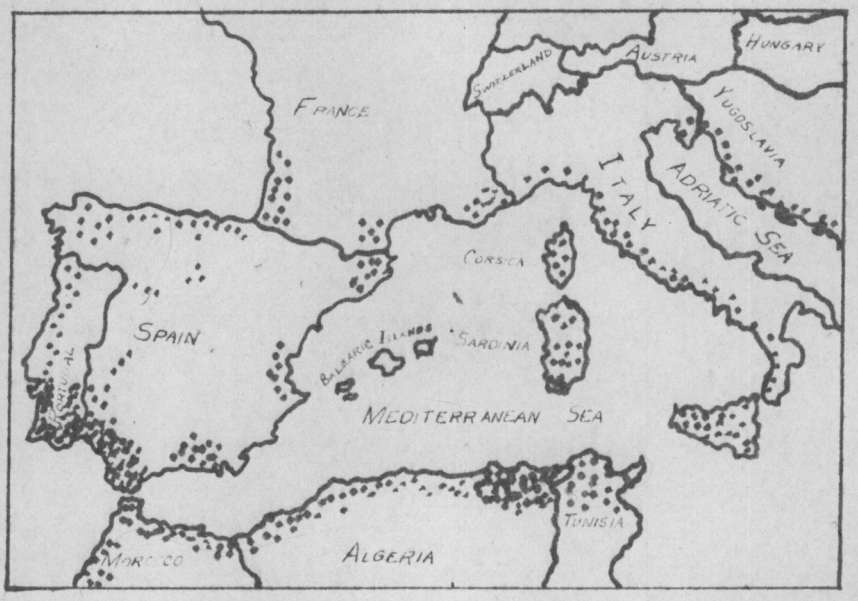
The foliage, to the casual observer, appears identical to that of canyon live oak or, possibly, that of tanbark oak; even the acorns have a marked similarity. The leaves are one and a quarter to two inches long with a width of one inch. They are oval-oblong and have entire (smooth) edges or toothed edges. The teeth are often jagged (12).

The best development of cork oak is along the northwestern coasts of Spain and Portugal. Here the temperature stays between twenty-five and ninety-five degrees Fahrenheit and the average rainfall is a little more than forty inches. The lowest rainfall in this region is about five to eight inches. (7).

Growth is best on granitic, siliceous, and slate soils of latitudes from thirty-four to forty-four degrees north of the equator and with a mean air temperature of

Figure 1

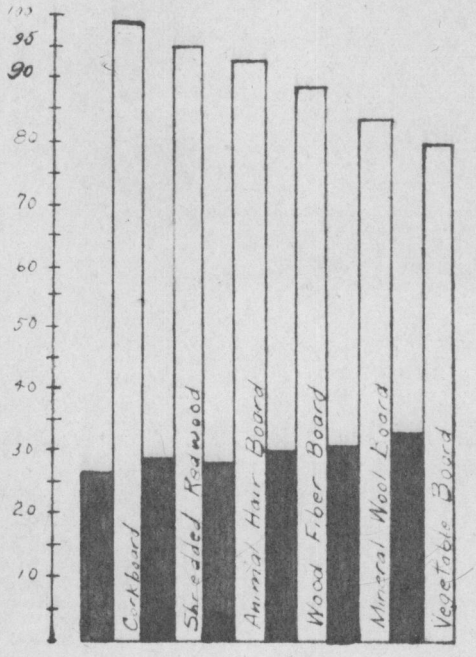
A




SOURCE OF THE WORLD'S CORK SUPPLY
• TREE SYMBOL

B

RESULTS OF THERMAL CONDUCTIVITY TESTS ON DRY MATERIAL




Thermal Conductivity (60°F mean temp)

Relative Insulating Value

fifty-nine degrees Fahrenheit (12) These are represented by sandy clay loams which are well drained but abundantly supplied with moisture.

"Flourishing as it does in a hot, semi-arid climate, there seems to be no reason why this valuable tree should not be successfully introduced in the southern and southwestern sections of the United States;..."(2). At the time of introduction in 1858, the Civil War had the country disrupted. Since this time the fires of interest have smoldered along, but nevertheless they have been there as is demonstrated by the amount of work done.

# CHAPTER II

## COMMERCIAL IMPORTANCE

To understand the commercial importance of cork bark, we must first analyze it and see what properties make it useful. These properties are resistance to the passage of moisture and liquids, buoyancy and light weight, resilience and compressibility, ability to absorb sound and vibration, strong resistance to progressive deterioration, low conductivity of heat, and an uncommonly high coefficient of friction---first in an actual test against rubber and leather. These seven points place it in great demand for innumerable industrial products (3).

What lies behind the peculiar physical properties? The answer is in the structure of the bark cells. The cell shape is fourteen-sided. This results in the minimum surface for a uniform body having no interstices (openings between bodies). In cork interstices is stored a resin which is impervious to water and most liquids. Composition of the cell lumen or interior cavity is more than half air which has a specific gravity of fifteen to twenty hundredths. The cell walls are much more elastic than rubber (9).

Several years ago in Lancaster, Pennsylvania, a one-inch cube of cork was put under a pressure of 14,000 pounds to the square inch. The sidewise spread amounted to only one-quarter of an inch. After remaining under

this pressure for some time, samples took only a few hours to regain ninety to ninety-five percent of their former height. The loss in height was due to a slight escape of cell air (9). The secret of success is the fact that only the air is compressed. Research has shown that corks, after being in wine bottles for ten years, regain at least three-quarters of their former volume.

More recently a three-inch block of cork was compressed under 4000 pounds per square inch. It was placed over a steel block of the same size, and the two had the pressure exerted at the same time. The spread of the cork over the edges of the steel was hardly noticeable, not measurable with the average ruler (11).

The means used in getting the highest coefficient of friction is to make a clean cut across the surface. The cut exposes a multitude of the tiny fourteen-sided cell openings which act as suction cups. It is this feature that makes cork so desirable for polishing fine mirrors, expensive jewelry, and other minor polishing jobs (9).

There are five main divisions of the cork products business as follows: (a) Business of making a natural product, stoppers. (b) Composition products, scraps and grinding. (c) Cork board, insulation, Figure 1B. (d) Floor coverings, tile and linoleum. (e) Cork marine goods (11). These four lines cover a rather large field of industry. Below are listed a few of the uses of

cork and its effect on the product. (1).

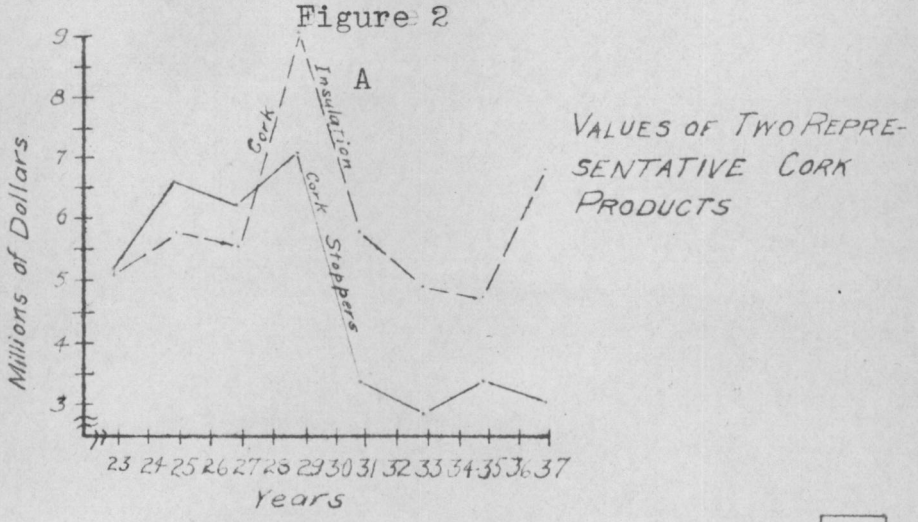
1. Cork gaskets--resistance to passage of liquids and gases.
2. Linoleum--resiliency.
3. Cork polishing wheels--glass work.
4. Washers--water faucets.
5. Cushion--back in pictures and mirrors.
6. Covering--textiles.
7. Shoes--soles, toe box, counters.
8. Food--table pads, refrigeration insulation in box cars etc.
9. Flooring--cork bricks.
10. Paper mills--cork padded rolls, printing.
11. Machinery--gaskets and seals
12. Cigarettes--cork tips.
13. Auto-mats, cork clutch inserts, gaskets, universal joints, spline shafts and rear axles, carburetors, gas and oil guages, insulation (squeaks) in head-lights, signal lights and blinkers, whistles and gasoline pumps.
14. Elevator cork brake shoes.
15. Offices--table tops, pens (bushings), telephone switchboards.
16. Cork strips--cutting and creasing paper.
17. Miscellaneous--cushions on golf clubs, bottle caps, baseball centers, surf balls, faces on ping pong bats, sandals, beads, hats, accoustics in

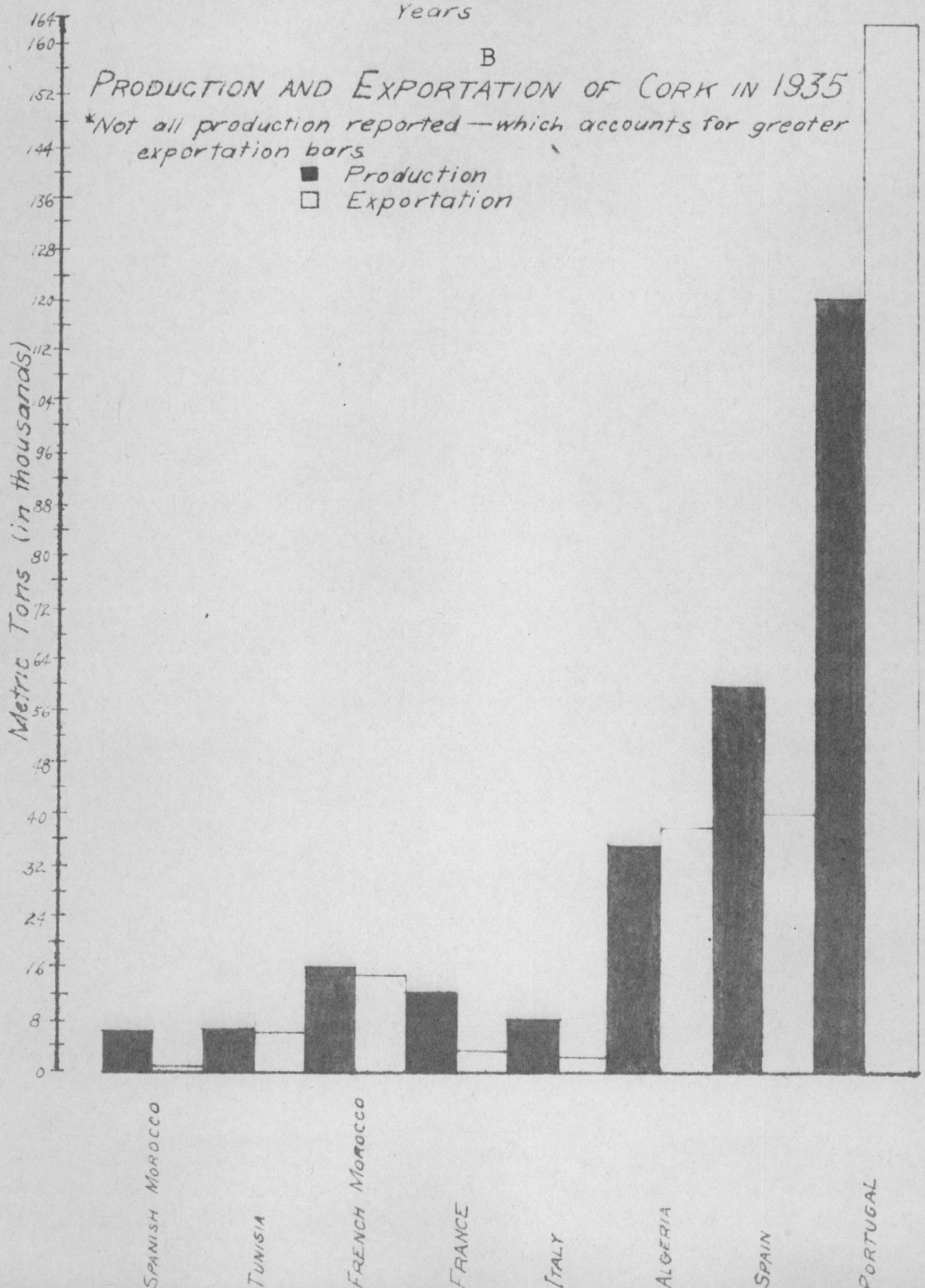
auditoriums, organ gaskets in the pipes, movies, bungs and taps, bath mats, life preservers, buoys, yacht fenders, toys, fishing rod handles, pin cushions, and paper (500 sheets equal one inch).

The importance of cork bark to industries in the United States is shown by very little restriction on importation. There are no duties or taxes on the raw material entering the United States. Spain, though, has an export tax of approximately a dollar per 220 pounds (equivalent to 100 kilograms) of raw cork. The United States protects its home industries by placing heavy taxes on importation of manufactured cork. Stoppers are taxed twelve to fifteen cents per pound. Other material is generally taxed thirty percent of its value (5).

During the year 1937, $8,500,000 worth of raw cork was imported into the United States. In 1938, the following year, this figure dropped to $3,300,000. To carry the trend a little bit further, the first nine months of 1938 saw an importation of $2,400,000; and in the next year, 1939, the first nine months showed an increase to $2,800,000. These figures came to the author in a letter from the Cork Institute of America (17). Reason for the slump was stated to be caused by the reciprocal trade agreement between this country and the United Kingdom. The slight recovery during the first nine months of 1939 may be explained by the American public realizing the

Figure 2


A
Values of Two Representative Cork Products
Millions of Dollars
9
8
7
6
5
4
3
Cork
Insulation
Cork Stoppers
23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
Years


B
Production and Exportation of Cork in 1935
*Not all production reported — which accounts for greater exportation bars
Production
Exportation
Metric Tons (in thousands)
164
160
152
144
136
128
120
112
104
96
88
80
72
64
56
48
40
32
24
16
8
0
Spanish Morocco
Tunisia
French Morocco
France
Italy
Algeria
Spain
Portugal

superiority of their own goods over foreign goods. At the same time no agreement as to trade could be reached between America and Portugal. Any negotiations with Spain, of course, were out because she was in a civil war. Portugal anyway, is the leading supplier of cork to the United States; the annual supply from Portugal averages around $2,000,000 (12).

There are thirty-four cork manufacturing plants in the United States which employ 3,000 people directly. There are many more people connected with it indirectly in transportation, selling, and handling. In one year the manufactured value of cork was $12,800,000. These figures are from the Bureau of Census for the year 1935 (12).

# CHAPTER III

## CORK PRODUCTION OF THE WORLD

Almost all the world's supply of cork is grown in 5,000,000 acres of cork oak forests bordering the Mediterranean Sea. Little Portugal produces almost half the world's production of about 300,000 tons (12). This is more graphically presented by the chart (Figure 2B) and the map (Figure 1A).

The industrial quantity and quality of production indirectly depends on the growth of the cork oak tree; so let us first deal with that. Good growth resolves itself into proper care and management.

The oak reproduces well vegetatively from the stems of young trees or seedling plants. In case of fire damaging a tree, this factor is resorted to by immediately cutting away the injured portions and permitting unrestricted coppice growth. Acorns, if falling on suitable ground, begin at once to germinate. The author can vouch for this point as he has witnessed fresh fallen cork oak acorns. It can be seen that ample reproduction is no problem (8).

Artificial reafforestation is no problem. Sowing is suitable to land which can be easily plowed at small expense. Acorns are deposited in little groups of three or four in furrows and are covered with three-quarters of an inch of soil. Another method of sowing is to plow the

entire area to be planted and then broadcast the acorns. In the first year it is advisable to grow a cover crop of corn which protects the tender seedlings against extreme weather conditions and enroachment of harmful weeds or plants. (8).

Greatest success with young trees is to plant the acorns soon after ripening in October. The acorns soon lose their power of germination and should not be planted any later than December or January. Gentle slopes with the plants oriented in the direction of the slope also helps (8).

In the case of transplants the radicles, primary roots, are cut two months after germination. The cotyledons still have ample food to nourish the seedling at this time (8). Such a procedure inhibits the vigorous growth of the tap root and relieves some of the problem of transplanting.

The acorn upon germinating sends a root into the ground four to five inches long. As the Portuguese and Spanish graze the lands heavily, the aerial portion of the seedling is often destroyed. Destruction does not mean death, for in the following autumn the aerial portion reforms. Being much more vigorous, the stem and leaves grow rapidly.

In the care of the young trees or seedlings after they are several years old--one precaution must be taken. The terminal bud must be protected from injury. Mutilation

or death of the bud inhibits growth of the seedling. Characteristic results are stunted, many-branched trees with little or no cork-producing trunks. (8).

In case of serious damage from animals and other factors such as fire, the area is plowed heavily. This incites a heavy coppicing from the roots and produces straight-trunked trees (8).

The yield and value derived from each tree varies somewhat due to size of the tree, thickness of bark, and quality. Thickness of the bark runs from a half inch to two and a half inches depending on the size and age of the tree. Actual yield from each tree runs from as low as forty-five to as high as five hundred pounds. The price reflected by the bark quality has a spread from $1.50 to $4.50 a hundred pounds (2).

Rotation of the forest is divided into two types, the general rotation and the bark-stripping rotation. In the first type the trees are stripped when physically mature. If the bark is decayed or thin, the tree is removed. The inner bark is used for tanning and the remainder is used for fuel wood or articles which require an average quality wood (6). After the best period of production of 120 to 200 years is past, the trees are removed and are replaced by the younger trees which have been growing contemporarily for the past fifty years or so. (4).

The other type of rotation calls for removal of

the bark only when it fits the specifications of a given manufacturing product. For example, a bottle cork requires a bark thickness of one and one-eighth inches. Otherwise the two rotations are identical (8).

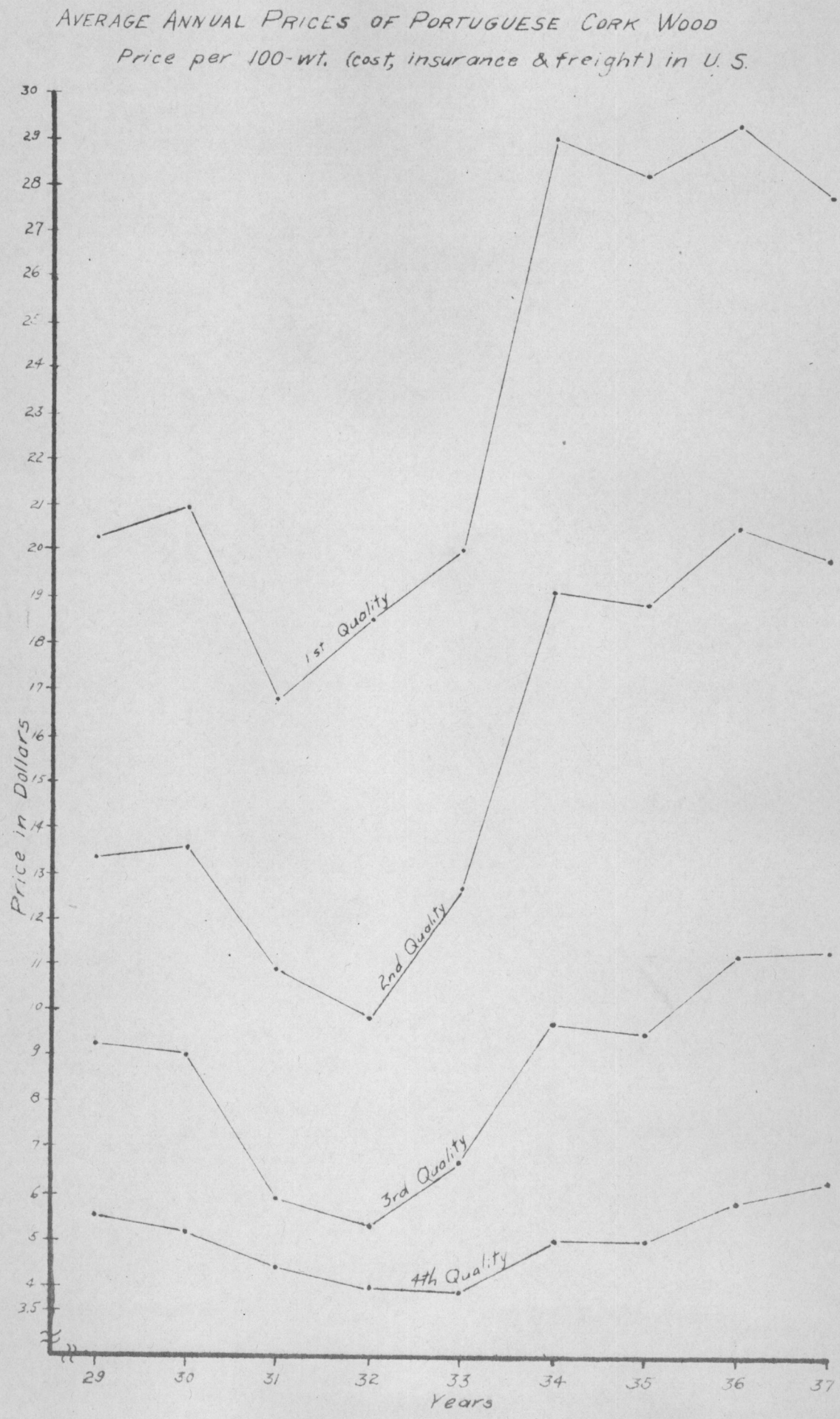
To eliminate a period of non-production for a large area, it is broken up into smaller units. Hence there is a stripping every year. This is known as systematic cork collecting (8).

There are two cuttings known as the first cutting (virgin cutting in Spain or male cutting in France) and the second cutting. The first cutting yields a low grade material which sells for a low price and is used principally for granulated cork products. (9).

The first stripping usually comes at the end of the twentieth year on those trees of fifteen inches at three feet above the ground. Care must be taken not to injure the inner bark, phellogen; scars to it end production at that point permanently. The tools are crescent-shaped saws in Algeria by the French and wedge-shaped hatchets with long handles by the Spanish (2). The bark is pried off, not peeled off (6).

Ten years after the first cutting occurs, the second one takes place. After that each stripping comes about nine to twelve years following the preceding one. Each successive crop is better than the last until the tree reaches the fifty year mark. The quality and quantity does not drop off perceptively until the tree

Figure 3 --


AVERAGE ANNUAL PRICES OF PORTUGUESE CORK WOOD
Price per 100-wt. (cost, insurance & freight) in U. S.
Price in Dollars
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3.5
1st Quality
2nd Quality
3rd Quality
4th Quality
29
30
31
32
33
34
35
36
37
Years

reaches at least 150 years of age (9).

Utilization is as complete as the tree will stand. The bark is removed from the base to the fork of the trunk. Even the bark from the larger branches is removed. Branches give a thinner but much finer grade of bark than the main trunk (2).

Following stripping the trunk, a beautiful color change takes place. The lower part near the tree base appears cream colored while that higher up looks ashen gray. The light colors soon change to a reddish purple, which in turn is replaced by a brown shade. Finally, after three or four seasons the bark pigments revert to the typical ashen gray. This cycle is almost as pretty as nature's painting of the New England fall foliage (6).

After stripping the raw bark is left on the ground to dry. It isleft in piles scattered through the groves for a few days. At the end of the drying period it is weighed on a "Romana" type of yard scale which was used by the Romans 2,000 years ago (4).

The standard unit of weight for the cork business is the metric ton (about 2,205 pounds), but each growing region has its own weight unit. Thus the cork buyer must keep in mind a dozen other units ranging from thirty-three to two hundred and twenty pounds (16).

The next necessary operation is getting the dry, raw bark to the boiling stations on a railroad line or on the edge of the marketing area. This initial transportation

is by burro. Boiling performs several things. It removes fifteen percent of the weight and tannic acid and increases the volume and elasticity. This facilitates drying the slabs of bark flat and scraping off the rough, creviced, outer layer of bark (9).

From this point the cured bark is taken to the warehouse. At the warehouse it is graded in twenty-five basic grades (Figure 3) for marketing. That to be exported is baled in a hydraulic press, bound tightly with steel straps, and stenciled finally to be loaded into the holds of ships. Each bale weighs between 140 to 180 pounds. The last sorting in the United States results in 150 grades which can only be differentiated between by experts (11).

The methods of purchase are by contractor or buyer at auctions conducted by a dealer or the government. Such quantities are sold that sampling is necessary (4).

The buyer sends a sampler through a grove on a bee line. Samples are made with a cylindrical punch on every fifth, tenth, or twentieth tree depending on the accuracy desired. All the cores are mixed together and an average taken at the office of the buyer to determine the quality.

There are four principal countries which consume eighty-five percent of the annual production of cork bark. These are, namely, the United States (using forty percent) Great Britain, France, and Germany, respectively (11).

The final step in marketing is the distribution to the ultimate user, you and me, in its complete manufactured form.

# CHAPTER IV

## CORK OAK ON THE PACIFIC COAST

In comparison to the oak's previous history, the United States has contributed a short but interesting period. The Patent Office, predecessor to the present Department of Agriculture, recognized the importance of cork oak and in 1858 introduced a small supply of cork oak acorns. These were sent to California and other states of similar climate (14).

The only record of the plantings is of those in California. There, the acorns were scattered through the state by a few parties who were tepidly interested. The first places of planting were in the mining camps of the lower Sierra Nevada Mountains and on the farm lands of the great, dry, central valley of California. Incredulous though it may seem these acorns, without much interest or care shown them, developed into healthy trees, many of which are still growing. Later on the University of California distributed more acorns and plants which accounts for the present widespread plantings over the "Bear" state (14).

For all this work, little public interest resulted; this was in the main due to the necessity of a too long time investment. The possibilities of such an investment were pointed out to Leland Stanford as follows: If a 1,000 acre tract was planted to the oak, in at least

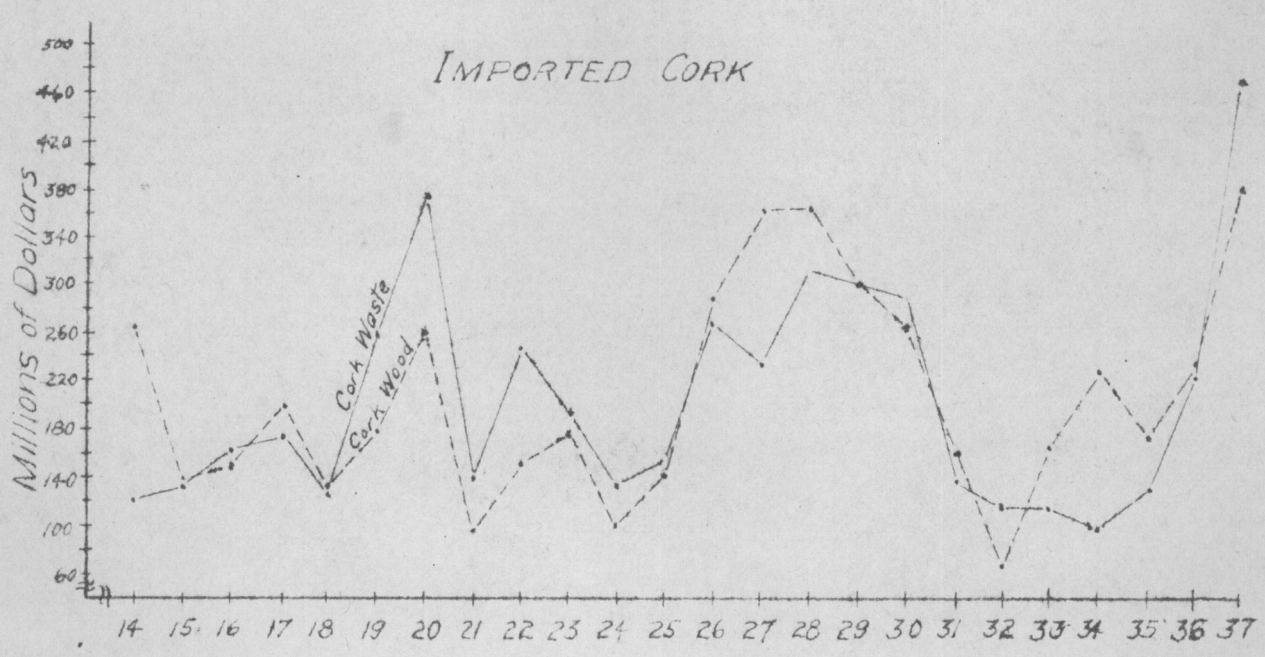
fifty years it would yield $200,000 to $300,000 for a period of several hundred years (14). It must be remembered that cork bark at this time was not in such demand as it now is; therefore the returns would have been much greater.

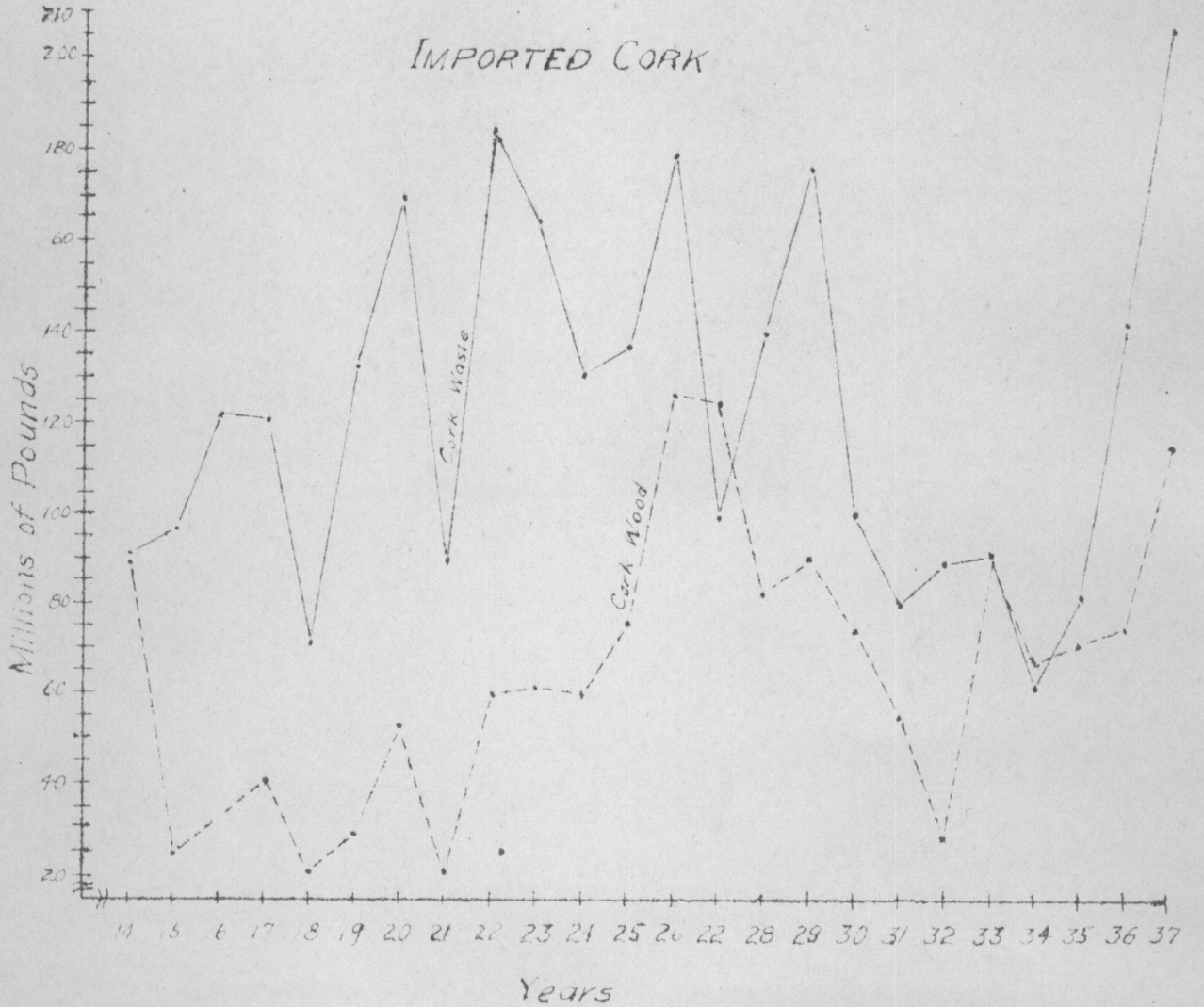
Stanford at this time was approaching the climax of his life and could see no benefits accruing from such a venture. However, if he had, the estate undoubtedly would have been much better off at this writing--more than eighty years have passed since the subject was presented to him. Besides benefiting his estate, Stanford would have started the development of the tree much sooner. He could not have lost very easily, for the growth of the tree on the Pacific Coast is two times faster than in its native land (14).

As has previously been mentioned, the tree does not impair grazing in the least. It does add feed, acorns, and adds protection for horses, cattle, or hogs in the form of shade, a prime requisite for grazing land in the hot interior valleys of California. Much low-grade grazing land could thus be easily turned to higher grades (14).

One authority stated that there are 1,500 trees of all ages and growing in varying conditions and being watched throughout California. Behind the University of California on the steep Piedmont Hills is a small grove of cork oak. Several hundred are vigorously growing as ornamentals (Figure 5) along avenues in Los Angeles; these

Figure 4



are now six to twelve inches in diameter at breast height. Generally speaking, there are thrifty trees in all the central and southern countries (14).

To be more specific, successful California plantings in part are: (13)

1. On the R. E. Fields place at Biggs, the trees are thirty to thirty-five feet in height and;four feet in diameter with a three-inch layer of bark. The planting was set out in 1889 by John Rock, president, of the California Nursery Company.
2. On the Ed Maher property at Campo Seco, Calaveras County, the trees are fifty feet in height, and three and a half feet in diameter and fifty years old. Reproduction is good nearby, due to the scattering of acorns by birds.
3. On the McGill ranch near Oakville, Napa County, there are fifty trees which are fifty years old. Those on the bottom land have attained a height of thirty-seven feet and a diameter of two feet, and averaged twenty to twenty-four feet by a foot and a half. Those on a rocky hillside have attained a height of fifteen feet and a diameter of two feet, and average twelve to fourteen feet by a foot. Reproduction occurred only on the bottom land.
4. At the corner of Franklin and clay streets in Napa is a tree sixty feet high, and two and a half feet in diameter with an age of fifty years. It produces a few acorns irregularly.

5. In Los Angeles the trees have been found to be good ornamentals. They are about thirty years old and average twenty-five feet high by a foot in diameter. The city nursery has 3,000 seedlings.

6. On the J. W. Mills ranch, five miles east of Marysville and south of the Yuba River, is a forty-year-old on clay loam soil. It is thirty-five feet high and has an abundance of flowers but no acorns.

7. On the Felix Gillette property, near Nevada City, is a thirty-year-old on shallow granitic soil. It has a height of twenty-five feet.

8. Professor W. L. Jepson reports three oaks at Tuttletown, Tuolumne County at an elevation of 1,500 feet. His notes, made on June 26, 1915, state that the trees are one-quarter-mile below town at the foot of the Patterson Mine dump and were planted in 1858. The bark averages one and three-quarter inches to two and one-eighth inches in thickness. He claims the trees were growing in the best of soil and moisture conditions.

| Tree | Height | Trunk height | Average diameter (B.H.) |
|---|---|---|---|
| West tree | 72 ft. | 26 ft. | 19 in. |
| Central tree | 78 ft. | 30 ft. | 19.5 in. |
| East tree | 52 ft. | 18 ft. | 20 in. |

The following are descriptions of various plantations: (13)

1. The largest one, planted in 1904, is on the grounds of the old forestry station at Chico, Butte County,

which is now part of Bidwell park, Chico, Planting was on thin gravelly red soil with a six by six foot spacing. Initially the land was cultivated against weeds. The following measurements were taken in 1935 at the age of twenty-one years.

| | |
|---|---|
| Number of trees per acre | 383 |
| Average diameter breast high | 5.5 inches |
| Average height | 24 feet |
| Diameter breast high of the largest | 15.6 inches |
| Height of the largest | 39 feet |

The trees have never been thinned and some parts are overcrowded. All the trees, though, have a good coating of cork bark.

2. At Angel's Camp, Calaveras County, a plantation was planted in the spring of 1928 by D. Fricot. There were two hundred trees which grew twelve to fourteen inches high the first year. The soil is formed from decomposed shale. The start was made by direct planting of acorns. So far the plantation is doing well.

Going back to the Chico plantation (Figure 5), the author would like to express a few of his impressions here. The tract is bordered on the north and east by a wood lot of native trees, on the south by a road, and on the west by a field. The area appears to be an acre and a half to two acres in size. It is plain to see that in recent years little care has been taken of the trees, for

much branch debris is scattered over the ground.

The largest trees are now twenty-four inches in diameter and showing continued good growth without care. Tree sizes progressively become larger as the visitor approaches the south and west sides of the tract. Considerable damage to the trees has been wrought by snow break. In several places the stand has been opened up. This appears to inspire the surrounding trees to better growth. Evidently the trees were too closely planted originally.

The inspection of the trees was in December just after maturing of the acorns, and there was a good crop on the ground. This was very interesting, but the high germination rate was far more interesting. Nearly every acorn was sprouting whether it was on top of the ground or under it.

Samples were taken of the bark which apparently had all the characteristics of foreign cork (Figure 5). A razor-sharp knife blade hardly phased the material. Considerable effort finally dislodged the prospective samples.

Unfortunately the bark has never been systematically stripped and given a fair test on any of these plantings or plantations.

Now let us make a jump of several hundred miles north of Chico, California, to Roseburg, Oregon. It will be noted that this is close to the forty-fourth degree of latitude which is the northern limit of cork oak.

Through E. S. Barstow, a former seaman and at

present a retired railroad executive, the Umpqua National Forest with headquarters in Roseburg was interested in planting cork oak on its land. After much painstaking study of the matter, a small plantation was decided upon.

The place selected was at Devil's Flat Guard Station on Cow Creek of the Umpqua National Forest fifty miles south of Roseburg. This perhaps is more easily found by referring to the northeast quarter of the southwest quarter of section two of township thirty-two south, range three west from the Willamette Meridian. The elevation here is five hundred feet.

Acorns were obtained from Chico, California, and planted in the Clarke-McNary Nursery near Corvallis, Oregon. Five hundred plants were obtained, but due to ignorance of correct nursery practices with cork oak almost all the tap roots were cut in lifting at the end of the first year in the nursery.

The Siskiyou National Forest with headquarters at Grants Pass now took an interest in the seedlings and asked for some. Consequently about two hundred were given to the supervisor. The remaining two hundred and fifty plants were set out with their injured tap roots at Devil's Flat Guard Station on February 28, 1938.

Holes, fourteen to sixteen inches deep, were made in which to set the seedlings. In the meantime they were kept moist and not exposed to the air. In being set out the trees were not watered because the soil was

Figure 5

West Side

South Side From Road

CHICO, CALIFORNIA

PLANTATION

Typical Trees With No

Care

Bark Cuts

thick

thin

(225 microns)

Figure 6

ORNAMENTALS AT

LOS ANGELES, CALIF.

Half-dollar_____

Leaves

sufficiently moist. Labor was provided by CCC enrollees who were carefully watched and supervised. Each seedling was marked by a stake. At the time the weather was cloudy; in the evening a light rain fell making conditions ideal for growth.

The plantation was on a southern exposure in a natural oak type with the least frost in the vicinity. Sub-irrigation was good, and from all indications the seedlings should have done well. However, late spring frosts and the crippled tap roots led to disastrous results.

On October 1, 1938, all the trees were reported dead except for two hardy individuals. A final report in February, 1939, revealed complete fatality.

The Siskiyou National Forest took their trees and planted them along the Oregon Coast at Gold Beach, Agness, and Gasquet ranger stations. At present some of them are doing very well.

At Agness five out of ten died because of poor attention during the forest fire season. At Gold Beach twenty-seven died due to being dried out and eighteen survived. Gasquet reported that of the thirty-six received, twenty-seven were alive to be planted and they were in poor condition. Only eight survived the first summer. As the trees were given good care, shipping procedure was blamed for the high fatality.

A few suggestions for nursery practice might be appropriate here. If the trees are to be transplanted, plant the acorns alongside laths soaked in liquid manure. The roots will adhere to the laths when the soil is removed and then they can easily be planted. More than a year in the nursery is inadvisable since the tap root grows rapidly and is easily injured. According to Professor Woodbridge Metcalf in a letter to the Umpqua National Forest on May 23, 1939, he says in part, "....young trees are highly esteemed by gophers as an article of diet." Hence it is a good idea to eliminate this rodent element as far as possible from the nursery.

Plant acorns in the fall and leave them alone. They germinate well and need not be grown in pots and petted. They should be planted with the small ends down and a quarter-inch below the surface in moderately dry earth (12).

As to diseases and insect enemies, the trees are generally free from them. The acorns are sometimes damaged by the acorn grub worm. A few trees have a leaf curl, and some have witches broom, better known as powdery mildew; both of these may be cured with a dusting of dry sulphur (13).

The city of Los Angeles reports slight attacks of the oak twig borer and slight defoliation by the oak moth. Such enemies may be corrected with a lead arsenate spray. (13).

Rodents have been found to be the worst pest. Acorns are relished by ground squirrels. As mentioned before, gophers are particularly fond of roots. They must be exterminated before attempting a plantation. Sometimes trees fifteen years or older have been killed (13).

Fire risk is high in cork oak stands. Due to the dry nature of its habitat, a good organization for protection is needed (13).

A few economic disadvantages are: Few trees being grown, low quality bark, labor, costs, and inexperience. Low quality does not bother noticeably because ground cork products using low grades, are more and more in demand. Labor is more costly in the United States but the difference saved in freight rates offsets this.

Costs place cork at one cent a pound in America for "stumpage." This comes to an aggregate profit of two dollars per acre if the average yield is 200 pounds per acre per year. From this must be deducted interest and taxes. Regardless of this, cork land is worth several times the value of the undeveloped grazing land (13).

# CHAPTER V

## CONCLUSIONS

Here are the conclusions of some authorities on the growth of cork oak in California (13).

(a) Individual cork trees made good growth at scattered points.

(b) Only one plantation has been successful.

(c) Complete failure of several plantings points to further research as to propagation.

(d) The Chico Forestry Station plantation yields some acorns every year.

Annual crop of ten sacks of 7,000 acorns per sack. Cost of collection $5.20 per sack or 10¢ per pound. May be obtained through W. H. Russell, 1820 Mulberry Street, Chico.

(e) Very little known about stripping as practically none has been carried on.

(f) Prevalence of fire in the foothills is a problem.

President Natividade of the Junta Bulletin in a letter from Lisbon, Portugal, dated March 23, 1939, to the Umpqua National Forest exploded the idea that there were two species of cork oak. He claims Quercus suber and occidentalis are one and the same as to hardiness. He based his decision to the similarity of the acorn cupule scales. However, Arthur L. Faubel, Ph.D., and Secretary of the Cork Institute of America, claims that the proof is

not too sure since the distinction is not based only on the cupule scales of the acorns. Quercus suber is generally considered the hardier of the two, but to the layman the differences of the two are so slight that it makes very little difference.

The cork market is constant, and no substitute has been found to replace the useful properties of cork. An infinite number of products are dependent on it completely or as an important component part.

A question of finance now arises--what to do? Mr. Average Man can see no future in tying up his money in such a venture for fifty years with apparently no immediate returns. Since the lands of this country have been mismanaged and wasted in its first several hundred years, the answer lies in the handling of the lands by the government. Hence lands suitable to cork oak should be considered by the government from erosion, rejuvenation, and multiple use standpoints. As liberal financing has been applied on other conservation measures, there is no reason why cork oak cannot be financed by this means. Financing could be handled by permitting loans of low interest rates to farmers and land owners specifically for the purpose of growing cork oak.

All in all, the government would be conserving American lands and insuring industry of a permanent cork supply. This would be practicing the axiom "the greatest good for the greatest number."

Some doubt is expressed by one author as to the matter of a cheap labor supply. In California or Oregon the lands best suited to the plantations is well supplied by intrastate and interstate transient fruit and cotton pickers' traffic. There are off seasons of no work for this element and an over-supply of laborers; so this would be an excellent labor reservoir.

On well-managed European forests, there is only a two percent fatality in stripping the trees (12). Americans grasp new problems and adapt themselves rapidly; hence stripping should not offer any trouble. We should get an equally good survival of the trees within a short period.

Let us review the advantages of growing cork oak on the Pacific Coast:

(a) Enemies are unimportant.

(b) High quality is less in demand each year (Figure 2A)

(c) Proximity of world's greatest market.(Figure 4)

(d) Rapidity of growth.

(e) Adapts poor land to multiple use.

Benefits derived would be multiple use of land, productive use of submarginal land, and independence at least partially from Europe. Submarginal land is that land which is not yielding any material good above the carrying and operating costs.

Multiple use of lands for cork oak would work

well with conservation, grazing, and employment. Some independence for the United States from Europe could be obtained so that future wars and world economics (Figures 4A and 4B) would not affect the supply of raw cork.

# BIBLIOGRAPHY


1. Armstrong Cork Co., A Day with Cork, Lancaster, Pennsulvania, 1930.
2. Armstrong Cork Co., Cork, Lancaster, Pennsylvania, 1909.
3. Armstrong Cork Co., Industrial Applications of Cork, Lancaster, Pennsylvania, 1909.
4. Armstrong Cork, Fortune, May, 1937, page 107.
5. Brown, Nelson Courtlandt, Forest Products, Their Manufacture and Use.
6. Buttrick, P. L., The Romance of Cork. American Forests, March, 1933, v. 39;110-113.
7. Cunningham, Charles Henry. Spain. Supplement to Commerce Reports, no. 243.
8. Cultivation of Cork Oaks and Production of Cork in Spain. International Review of Science and Practice of Agriculture (Rome, Italy). New series, 1923, v. 1.
9. Davis, Burton. The Tree Bark of a Hundred Uses. Scientific American, November, 1930, v. 143:344-348.
10. Encyclopedia Britannica, 14th edition, page 437.
11. Faubel, Arthur L. Cork and the American Cork Industry. New York, The Cork Institute of America, 1938.
12. Fernow, B. E. Some Foreigh Trees for the Southern States. U.S.D.A. Bulletin No. 11, 1895.
13. Metcalf, Woodbridge. Monthly Bulletin of the Department of Agriculture, State of California, v. 18, no. 10, October, 1929.

14. Proceedings of the Second Dearborn Conference of Agriculture, Industry and Science, 1936.

15. Zon and Sparhawk. Forest Resources of the World.

LETTERS TO THE AUTHOR

16. Congoleum-Nairn Incorporated, Kearney, New Jersey.

17. Arthur L. Faubel, Ph. D. The Cork Institute of America, 25 West 43rd Street, New York.