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THE APPLE

—
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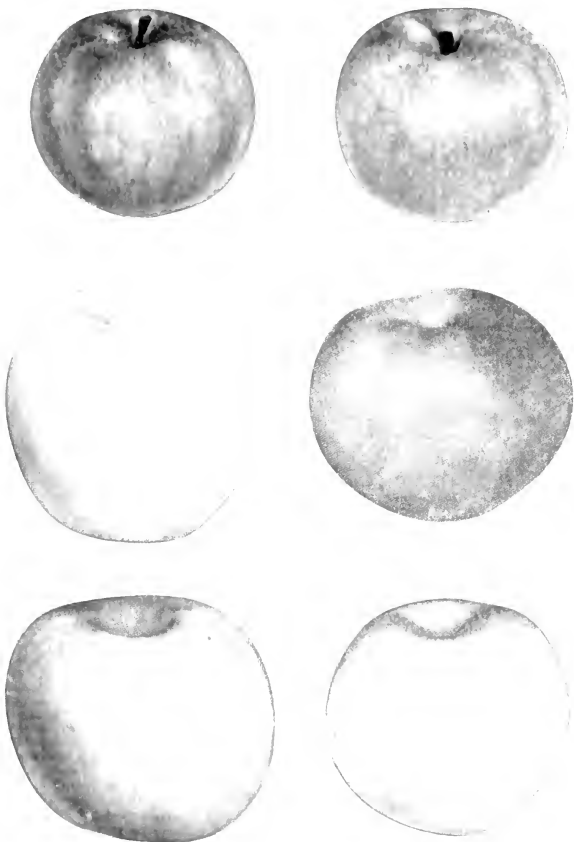


PLATE I. REPRESENTATIVE APPLES

A few of the representative apples offered for sale on the general market. They are good examples of the product obtained from the northeast, northwest, midwest, and south. Each personifies a definite fruit region. (Half size)

Baldwin
Winter Banana
York Imperial

McIntosh Red
Rhode Island Greening
Rome Beauty

THE APPLE

A PRACTICAL TREATISE DEALING WITH THE
LATEST MODERN PRACTICES OF
APPLE CULTURE

BY

ALBERT E. WILKINSON

DEPARTMENT OF HORTICULTURE, CORNELL UNIVERSITY

GINN AND COMPANY

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PREFACE

Much has been published on apple-growing. Growers and others have written many books dealing with the subject; experiment stations have carried on various kinds of investigations to determine conclusively the most efficient methods in all the subdivisions of the culture of this kind of fruits; bulletins have been issued in large numbers, until fruit growers are overwhelmed with the mass of information that has been collected about apples.

After a careful perusal of all the available writings on apple-growing, the author of this book became deeply convinced of the need of a single volume that would present in a logical manner the most essential of the recent practical ideas and methods. Such a book he has endeavored to prepare. While he has drawn on his own experience in the subject, he has also culled largely from the writings of others, and particularly from the experimental evidence they have offered.

In presenting this work the author hopes that the investigator will gain easier access to much that will aid him in a study of the question; that the farmer or fruit specialist will find just the up-to-date information and directions needed; that the amateur will feel confidence in basing his cultural requirements on the matter herein contained; and, particularly, that the student may find here the subject matter and the arrangement required for a systematic course in apple-growing.

The field covered has been made broad enough to include the practices of a large number of the typical apple-producing regions of North America. In so highly specialized an industry as this, a somewhat comprehensive treatment is felt to be decidedly important. Otherwise the special practices followed in limited areas are likely to be mistaken for rules of general application.

For material and suggestions the author wishes to acknowledge his deep indebtedness to all experiment stations in general, and, in particular, to the United States Department of Agriculture and

the experiment stations of Iowa, Oregon, Geneva, Cornell, Rhode Island, Georgia, Illinois, Massachusetts, Michigan, Connecticut, Pennsylvania, West Virginia, Maine, Ohio, North Carolina, New Jersey, Virginia, Nebraska, Utah, and Washington ; to the reports of the Iowa State Horticultural Society, the Western New York Horticultural Society, the Illinois Horticultural Society, the Vermont Horticultural Society, the American Pomological Society, and the Department of Agriculture at Ottawa ; and to *Farm and Fireside*, *Better Fruits*, *The Fruit and Produce Distributor*, *The Garden Magazine*, *The Country Gentleman*, and *The Fruit-Grower*.

Grateful acknowledgments for aid are due Mr. Madison Cooper and Professor C. S. Wilson, pomologist at the New York State College of Agriculture, Cornell University. The latter has read the proof and made many valuable suggestions.

ALBERT E. WILKINSON

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THE APPLE

CHAPTER I

SELECTION OF SITE

Many factors present themselves as important when the future location of a proposed orchard is being considered. Some of the chief ones will be discussed, in order that they may serve as guides for consideration by individuals interested in establishing orchards of apple trees.

Climate. Perhaps the most important single factor in the location of a site for an apple orchard is that of climate. It has been found after careful observations that certain locations seem to be more favorable for the growing of apples than other sites in the neighborhood. Careful survey has shown that the daily change of temperature, or its range during the day and night, has an important bearing upon this question. By daily range, or change, is meant the difference in the thermometer reading between the warmest part of the day and the coolest part of the night.

It has been clearly demonstrated that where the range of temperature exceeds 20 degrees, the blooms on the trees are injured by the sudden change. This change is quite marked during the spring, when bright, warm, sunny days are followed by cold nights. The results from these extreme temperatures are that the warm days force out the blossoms quite rapidly, causing the growth to be sappy and tender. This growth does not seem to be able to withstand the cold nights, and the fact is that the growth loses its vitality and is therefore stunted. This may often happen although a frost may not occur during the night.

Careful observations have determined that a climate suitable for growing apples should be one in which comparatively small change of temperature occurs.

Immediately one asks, Where are these places located? Generally speaking, they are not to be found in the unsheltered interior or at high elevations, but they may be found in the vicinity where the influence of large bodies of water, such as the oceans, lakes, and rivers, is predominant. The reason for the water influence is found in the fact that water changes its temperature very slowly, and the change from day to night is very slight. The air over a body of water partakes of this characteristic and passes it on, to



FIG. 1. Falling fruit

The effect of extremely early frost in a poor location

a certain degree, to the air over the adjacent lands. This, then, results in making the climate near large bodies of water cooler during the day, with but a slight range, or degree change. The growth of the tree, especially the blossoms, is thus somewhat retarded and therefore more hardy; and, not being chilled during the night, the tender blossoms are able to perform their functions.

Notable examples of the influence of large bodies of water upon the daily range of temperature are the regions near the Atlantic and Pacific coasts, where the range is 16 degrees or less; also those near the Great Lakes, the large rivers, and many other bodies of inland water. New York and other states where smaller

lakes are common have locations which are particularly favorable for apple-growing, as far as climate is concerned.

Frosts. Closely allied to climate are the very destructive spring frosts. There is scarcely a locality in the northeastern states where apple trees, especially the blossoms, are immune from injury from spring frosts. It has been clearly demonstrated, however, that close proximity to a body of water has a tendency to minimize the frequency of spring frost. Careful notes upon condition during frosty periods in the spring have been taken upon orchards near lakes and rivers and also upon orchards at some distance from a body of water. Comparison of these has shown that the injury is less frequent where the influence of the water is felt. A good example of this is Ithaca, New York, situated upon the shores of Cayuga Lake, where killing frost has only occurred four times during a period of thirty-two years, while at Cortland, twenty miles inland from Ithaca, there have been six killing frosts in eighteen years.

Nevertheless, even these seemingly frost-protected belts are not entirely free from injury. The Delaware peach crop is produced on land which lies between the Atlantic Ocean and Chesapeake Bay. Still it has been destroyed or badly injured some years by late spring frosts.

Considering the influence that is exerted in protecting fruit on land situated near large bodies of water, it is found that the most important effects are :

1. That the air being cooler during the day, the rapidity of growth of the blossoms is retarded.
2. That as the night air is but slightly cooler than the day air, the change, or range, of temperature is but little. Thus the injury from frosts is prevented.

Even when at some distance, a large lake, such as are the Great Lakes, is often sufficient to make apple-growing quite profitable over a large amount of land. This is particularly noticeable in the influence which Lake Ontario exerts upon a large part of the western and northwestern sections of the state of New York. This particular section is further aided by its innumerable smaller lakes, which in many cases are sufficient to make the farm orchard more profitable, especially if the orchards are located so as to obtain the full influence of this smaller body of water.

Near other smaller lakes or even rivers or ponds, if the orchard is properly located to receive the maximum effect of the water, it may be quite profitable even in an otherwise frosty region. The best location adjoining these bodies of water seems to be on the south or east side, because during frosty nights the wind is often from the north or west; therefore the warmer air would have a tendency to be blown toward such a location.

Positive figures are not obtainable upon the amount of heat given off by a certain body of water, but the following may give some idea of the amount of heat given off by water as it cools during the night.

According to O'Gara's¹ figures, if seventy oil pots per acre are sufficient to hold the temperature in an orchard, during quite a frosty night, 4 degrees above that of the air surrounding the orchard, actual tests have demonstrated that a body of water one foot deep and an acre in extent will give off considerably more heat than the seventy oil pots during the night where there is a decrease in the surrounding temperature of 1 degree per hour.

Not all of this heat from the water is available to an orchard. However, if it is properly located a favorable wind would cause the heated air to affect the trees appreciably.

Records of temperature to show this effect are occasionally available. For a period of twenty years records were kept at Cooperstown, New York (which is situated near the southern part of Otsego Lake), and also at New Lisbon, New York (about fifteen miles inland and toward the west from Cooperstown). These two places are ideal for comparison in regard to this matter, owing to their being practically at the same elevation.

At Cooperstown the average date of the last frost in the spring has been ascertained as May 8. Killing frosts have occurred after May 1 in only twelve out of twenty years. During this time no frost has been recorded later than June 1. In comparison with this, New Lisbon's average last frost in the spring is May 23, about fifteen days later than at Cooperstown. During the twenty years there has been a frost each year later than May 1. In fact, four killing frosts have occurred later than June 1. The average growing period between frosts at Cooperstown is one hundred forty-eight

¹ P. J. O'Gara, investigator, Rogue River Valley, Oregon.

days, while at New Lisbon only one hundred twenty-three days are available, a difference of twenty-five days, which may mean much to the apple-grower.

The deduction from these figures, as well as a study of the conditions at these two places, will show clearly that the difference is due entirely to the influence of the body of water upon the adjacent land and the orchards.

Winter temperature. Although the minimum winter temperature which a given variety of apples can withstand cannot be positively stated, owing to the fact that it depends not only upon the degree of cold but also upon many other factors, such as (1) the condition of the tree as to maturity, (2) the question of moisture, and (3) the daily range of temperature, that is, the rapidity and amount of the rise and fall, it is possible to give a general idea of the lowest temperature average trees will endure.

In Minnesota and other states of the northwest this is one of the great problems of apple-growing. After much study it has been found that for this territory the minimum winter temperature under official Weather Bureau records is about 40 degrees F. below zero. These results seem to tally with those from other sections. From these facts deductions may be obtained that would uphold the statement that it is not practical nor profitable to grow apples under conditions giving a lower degree temperature.

Summer temperature. Excessively high or low temperature during the summers seems to be an important factor in determining the site or location for certain varieties of apples. It seems from the results of investigation that it is possible to determine a mean summer temperature at which an apple tree will produce fruit at its best. Deviation from this mean generally results in greater or less inferiority of the fruit. This depends largely upon the variety and the amount of deviation.

A low summer heat, indicated by the mean temperature of the summer, has the following effects upon the fruit :

1. *Less color.* The greatest amount of color on a given variety of fruit is obtained when correct conditions for the variety are given. If, then, the degree of mean heat for a certain variety is 56 degrees and the summer temperature falls below this, there is a decrease in the coloration of that variety.

2. *Increased acidity.* Analysis shows that acidity of fruit steadily decreases throughout the stages of growth, ripening, and decay. If this is true, then fruit which does not have time for its proper maturity will be acid.

3. *Decreased size of fruit.* Although it is quite difficult to determine whether or not the difference in lots of varying size is due to methods of culture, condition of plant, or climate, it has been clearly determined by careful records that almost invariably a decreased size is obtained with a low summer mean temperature.

4. *Increased content of insoluble solids.* This is determined by analysis and with some varieties has been very marked. The Ben Davis in its belt shows an average of 2.97 per cent, while samples from sections north of its natural home increased to 3.6 per cent.

5. *Apple scald in storage.* The scalding of apples in storage sometimes occurs when the fruit is grown under poor conditions, such as poor soil or cultural methods. However, immature apples have been found to be more subject to scald than well-matured fruit.

6. *Increased astringency.* Green apples, from their taste, demonstrate quite conclusively that they have increased astringency over apples of the same variety grown farther south or more matured.

In contrast to the low temperature, excessively high temperature over the summer mean would show the following effects upon certain varieties :

1. *Lack of color.* No matter how favorable the conditions may be during the ripening period, apples that are not fully developed do not take on a natural, satisfactory color. (Example : A red variety under the above conditions might be pinkish, pale, or faded red.)

2. *Poor flavor.* A relatively cool atmosphere is to be desired for the highest development of the essential, or flavoring, oils. High temperatures do not give these results.

3. *Decreased size.* The Winesap, Ben Davis, and some other varieties which have been grown farther south than their normal belt have produced evidences of smallness in their fruit.

4. *Uneven ripening.* This is noticeable when a winter variety is grown in the South out of its normal habitat.

5. *Poor storage qualities.* Most varieties under excessive heat continue the ripening process until decay sets in. This may be

somewhat overcome by watching the fruit carefully, picking at the correct time, and placing the apples in cold storage immediately.

6. *Mcaliness and premature dropping.* These are caused by the fruit being overripe.

As a general rule the deduction from the extremes of heat and cold may be summed up in the following pertinent remarks: For winter varieties a departure of 2 degrees or more in either direction from their normal requirements will produce something quite noticeable. This is less true of fall varieties, and even less for summer sorts. In short, the earlier the variety the greater the temperature range without decided deterioration of the fruit.

Exposure. Just what is meant by the term "exposure" as applied to an apple orchard? According to Webster, *exposure* means "the position in regard to the points of the compass or to influences of climate and so forth," "accessibility to anything that may affect"; for example, a northern exposure, that is, open to the north winds.

A farmer would define *exposure* as "the slope of the land" (as a western slope, a southern slope, etc.). This is undoubtedly correct. Most authorities claim that a northern hillside or gradual slope is best because it is the coolest, the western next, the eastern next, and the southern the least desirable of all, because it forces the trees into early blooming. The majority of fruit growers in the East prefer the northern slope for apples, owing to the fact that, being cooler, it retards the growth of the trees in the spring, making the blooms less liable to injury, so that it compensates for the greater freedom from frost with which the southern side is favored.

It is not good policy to locate an orchard in a pocket made by hills or on a level valley floor. Always select a gradual, sloping hillside. Even a low hill will be satisfactory.

The author carried on a survey upon a large farm one year during the fall and spring to ascertain just the correct location for an orchard. This survey consisted in placing ten self-registering thermometers at different points on the farm on stakes, trees, etc. All these places seemed to offer some advantages for the location of an orchard. By carefully watching the thermometers morning and night and keeping a record the best of these locations was determined. It is the opinion of some practical orchardists that this

simple survey may mean the saving of hundreds of dollars later on, and it not only increases the money value but gives the satisfaction of knowing that the best site has been selected, considering climate.

Soil. Only recently has the selection of soils for an apple orchard been given much notice in comparison with the attention which has been given to the selection of soils for other crops. The old prescription, "a deep, well-drained soil for successful apple-growing," is as applicable to-day as in the past, but it applies to other crops just as much as to apples. However, it has been found, when other conditions are equalized, that the best results are obtained when a certain variety is favored with a definite soil type. This observation has led some scientists into the more detailed study of the relationship between certain varieties and different soils, so that to-day soils are mentioned as Baldwin soils, others as Rhode Island Greening soils, Northern Spy soils, Grimes soils, and so on. A later chapter will be given over to a detailed discussion of these different soil types as applied to their adaptability to certain varieties of apples.

Water supply in the soil. In general, medium loams with slightly heavier, fairly friable subsoils are the best soils for apples. If the soil tends toward heavy clay it is likely to be too wet, compact, and therefore too cold. On the other hand, light sandy soils are too loose and therefore often dry out very quickly. This dryness of the soil often increases the desired color of the fruit, while the wet, heavy soil has a tendency to decrease the desired color; but the heavier soils have ranker growth of wood and larger leaves, while the sands produce much poorer leaf and wood growth.

The water-holding capacity of the soil seems to be the fundamental factor in making a certain soil suitable for the most successful growth of a given variety of apple within the fruit's general climatic region. Why this is so may not be perfectly clear to the reader, but it may be somewhat clearer when it is understood that the only kind of water which plant growth seems to be able to use is the capillary water which the soil holds, and that the capacity of a soil to hold capillary water depends on several factors.

The size of the soil grains, or the soil texture, is a very important factor. Every soil particle is surrounded by a film of moisture,

Thus the finer these soil particles the greater the number of films, resulting in a larger amount of moisture in a given soil. Drainage does not remove this film moisture. It is only removed through the growing plant by transpiration and by evaporation from the surface of the soil. The latter may be controlled by proper tillage or soil-mulch conservation.

The humus content of a given soil is another important requirement in regard to the water supply in the soil. The supply of humus in the soil, generally included in the surface layer, greatly lessens the loss of moisture by evaporation, and further increases considerably the moisture-holding capacity of the soil, both as to rainfall and the rise of capillary water. Hence the greater the amount of moisture in a soil, the lower the temperature of that soil during the summer.

Closely connected with the texture and the humus content of a soil in regard to the water supply is the degree of soil tilth. The more complete the mulch formed by cultivation, the greater the conservation of soil moisture; or, in other words, the loss by evaporation is materially lessened where good tillage is practiced.

Surface, drainage, air, and water. It is essential that some elevation be given to the site for an orchard, in order that good air and water drainage may be obtained. Cold air, being heavier than warm air, has a tendency to flow or run downhill, while the warmer air will rise. This flow, or free movement, of the air is obtained if an elevation is selected as a site for an apple orchard. Often an elevation of not more than from fifty to one hundred feet will be sufficient to give this action, particularly if there is a good outlet, such as a water channel, below; but if a pocket is formed and the cold air is retained, as in valleys and such places, the location is not desirable, owing to the fact that on still, clear, cool nights frost is likely to occur and great injury may result.

Besides the desirable air drainage, water drainage will be given on these elevated sites, doing away with the injury of standing water around the roots of the trees. Nevertheless, washing of the soil should be avoided by the selecting of gradual slopes, the planting of cover crops, or other means.

CHAPTER II

ADAPTATION OF VARIETIES TO SOILS¹

The selection of the soil for orchard planting has received relatively little attention in the past as compared with that given to selecting soils for other special crops. In the production of the latter, such as tobacco, onions, garden and floral crops, competition has forced the selection of favorable soils as well as suitable conditions. The most successful growers have learned through experience, moreover, to discriminate carefully in choosing their soils.

The general farmer has not advanced so far in the matter of selecting particular soils for his crops, or, conversely, in using his soils to grow only those crops which they are best adapted to produce. This is largely due to the fact that the money returns per acre are much less than the returns from special crops, and hence it has not been so essential to select soils with as much care as for special crops. Even so, in the eastern United States there are many soil areas from which general farming has been driven because the soils were not adapted to such use. And this statement is not meant to include rough lands which have been unable to compete on account of the relatively heavy expense of working them.

There is no longer any question as to whether orcharding is a specialized business. The steadily increasing demand for orchard products of select appearance has compelled growers, if they would succeed, to spray thoroughly, to maintain a well-balanced wood growth, and to market the fruit in an attractive manner.

As a result of the vast amount of orchard experience already acquired, it is apparent that some soils have given better returns than others. Hence we get from many sources the prescription of "a deep, well-drained soil for successful apple-growing." No one will question the excellence of this general rule (which is, in fact, just as applicable to other crops as to apples), but there is a

¹ After H. J. Wilder, Department of Agriculture, Washington, D.C.

tremendous range of soils in any state, and it is found, when other conditions are equalized, that certain varieties of apples give the best results on certain kinds of soil.

It is not uncommon to find one orchardist who thinks that the point of chief consideration should be variety ; another, climate ; another, tillage or sod mulching ; another, spraying ; another, pruning ; another, fertilizers ; and so on. Several of these factors usually receive careful thought from orchardists, but relatively few men will claim not to have neglected some of them. The point needing emphasis is that while all these elements are essential, no one is of much avail except in conjunction with all the others. Thus, all the other conditions will avail little if the soil is not well selected ; yet the character of the soil is of little importance if the trees do not receive proper care after planting. The orchardist should choose soil that is generally suitable for orcharding, and on such given soil he should plant only those varieties to which it is best adapted.

The necessity for soil-variety selection is most forcibly illustrated by the experiences of fruit growers who have found orcharding profitable. There are very few, even of the most prominent growers, who have not found, at marked cost and with years of waiting, that certain varieties of fruit would not succeed under the conditions which they were able to supply. Yet the reason for this has rarely been investigated seriously, and failure, when it comes, is commonly ascribed to the climate or to some inherent fault of the variety. Then the grower often does untold harm by the announcement that this or that variety is not adapted to the surrounding locality. He is honest in his opinion, and his experience, from the very circumstances of the case, will be largely accepted. Yet other soils in the locality, or even soil on another part of that particular farm, may be favorable to this rejected variety, which may possess good commercial possibilities. This is an illustration of the fact that all other circumstances combined, though favorable, are insufficient for the production of any variety if the proper soil is not selected. Yet other varieties may have been growing eminently well upon the soil tested.

In view of such facts it is not strange that there is a rapidly growing commercial demand for such knowledge of the soil as will enable the grower to know how to avoid planting those varieties not

adapted to available conditions, and to select those varieties that will do well. The cause of this demand is illustrated not only by the unprofitableness of many orchards as a whole, but even more forcibly by the unprofitableness of varieties now growing on certain soils, or under certain soil conditions, in orchards of the best fruit growers.

A given variety, for the best success within its general climatic region, should be planted on certain kinds or under certain conditions of soil. Outside this region certain compensating factors may make the production of such variety feasible. The Baldwin, for instance, which originated in Massachusetts and may be grown with success much more universally north of a line drawn from New York City west to, say, Sunbury, Bellefonte, and New Castle near the Ohio line than anywhere else, is still a valuable sort for elevated areas from central Pennsylvania to northern Virginia. In this case a greater elevation compensates for the more southerly location, and as a result this variety, when grown upon suitable soils, is a commercial sort far south into Virginia. The climatic factor is always in evidence, however, for with increasing distance southward a higher altitude is necessary. At lower elevations the Baldwin becomes a fall apple, and as such it is not so desirable as other varieties. A slight exception to this statement, and yet one that strongly illustrates the effect of soil influence, lies in the fact that if, at the very point where the Baldwin tends to become a fall apple, it is planted on a soil somewhat heavier than the ideal, such departure from the normal soil offsets in some degree the unfavorable change in climatic influence. This is due probably to the lower specific heat of the more clayey soil, and is of importance only where the climatic departure is not very marked, a wide difference not being susceptible to amelioration by soil selection. As grown in the district above outlined, the Baldwin is an excellent No. 2 winter sort.

With this understanding of the problem the soil requirements of several varieties of apples will be discussed.

Baldwin soils. If soils are thought of as grading from heavy to light, according to the range from clay to sand, then soils grading from medium to semi-light fulfill best the requirements of the Baldwin. Following definitely the classification standards of the United States Bureau of Soils with reference to the proportions of

clay, silt, and sands, this grouping would include the medium-to-light loams, the heavy sandy loams, and also the medium sandy loams provided they were underlain by soil material not lighter than a medium loam nor heavier than a light or medium clay loam of friable structure.

From this broad generalization it will be seen that the surface soil should contain an appreciable amount of sand. The sands, moreover, should not be all of one grade; that is, a high percentage



FIG. 2. A Baldwin that has found congenial soil

When fifteen years old this tree produced nine barrels of No. 1, the small pile (at the left) of No. 2, and the very small pile (at the right) of culls. (From the farm of Edward Van Alstyne, Kinderhook, New York)

of coarse sand would give a poor soil, whereas a moderate admixture of it with the finer grades of sand, together with sufficient clay and silt, would work no harm. In general the sand content should be of finer grades, but soils also occur, though comparatively rare, which would be too heavy for this variety if it were not for a marked content of the coarse sands, the effect of which is to make the mass of soil much more friable and open than would be expected with the presence of so much clay. Such soil dries quickly after a rain and is not to be classed as a moist soil. It will never clod if worked under conditions at all reasonable. The subsoil, on the

other hand, must never be heavy enough to impede ready drainage of excess moisture, yet must be sufficiently clayey to retain a good moisture supply ; that is, it must be plastic, not stiff.

The ideal to be sought is a heavy fine sandy loam, or light mellow loam, underlain by plastic light clay loam or heavy silty loam. It is fully realized that many will not possess this ideal soil, but the soil that most closely resembles it should be chosen. If corn is grown on such soil, the lower leaves will cure down before cutting time, giving evidence of moderately early maturity. This is one of the safe criteria by which to be guided in choosing soil for Baldwins.

In the above description, mention was not made of the color of the soil. The desirability of a surface soil of dark brown (the color being due to the presence of decaying organic matter) is unquestionable and generally recognized, and if the soil is not of that color, the successful orchardist will make it such by the incorporation of organic matter through the growth of leguminous crops or by some other means. It is often cheaper to buy soil with a good organic content, or humus supply, than it is to be compelled to put it there after purchase before good crops can be secured. Hence this is purely an economic feature. The warning should be stated, however, that a soil should not be purchased or planted to apples of any variety because it is dark-colored and rich in humus. The soil should be selected because of its textural and structural adaptation, regardless of the organic content. Then, if such soils happen to be well supplied with vegetable matter, so much the better ; if not, it may be supplied.

Ben Davis and Gano. These varieties show less effect from variation in the soils upon which they are grown than any others observed. Their well-known quality is probably somewhat indicative of why this is so, yet there are differences to be noted in the character of the fruit as affected by soil and climate. The latter feature is believed to be of great importance, for while there is no gainsaying the fact that the Ben Davis will grow anywhere and produce fruit of some description, it requires a good deal of warm weather for its best development.

The mere fact that the Ben Davis may well be called the "apple of neglect," because it will probably stand more neglect than any other commercial variety and still bear fruit, accounts for the

commercial growers' dictum that it is "a good barrel filler and a good shipper"; while they may follow this saying with the words, "and that is all." No other varieties are so cosmopolitan with regard to climate, and from New York to Alabama these apples have numerous advocates.

Soils as heavy and moist as described for the green Rhode Island Greening are not desirable for either the Ben Davis or Gano. The tree is naturally of strong growth, hence this characteristic should not be intensified by planting on an excessively rich soil, both on account of the growth of tree and the poor quality and color of the fruit. At the same time, the opposite extreme is not desirable, for if the soil be too sandy the tree grows stragglingly.

Both of these varieties as planted are bound to prove profitable, but they are not altogether satisfactory. Soils adapted to the Baldwin, York Imperial, or Winesap will grow good trees and fruit of both Ben Davis and Gano. Hence, there are extensive soil areas, particularly in Pennsylvania, Maryland, and the mountainous areas of Virginia and West Virginia, that are well adapted to these varieties, and they are also profitable varieties in western New York and in the Hudson valley.

From careful observation it is believed that the Ozark Ben Davis is a little larger than the Appalachian-grown fruit, and that under the same conditions the Ozark fruit is sufficiently superior to the latter to bring a slightly higher price in market. As a commercial proposition, however, the greater number of crops secured in the Appalachian region in any considerable period, such as a decade, enables that section to compete successfully in the production of these varieties. An important point to be considered, nevertheless, by the Eastern growers is the outlook for future markets.

Fall Pippin. The Fall Pippin soils are somewhat wider in range than those of the two preceding varieties. In fact, this variety will succeed on the soils described for the Tompkins King and the Northern Spy. It is preferable, however, that the surface soil be a fine loam rather than the open-textured loam described for the Tompkins King.

Grimes. The Grimes is so similar to the Rhode Island Greening in soil adaptation that a separate description of the soils best for this variety will not be given. The Grimes has been so profitable

in some districts, under certain conditions of soil and climate, however, that its desirability for general planting has been widely heralded, and as a result it is now being planted with too little discrimination, with reference to both soil and climate.

The best general guide is to plant the Grimes where the Rhode Island Greening tends to become a fall apple; that is, the Rhode Island Greening soil, located far enough south for that variety to be undesirable for extensive planting, is well adapted to and may



FIG. 3. Apples from one tree nineteen years old

No. 1 in the barrels; No. 2 at the right; small pile, culls. An indication that this tree is growing in the correct soil type. (*Tribune Farmer*)

well be utilized for the Grimes. It is recognized that some growers as far north as New York may dissent from this view. The tendency for a considerable percentage of the fruit to be undersized when grown there is one of the prime reasons why it cannot compete commercially with that grown under more favorable conditions. Besides, it is often not up to the standard in color.

The tendency of the tree to make unsatisfactory growth may be overcome in some measure if planted in soil to which it is adapted. It should never be planted on a light or thin soil, nor yet on a stiff soil. The tree maintains its best growth on a well-drained, fertile, moist soil, and under such conditions is a very desirable variety in

its region. Good air drainage is essential. Lack of it makes necessary the elimination of many soil areas that would otherwise be desirable. Its excellent dessert quality makes the Grimes a favorite sort both for family and for commercial use. For a special box trade, it is especially valuable.

Hubbardston. Compared with the Baldwin soil requirements, the heaviest soils desirable for the Hubbardston in the northern districts lap over for a little upon the lightest soils desirable for the Baldwin, while at the other extreme the Hubbardston will utilize the most sandy soil of any of the varieties of that region. This does not mean that it will succeed on poor light sands, for on such soils the apple will not attain sufficient size to be of value, nor is the tree vigorous enough, but the soil should always be very mellow.

A rich fine sandy loam to a depth of at least a foot is preferable, and the subsoil may well be of the same texture. On such soils this variety gives remarkable results in New England, where it originated. A subsoil containing enough clay to make the fine sandy material somewhat coherent or sticky is excellent, but there should never be enough clay present to render the subsoil heavy. If the soil is too heavy or too clayey the fruit is liable, in the northern sections especially, to have greasy skins, the color is deficient, and the flavor insufficiently developed; but in the southern sections fairly heavy soils, such as loams, may well be used if mellow and friable. In common phraseology the soil should be such as to respond quickly to fertilizers, not the earliest soil but one moderately early. The Hubbardston requires good air drainage and local elevation for the best results.

King. The Tompkins King is fully as exacting as the Northern Spy in soil adaptation. The tree, with its straggling tendency of growth, does not develop satisfactorily on sandy soils, but succeeds best on a moist yet well-drained soil; that is, the light Rhode Island Greening soils—a soil capable of maintaining such supply of moisture that the tree receives no check at the approach of drought. But the fruit grown on soils so heavy lacks clearness of skin, and the appearance of the apple is marred by the greenish look, extending far up the sides from the blossom end, and the lack of well-developed color, which makes this fruit at its best very

attractive. Hence the problem is to balance these two opposite tendencies as well as possible, and soil of the following description seems best to do this: light mellow loam, the sand content thereof being medium rather than fine, thus constituting an open-textured loam instead of a fine loam. The subsoil should be either of the same texture or only slightly heavier, in no case being heavier than a very light plastic clay loam. The soils must be brought to a productive condition. Subsoils inclining toward stiffness in structure should be carefully avoided.

The Tompkins King is commercial only in the northern sections, and even there it is seldom as profitable per acre as other varieties, unless it receives special care. It is a choice variety for the specialist who caters to select city trade.

Mammoth Black Twig (Arkansas). This variety bears the reputation of being a shy bearer, and while such repute may be deserved in a measure as a varietal characteristic, yet the variance of results due to the differences of soil shows the importance of the latter factor in growing the Arkansas. Originating near the southern end of the Ozarks in northwest Arkansas, its growth on most of the soils there, although it is still a comparatively young variety, has been luxuriant. The indications are that the stronger the growth of this variety the smaller the yield of fruit, and it is certainly not desirable on moist or rich soils. Hence, in soil adaptation it is the opposite of the Yellow Newtown, Rhode Island Greening, and Grimes.

The heavy loams and the clays not in a very rich condition are often well adapted to the Arkansas. The Porters clay, for instance, which has been "farmed out" produces tree growth as vigorous as this variety seems able to stand and still bear satisfactorily. Shale hills are well adapted to the Arkansas, for, generally unproductive, they do not effect excessive growth, while if deficient in this respect, slight fertilization will remedy the condition and bring the trees into bearing. On rich soils, however, it is very difficult so to check the growth as to induce prolificacy. The limestone-valley soils are an illustration of this, and on some of these soils in Virginia, leaf blight is very serious with this variety. It may be added that this soil adaptation holds for the Ozark plateau, as well as the Appalachian region. Hence the soil conditions for this

variety must be such as to be held in control, making sure that the wood growth is not too rapid. In North Alabama the DeKalb fine sandy loam is the best soil for the Arkansas. From its adaptation it will be seen that very cheap lands may be used for growing this variety, and if one has such soils and wishes to turn them to apple orcharding, moderate returns may be obtained from growing the Arkansas. From a commercial viewpoint, however, there are few growers who do not possess enough better orcharding land to make it unnecessary to grow this apple; and even on the thin soils it is probable that other varieties, such as the Ben Davis, would be far more profitable.

Newtown Pippin. The Yellow Newtown has always been regarded as exacting in soil requirements, as well as climatic environment. Great stress has been laid upon this point in Virginia, where it has received the local name of Albemarle Pippin. An ideal soil for this variety in Virginia consists of dark-brown, heavy mellow loam to a depth of twelve inches, which grows gradually heavier to twenty-four inches, where it becomes a clay loam. This clay loam, however, is not stiff. Heavier soils are also well adapted to this variety if there is sufficient decayed vegetable matter present to render them friable. This is very noticeable with the Porters clay. Such soils, rich in plant food and retentive of moisture, furnish ideal conditions for this variety, which requires a luxuriant growth of tree to produce the crisp grain and delicate flavor of fruit, as well as a profitable yield. So well did the Yellow Newtown thrive in protected coves of the Porters series of soils in Virginia, where the leaves and vegetable débris had collected for so long that the surface material was black to a general depth of several inches and to a depth of several feet in particular cases, that it was only natural in the course of time for the idea to prevail that a great accumulation of organic matter in the soil was a preliminary essential for success with this variety.

Again, the enormous amounts of accumulated vegetable matter changed heavy clay loams, and even clays, into deep, friable soils, thus furnishing the moist, productive conditions so necessary for the Yellow Newtown. Hence the belief that the Yellow Newtown should be planted only on a black soil became firmly grounded. Yet many orchard soils chosen with this characteristic in mind

soon lost their dark color as a result of intercropping, and in most of the orchards planted on very dark soil the color is now at most only a dark brown. On the other hand, areas of the Porters loam and Porters clay that had not been blessed with the accumulation of extraordinary stores of decayed vegetable matter, but otherwise were the same, have produced results just as good with this variety. And the secret of this success has been simply to provide an increase of humus in the soil by the growth of leguminous and other crops, in conjunction with stable manure where available, instead of steadily decreasing such supply by wasteful practices in cropping.

In fact, it is now known that there is such a thing as having an excess of organic matter, even for the Pippin, and that there is a happy mean which produces fruit firmer in texture and better in quality than that grown on the blackest soils.

In choosing soil areas for the Yellow Newtown in the type Porters clay, localities with stiff, heavy clay subsoils should be avoided, as they tend to produce greasy skins, making the fruit defective in appearance.

The increase of insects and fungi injurious to fruits has brought about the necessity for a change in the methods of growing the Yellow Newtown. Orchards located in coves so inaccessible or steep as to render power spraying impracticable have been profitable, but the necessity now for planting orchards not only where spraying may be readily done but also where the various processes of tilling, harvesting, and hauling may be economically accomplished makes the profitable production of this apple depend upon its being grown on suitable soils in an accessible location, as well as with necessary climatic attributes. Such areas occur in the types mentioned and, with the methods of soil management briefly outlined, indicate the excellent possibilities for the production and extension of this important commercial variety. Hence, soils however suitable should not be planted if too steep for economic production. This is a crucial feature in the Virginia region, and fortunately the best growers are coming to realize it.

In the Hudson valley region the soils described as adapted to the Rhode Island Greening are also suited to the growth of the Yellow Newtown. Some of these soils will grow magnificent

Pippins in their present condition, while others should be enlivened by increasing their organic content either with stable manure, with leguminous and other green crops, or with both.

In the southern tier of counties midway across the state of Pennsylvania, in western Maryland, in Virginia and the extreme northeast part of West Virginia, areas of loams and clay loams well elevated locally will produce the Yellow Newtown successfully



FIG. 4. Northern Spy — an ideal tree

Surely this orchard shows the results of proper variety on soil type

if properly handled. Such areas occur in the Hagerstown, Edgemont, and Mont Alto series of soils principally, but are sometimes found in other series. The tendency of this variety, however, not to bear a profitable crop until fifteen or twenty years old, and even then not to be a reliable biennial bearer, will prevent its planting to any large extent in some states.

Northern Spy. This variety is one of the most exacting in soil requirements. To obtain good quality of fruit — that is, fine texture, juiciness, and high flavor — the soil must be moderately heavy, and for the first two qualities alone the Rhode Island Greening soil

would be admirable. The fact that the Northern Spy is a red apple, however, makes it imperative that the color be well developed and the skin free from the greasy tendency. This necessitates a fine adjustment of soil conditions, for the heaviest of the soils adapted to the Rhode Island Greening produce Northern Spies with greasy skins and usually of inferior color. The habit of tree growth of this variety, moreover, is such as to require careful attention. Its tendency to grow upright seems to be accentuated by too clayey soils, if well enriched, and such soils tend to promote growth faster than the tree is able to mature well. On the other hand, sandy soils, while producing good color and clear skins, fail to bring fruit satisfactory in quality with respect to texture and flavor. The keeping quality, too, is inferior to that of the Spy grown on heavier soils in the same district. Hence the soil requirements of this variety are decidedly exacting, and are best supplied apparently by a medium loam underlain by a heavy loam or light clay loam. It should not be planted on a soil lighter than a very heavy fine sandy loam, underlain by a light clay loam or possibly a heavy loam. On light soils the Northern Spy very often yields less per acre than the Baldwin. Good air drainage is also very essential with this variety.

The Northern Spy should be grown commercially only in the Baldwin district, and does not succeed so far south as that variety, even at high elevations. Central Pennsylvania seems to be its southern commercial limit. For family use or for local markets, it may be grown on elevated positions somewhat farther south, but it fails to keep until its normal season.

Rhode Island Greening. Soils adapted to the production of a green Rhode Island Greening, as distinguished from the Rhode Island Greening carrying a high blush, are distinct from the Baldwin standard. New York City has been the largest market for this variety. She prefers a green Greening, and for it the great majority of her apple dealers will pay more than for a blush Greening, or more than other cities will pay for the latter. Consequently it has been the aim to ascertain the soil conditions that best contribute to this standard. For it a surface soil of heavy silty loam or light silty loam, underlain by silty clay loam, excels. Such soil will retain sufficient moisture to be classed

as a moist soil, yet it is not so heavy as ever to be ill drained if surface drainage is adequate. The soil should be moderately rich in organic matter, decidedly more so than for the Baldwin. In contrast to the Baldwin soil in the growth of corn, it should keep the lower leaves of the plant green until harvesting time or at least until late in the season. Such soil conditions maintain a long seasonal growth under uniform conditions of moisture, and thus produce the firm yet crisp texture, the remarkable juiciness, and the high flavor for which this variety is noted when at its best. If a high blush is desired, however, to supply other market conditions or for home use, a soil somewhat warmer than that described should be selected—a deep light mellow loam or a productive fine sandy loam being favorable.

The Rhode Island Greening is also more restricted in area than the Baldwin, not adapting itself to the climatic conditions as far south as the Baldwin, even though suitable soils occur there. In fact, its southern boundary may be estimated roughly as $\frac{1}{4}$ degree north of the forty-first parallel. South of that it becomes a fall apple and keeps very poorly.

Rome Beauty. The Rome Beauty bears the same relation to the Grimes in soil requirements as the Baldwin does to the Rhode Island Greening in their respective regions. There is, however, something of an overlapping of regions; that is, the Baldwin extends farther south in adaptation than the Rhode Island Greening, and the Rome Beauty extends as far north as the Grimes. But this intra-regional overlapping of the Rome Beauty and the Baldwin is largely a matter of dovetailing due to variations in elevation. Thus in southern Pennsylvania, as the Baldwin in its southerly extension seeks its soil at higher elevations to offset the climatic changes, so does the Rome Beauty in its northern extension seek the same soil at a lower elevation for the same reason.

It is grown with marked success in West Virginia, where it is a leading commercial sort. It has given excellent results there on fine sandy loams and mellow loams of the Westmoreland, Upshur, and DeKalb series. In western Kentucky, too, the Rome Beauty is of commercial importance, and it promises well for growing farther south at considerable elevation. In a few instances it has grown

successfully in north Alabama on the loam and fine sandy loam of the Cecil series. The heavy, fine sandy loam and the loam of the DeKalb series would also be moderately good for this variety, though very often these soils would need to be made more productive to effect a good growth of tree.

The Rome Beauty is grown with fairly good success in the lower Hudson valley and at low elevations in western New York, but there is some question as to whether it will become a leading commercial sort in either region.

Stayman Winesap. In the South Mountain and Piedmont districts of Pennsylvania, Stayman Winesap has thus far given good results. In Virginia the variety does well on a heavy loam or even light clay loam underlain by clay loam, as the Porters loam or Porters clay.

The Stayman Winesap is an apple of great promise in southern and central Pennsylvania and for the middle Appalachian region to the south. It is possibly of moderate worth also in the Rhode Island Greening belt of southern New York and in the Hudson valley region, but its success has yet to be demonstrated for general planting in New York, New England, and at high altitudes in northern Pennsylvania. Hence, while perhaps worthy of trial in favorable locations there, commercial plantings are ill advised without further evidence of its desirability under the existing climatic conditions. In the southern Appalachians it becomes too early in many places for an apple of commercial importance, not succeeding quite as far south as the old Virginia Winesap, but it is desirable for local markets. In the mountains of North Carolina it grows well, is productive, and readily keeps in good condition until Christmas. With better methods of handling and storing, the season could probably be somewhat lengthened. The medium-textured members of the Porters soils are adapted to its growth in that region.

Wagener. The tree is weak in growth, hence a soil that is deep, strong, mellow, and loamy should be selected. Stiff subsoils are especially objectionable with this variety, and thin hills should be avoided. The Wagener thus fits in well with the Northern Spy in soil requirements, and its early bearing makes an effective offset to the latter's tardiness in this respect.

Winesap. The Winesap is a standard variety of Virginia and the southern Appalachians — an apple of good quality that responds readily to favorable conditions of soil and treatment, and also brings surprisingly good returns under neglect.

The soil need not be so rich as for the Yellow Newtown, because the presence of too much organic matter detracts from the color of the fruit, yet the tendency of this variety to yield fruit below standard size makes desirable a soil as rich as may be while securing a well-colored product. Much of the fruit as grown has been from thin soils, and little or no effort has been expended in improving the condition of such land. This has accentuated the tendency of the variety to be small.

The Winesap is adapted to both the Appalachian and the Piedmont soils. In the mountains the Porters loam and loamy areas of Porters clay are best; in the valley of Virginia the Hagerstown loam and Hagerstown clay loam; and on the Piedmont plain the Cecil loam and Cecil clay. The Cecil soils are usually so deficient in organic content, as a result of exhausting systems of farming, that the fruit is very small unless the land is put into good condition. Fortunately this is entirely practicable under present conditions, and may be done with profit. Hence selected areas in the Piedmont plain offer good opportunities for developing small and medium-sized apple projects in connection with other lines of farming. The Porters soils have not been so reduced in productiveness and are better adapted to the Winesap conditions, but the valley limestone soils there represented by the Hagerstown series are also now producing the Winesap with great success. At the southern end of the Appalachians, in north Alabama, the Clarksville stony loam is also well adapted to this variety. The problem, then, with the Winesap is to bring the soils adapted to it into a productive condition and then to thin the fruit where economically feasible.

York Imperial. This variety is adapted to an extensive scope of territory. This would naturally give rise to several soil series of which the loamy members are well adapted to the production of this apple. The so-called "soapstone land" in West Virginia gives excellent results. This name is derived from the rock formations, which range from a schistose limestone to a limy

shale, the latter when in small pieces of disintegrated rock being characterized by a soapy feel.

The surface of this soapstone land consists for the most part of a mellow friable loam, which is usually silty and in local areas is a silt loam, very mellow in character. The surface soil is from eight to twelve inches deep, with a medium brown color. This soil is extremely friable and workable. The subsoil consists of yellow friable loam, which usually grades into silty clay loam at a depth of from twenty to thirty inches.

Both soil and subsoil contain from 10 to 20 per cent of smooth, shaly fragments. These particles are of yellowish color, small and crumbly, seldom exceeding one-quarter inch and mostly from one-sixteenth to one-eighth inch in diameter. The amount of these increases slightly with depth to an average depth of thirty inches, below which is found a subsoil of smooth, plastic yellow clay loam to clay.

From the preceding descriptions of definite soil occurrence, an idea of the soils adapted to the York Imperial may be obtained. Extensive areas of soil types mapped and described in various reports of the Bureau of Soils are also well adapted to this apple. Among them the Hagerstown loam may be prominently mentioned. Some excellent soils for this variety are the Porters clay and the Floradale stony loam, including the "copperstone," the "gray flint," and the "white flint" phases. The surface soils are friable, gray-brown clay loams or heavy loams.

The Chester loam and the Chester stony loam, as they occur in Pennsylvania, also in central Maryland, and extending for a little way into northern Virginia in the vicinity of Leesburg, are also excellent.

The York Imperial is unsatisfactory in the North. This variety should not be grown where the Baldwin succeeds.

CHAPTER III¹

ORCHARD HEATING

Late spring frosts cause immense losses of fruit in many sections of the country and help to discourage growers until many of them neglect, destroy, or dispose of their orchards.

Test by individuals and experiment stations that have tried out heat as a means of frost protection has demonstrated the following facts :

1. That the temperature in an orchard can be raised several degrees in time of frost.

2. That orchard heating as a method of insurance against frost is practical in many sections during most seasons.

The type of heater to use. The type of heater to be used must be determined by each grower for himself. In a general way it may be said that the larger heaters will give best satisfaction, as they furnish a reservoir for the storing of oil for longer periods of firing. It is almost impossible, and at least impracticable, to try to refill the pots during the night. If the refilling equipment is not working well, great loss is apt to result. A gallon of oil will burn only about four hours, and as frost periods are apt to be much longer than this, greater capacity is needed. Even though some heaters may burn a gallon of oil for a longer period than four hours, there must be a loss of heat, as it requires a certain amount of burning oil to raise the temperature a given amount. If a larger number of the smaller heaters are provided, so that a part can be fired in the early part of the night and the remainder at successive

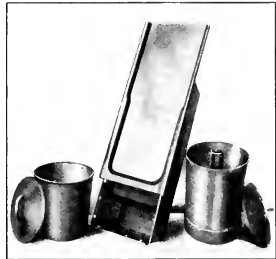


FIG. 5. Three different types of orchard heaters. (Iowa Agricultural Experiment Station)

¹ After Iowa State College bulletins.

periods, they will give as good satisfaction as the larger heaters. With most heaters there is less heat given off as the oil burns low in the pot, and a reserve supply of heaters should be on hand to take care of this deficiency. In addition the temperature is usually lower just before sunrise than at any other period, and the burning surface of the oil should be greater at this time than earlier.

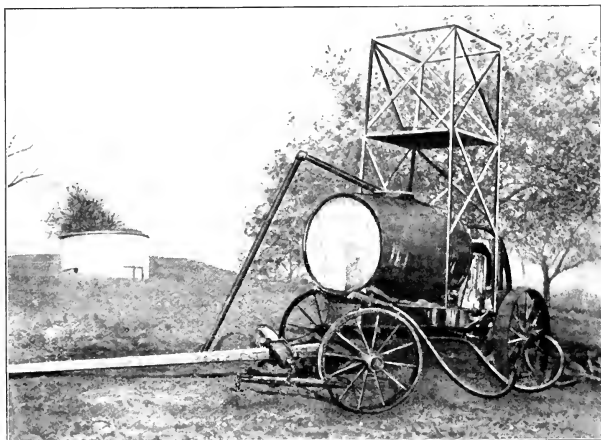


FIG. 6. Filling the distributing tank

The standpipe in the rear contains the storage oil; the oil runs by gravity through the pipe at the left. Note the nozzle for filling the heaters resting on the front wheel. (After Iowa State College)

Number of heaters per acre. Of the smaller heaters, it will be necessary to use from 80 to 120 per acre; probably 100 is a good average number to use. Of the larger pots, 60 to 80 per acre should be used. It should be remembered that the smaller fires scattered over the orchards are much better than a few large fires. In using the large heaters it is not wise to reduce the number too low, even though the burning surface can be made much larger than on the smaller heaters. Moreover, in using a large number of the larger heaters, the amount of the flame per heater can be reduced, thus giving greater reservoir capacity and long-continued fire.

The oil to use. At present the smudge oil put out by the various oil companies seems to be the cheapest.

Oil can be purchased in tank-car lots from $1\frac{1}{2}$ cents to 3 cents per gallon. In barrels it will cost $4\frac{1}{2}$ cents to 6 cents per gallon. The amount of oil necessary will depend upon the number of frosty nights and the length of time that heating will be necessary. This will be hard to forecast, and sufficient oil should be provided to last through more than the ordinary number of frosty nights. In most seasons from one to three frosty nights are encountered. The frosty period usually occurs late in the night, after midnight, and lasts until sunrise. From three to five hours will usually cover

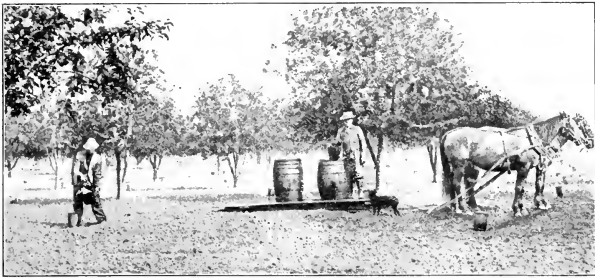


FIG. 7. Filling orchard heaters. (Oregon Agricultural Experiment Station)

this period. However, certain nights may occur when it will be necessary to keep the fires going from eight to ten hours, and others when perhaps only an hour's heating will be necessary. From three to six gallons of oil per heater should be provided. If there is good storage, this oil will keep from year to year, so that what is not used may be kept over for the next season. The grower is much better prepared for emergency if the larger amount of oil is on hand. Oil is too cheap to allow shortage of supply to occur.

How to store the oil. For storing oil a cement cistern lined with asphalt gives the best results. This is especially true if the cistern is located on a slope so that the oil may be handled by gravity from the tank wagon to the cistern and from the cistern into the distributing wagon. These oils are very difficult to handle

by dipping or pumping methods. However, the rotary pumps have given general satisfaction when the lighter oils have been used.

The cistern walls should be from 6 to 8 inches thick to give the best results. The floor need not be so heavy, probably 4 inches thick being sufficient. The mixture used should be composed of about 1 part of cement to 2 or 3 parts of sand. If crushed rock can be used in mixing the concrete, 1 part of cement, 2 to 3 parts of sand, and 4 or 5 parts of crushed rock will give good results. The walls should then be finished with cement plaster, thus giving a smoother surface. The whole inside should be painted with two or three coats of asphalt paint. Paraffin has not given thorough satisfaction among some of the Middle-West growers. The roof of the cistern can be made of a reinforced cement slab. This slab will vary in thickness according to the width of the cistern, but if it is not over 8 feet wide, a well reinforced slab 5 inches in thickness should be sufficient.



FIG. 8. Torch and can used in orchard heating
(Iowa State College Experiment Station)

A method of distributing the oil. In the distribution of the oil, wagons holding 300 to 400 gallons will be the best size. These should be sufficiently high so that good pressure can be obtained at the end of the hose used for filling the pots. A tank for this purpose can be secured at from \$15.00 to \$20.00. If 10 acres or more are to be protected, it will be well to provide two wagons;

and as these can be used in transporting the oil from the tank car, they will be found almost indispensable. It is very important that these tanks be perfectly tight and that pipe connections be tight, with good solid valves. Handling the oil is a dirty job

at best, and unless all leakages are prevented, it becomes doubly disagreeable. One should dress for dirty, oily work.

How to light the pots. The pots are lighted by the use of a gasoline can with valve fixture, which makes it possible to squirt a small amount of gasoline on top of the fuel oil. A torch can be made of a corncob fastened to a piece of wire and soaked in fuel oil.

It requires about forty-five minutes for three men to light 600 pots, but one man could easily light 300 pots per hour, providing his torches and gasoline can worked well.

When to light heaters. The temperature at which the fires shall be lighted will depend upon the predicted temperature for



FIG. 9. Heating a small home orchard with fire pots in full blaze. (After Iowa State College)

the night and the rapidity with which the temperature falls. If a very cold period is expected or if the temperature is falling rapidly, the fires should be lighted when the temperature is several degrees above the danger point, probably 33 degrees. If but little frost is expected or if the temperatures are falling slowly, the heaters need not be lighted until the temperature very nearly reaches the danger point, 29 or 30 degrees.

Predicting the temperature. The orchardist should provide himself with such information and equipment as will enable him to know when to expect frost and freezing temperatures. The United States Weather Bureau sends out daily forecasts for the succeeding twenty-four hours. The orchardist should supplement the forecasts sent out by the Weather Bureau by his own observations. Local conditions influence the temperature and humidity

to a large extent. The sling psychrometer is used for measuring the dew point, or the temperature at which dew will form. There is a close relationship between the dew point and the minimum temperature of the

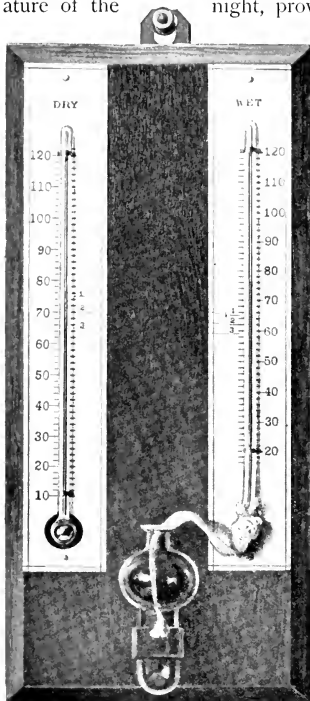


FIG. 10. A psychrometer

An instrument that has proved of much value in predicting frosts. (After Iowa State College)

or more if necessary, until at least two successive readings of the wet bulb are found to agree very closely, thereby showing that it has reached its lowest temperature. A minute or more is generally required to secure the correct temperature. These readings are then

late in the evening and the sky remains clear, with but little wind.

The sling psychrometer.

This instrument consists of a pair of thermometers provided with a handle which permits the thermometers to be whirled rapidly, the bulbs being thereby strongly affected by the temperature and the moisture in the air. The bulb of the lower of the two thermometers is covered with thin muslin, which is wet at the time an observation is made.

How to make an observation. The so-called wet bulb is thoroughly saturated with water by dipping it into a small cup or wide-mouthed bottle. The thermometers are then whirled rapidly for fifteen or twenty seconds, stopped, and quickly read, the wet bulb first. This reading is kept in mind, the psychrometer immediately whirled again and a second reading taken. This is repeated three or four times,

PSYCHROMETRIC TABLE, AIR PRESSURE 29 INCHES

TABLE FOR DETERMINING THE TEMPERATURE OF DEW POINT
IN DEGREES FAHRENHEIT

Air tempera- ture indegrees Fahrenheit	Dew point when the difference between the wet-bulb and dry-bulb temperature is														
	1° F.	2° F.	3° F.	4° F.	5° F.	6° F.	7° F.	8° F.	9° F.	10° F.	11° F.	12° F.	13° F.	14° F.	15° F.
35	33	30	28	25	22	18	14	8	1	-8	-28				
36	34	31	29	26	23	20	15	11	4	-4	-19				
37	35	32	30	27	24	21	17	13	7	-1	-12	-44			
38	36	33	31	28	26	23	19	14	9	3	-7	-25			
39	37	34	32	29	27	24	21	16	12	6	-3	-16			
40	38	35	33	31	28	25	22	18	14	8	1	-10	-35		
41	39	37	34	32	29	26	23	20	16	11	4	-5	-21		
42	40	38	35	33	30	28	25	21	17	13	7	-1	-13	-59	
43	41	39	36	34	31	29	26	23	19	15	10	3	-7	-28	
44	42	40	38	35	32	30	27	24	21	17	12	6	2	-17	
45	43	41	39	36	34	31	29	26	22	19	14	8	-2	-9	-37
46	44	42	40	37	35	32	30	27	24	20	16	11	5	-4	-20
47	45	43	41	39	36	34	31	28	25	22	18	13	8	0	-12
48	46	44	42	40	37	35	32	30	27	23	20	15	10	4	-6
49	47	45	43	41	39	36	34	31	28	25	21	17	13	7	-2
50	48	46	44	42	40	37	35	32	29	27	23	19	15	9	2
51	49	47	45	43	41	39	36	34	31	28	25	21	17	12	6
52	50	48	46	44	42	40	37	35	32	29	26	23	19	14	9
53	51	49	47	45	43	41	39	36	34	31	28	24	21	16	11
54	52	50	49	47	44	42	40	38	35	32	29	26	23	19	14
55	53	52	50	48	46	43	41	39	36	34	31	28	24	21	16
56	54	53	51	49	47	45	43	40	38	35	32	29	26	23	19
57	55	54	52	50	48	46	44	42	39	36	34	31	28	24	21
58	56	55	53	51	49	47	45	43	40	38	35	32	29	26	22
59	57	56	54	52	50	48	46	44	42	39	37	34	31	28	24
60	58	57	55	53	51	49	47	45	43	41	38	35	32	29	26
61	59	58	56	54	52	51	49	46	44	42	39	37	34	31	28
62	60	59	57	55	54	52	50	48	46	43	41	38	35	32	30
63	61	60	58	56	55	53	51	49	47	45	42	40	37	34	31
64	62	61	59	58	56	54	52	50	48	46	44	41	38	36	33
65	63	62	60	59	57	55	53	51	49	47	45	43	40	37	34
66	64	63	61	60	58	56	54	53	51	48	46	44	42	39	36
67	65	64	62	61	59	57	56	54	52	50	48	45	43	40	38
68	67	65	63	62	60	58	57	55	53	51	49	47	44	42	39
69	68	66	64	63	61	60	58	56	54	52	50	48	46	43	41
70	69	67	66	64	62	61	59	57	55	53	51	49	47	45	42

referred to what are known as psychrometric tables, from which the temperature at which dew or frost will form may be found.

Psychrometric readings should be made late in the evening, and the dew point will be approximately the lowest temperature of the following night. Practice in making these readings and records of the predicted dew point and lowest temperatures occurring for several nights previous to the frosty time will familiarize the observer with the use of the instrument.

Heating the small home orchard. The practicability of heating small orchards is often questioned. It is comparatively much easier to heat a large area than a small one. But there are many home orchards, both on farms and on city lots, where oftentimes the fruit is more highly prized than it would be in a commercial orchard.

After the first year's cost of installation, the cost of protecting the home orchard will amount to between one and two dollars per acre per hour. No estimate of the cost of labor or of oil storage is given, as the owners of small tracts can easily handle the equipment without extra labor. The oil will come in barrels and can be distributed from these, so that no storage is necessary.

Where the fruit is highly prized, this expense will not be prohibitive, and under ordinary conditions the fruit can be saved on small areas. Windbreaks will be found especially valuable in protecting small areas during high winds.

The need of thermometers. Accurate thermometers should be provided. At least one high-grade tested thermometer should be available in order to test less expensive ones. Faulty instruments are sure to cause loss, as firing may be begun too late and injury to buds result, or if the heaters are lighted before the danger point is reached, fuel is lost which may be needed at a critical time before sunrise.

An electric-alarm thermometer can be secured for about twenty dollars which will ring an alarm when the danger point at which it is set is reached. This will save considerable loss of sleep, which is valuable if several frosty nights are experienced and when the spraying season demands attention.

It will be well to place the thermometer by which the fires are to be lighted in the lowest part of the orchard. Cool air settles in low places, and these are often much cooler than the higher points.

The probable cost for a ten-acre orchard. Any estimate on the cost of heating an orchard must be approximate, because of the variable factors which enter. Equipment, cost of fuel, distance from railroad siding, and length of firing period vary in different localities and seasons. The following estimate for a ten-acre orchard is submitted as a guide only.

650 heaters at 30 cents to 50 cents each . . .	\$195.00 to \$325.00
3000 to 6000 gallons of oil at 3 cents . . .	90.00 to 180.00
One steel wagon tank	15.00 to 25.00
Lighters, torches, etc.	6.00 to 10.00
Thermometers	6.00 to 8.00
Storage for oil at 75 cents per barrel . . .	63.30 to 126.00
Total	\$375.30 to \$674.60

If smaller heaters are used, more will be required and thus the cost will vary but little. Labor items are omitted. At firing time two men ought to handle the ten acres at a cost of \$5.00 to \$6.00. This equipment will last for several years, and after the first year, labor and fuel will be the only expense and should not exceed \$10.00 to \$20.00 per acre annually. If the crop is well cared for, it is worth from \$100.00 to \$400.00 per acre, and insurance at so small a cost is good investment. Such insurance is not recommended for the man who does not make his orchard produce maximum crops.

CHAPTER IV

SELECTION OF THE TREES

The question of just what is best for the grower as regards trees is always very perplexing. One man will argue that the best trees are those which are home-raised and home-grafted. Another will combat this statement with equal force, saying that the nursery trees are by far the best, as they are the product of skilled men. However, it is not so important who grows the trees as whether the trees are first-class stock?

First-class stock. Now, just what is meant by first-class stock? The general conception of a first-class tree is one that has been well grown, generally being large for its age, with smooth bark, straight trunk, and with a well-formed, thrifty, stocky head. To this should be added that the tree should be insect and disease free and have the characteristic of the particular variety.

Taking up each of these essential factors in the order given, it is possible to obtain a better understanding of the requirements of a tree as regards its classification as first-class or not.

A well-grown tree is one that has had a normal amount of room, or lack of too close competition with its neighbor, so that its development aboveground has not been stunted by lack of sunlight. Below ground there has been enough space in the thoroughly prepared soil, and enough food contained in the soil, so that a thrifty, vigorous collection of roots has been developed.

Oftentimes in the hands of nurserymen, where nursery stock follows nursery stock, the soil runs out so quickly that it is not possible to grow first-class stock after a few years owing to the poor physical condition of the soil and the lack of proper food in it. Again, some nurserymen have a tendency to plant the stock too closely, and the competition between individual plants is so great that the stock develops into a very tall, spindly tree, which, as a rule, is not the kind that should be considered as included under the heading "first-class stock."

It is not always possible for an amateur to detect whether or not a tree is large for its age, owing to his lack of practical experience. However, experienced men can almost always detect the fact that a tree is above the average as regards its size for its age.

No hard and fast rules can be laid down for a tree one year from bud or two years from root graft, or some other age. The following may serve as a guide.

A tree one year from bud should be 3 feet to 3 feet 6 inches tall if well grown.

A tree two years from bud should be 3 feet 6 inches to 4 feet 6 inches tall if well grown.

A tree three years from bud should be 4 feet to 6 feet tall if well grown.

A tree one year from root graft should be 3 feet to 4 feet tall if well grown.

A tree two years from root graft should be 3 feet 6 inches to 5 feet tall if well grown.

A tree three years from root graft should be 4 feet to 6 feet tall if well grown.

Not only should the height of trees be noticed but the diameter of the trunks as well. This diameter of the trunk should be taken six inches above the graft union.

The following figures for a well-grown, first-class tree will serve as a guide for the inexperienced.

	DIAMETER
Tree one year from bud	$\frac{3}{8}$ to $\frac{1}{2}$ of an inch
Tree two years from bud	$\frac{1}{2}$ to $\frac{5}{8}$ of an inch
Tree three years from bud	$\frac{5}{8}$ to $\frac{3}{4}$ of an inch
Tree one year from root graft	$\frac{3}{8}$ to $\frac{1}{2}$ of an inch
Tree two years from root graft	$\frac{1}{2}$ to $\frac{5}{8}$ of an inch
Tree three years from root graft	$\frac{5}{8}$ to $\frac{3}{4}$ of an inch

Have you ever noticed the bark of trees—how some trees have bark that appears dark, dry, and dead, generally rough and unthrifty looking, while other trees have smooth, bright bark that almost spells live, healthy, vigorous growth?

Many times in grafting, especially budding, careful attention as to the time to cut the stock above the bud is not systematically given, and it is found that the budded growth is forced to grow out quite crooked. Other times mechanical injury, lack of proper sunlight, or some other cause will force the tree to have a very crooked growth of stem and sometimes a crooked top as well. This crookedness disqualifies the tree as a first-class stock.

A well-formed, thrifty, stocky head is only obtained where there is a balance in the development of the top. This balance is secured by placing each tree so that it has equal advantages for sunlight on every side, also by giving it proper pruning, in order that this balance may be maintained, and lastly lack of mechanical or other injury.

A tree may be insect and disease free, providing proper attention be given to spraying while the tree is growing and proper fumigation just previous to the time the tree is sold or purchased. Other factors enter into this disease-and-insect question, such as prevention of contamination by improved sanitary conditions and lack of troubles of a like nature on older trees near by, etc.

Trees that are purchased from nursery firms are generally dug in the fall and sold during the spring. It is very important, therefore, that these trees should have correct conditions in the storage houses, so that they are well preserved and do not lose any part of their vitality. If the tree looks black, with the bark more or less shriveled, probably old looking, or if the bark seems loose and not thrifty looking, then the tree has suffered mismanagement while in storage and is not in the best condition for satisfactory growth. It would be much better to discard such trees or send them back. Anyway, do not plant them.

Enough has been given concerning the qualifications of stock in order to include it under the title "first-class stock." However, the question of the age of the trees recommended to plant has not been discussed. What shall I plant, one-year-old trees or two-year old? This is one of the most disputed of all apple-tree questions. A very successful grower in Oregon claims that little or no difference has been marked between one-year-old and two-year-old trees.

It seems to be the general opinion that trees grown in the Northern states are preferable to those grown in the Southern states. This statement is disputed quite emphatically by some practical growers and by some experimenters, their claim being that it makes little or no difference where the stock is grown providing the trees are in every way first-class. There is considerable truth in this idea. Still, it is a well-known fact that plants have a tendency to modify or change their natural habit of growth under changed conditions. Also, men in different localities have varied opinions upon tree

production in the nurseries. From what little we know at present upon this question, it would seem advisable to stick to the older, more general idea that trees developed in nurseries near one's farm are more highly recommended for planting, provided they are first-class stock.

Standards versus dwarfs. As a rule the average commercial grower in America bothers but little with the dwarf apple trees. However, in the older countries across the ocean, there are many instances of success in the cultivation of these dwarf apples.



FIG. 11. Where the young trees are started
A portion of a nursery at Dansville, New York

One not familiar with the term "dwarf" might ask, What is a dwarf? A dwarf is a certain variety of fruit, in this case an apple, which is grown upon a slower-growing stock so that the limbs or top of the tree may never attain normal size. Examples of this would be the top or limbs of the Red Astrachan, Alexander, Dutchess, Northern Spy, King, Jonathan, etc. grafted upon the so-called Paradise or Doucin or some other very small-growing apple plant.

A well-grown, carefully attended dwarf apple will attain the height of from 5 to 8 feet in twenty-five to thirty years. Undoubtedly, a tree of this size offers many advantages over a larger-growing tree in the ease of spraying, pruning, picking, etc.

The average orchard in America, nevertheless, is of the standard type. A standard apple has been grafted upon a free-growing or ordinary seedling tree, the grafted variety through this union being able in general to grow to large size.

In the standard trees the trunk is left bare of limbs from the height of 18 inches to 8 feet. The general tendency to-day is for a lower-branching tree, and the older standard of 5 to 8 feet tree trunk is fast giving way to trunks only 12, 18, and 24 inches in length.

Recommendations for the average orchardist are to grow the low standards. The specialist, however, may be able, under certain conditions, to cultivate with great profit the more intensive dwarf apples. Dwarfs are also deserving of a place in the home garden, where special care and attention will be given.

Pedigree trees. The now generally accepted term "pedigree tree" is described as a fruit tree — in the present case an apple tree — of proved strain; that is, a tree which produces fruit of high quality, color, and characteristic markings of the variety, provided the tree is healthy and free from disease at the time the buds, or scions, are taken.

These trees, therefore, would be the results of selecting scions from trees that bear fruit which is able to win prizes at the horticultural-society exhibitions, following this selection by still later choice from the grafted offspring of the parent, and so on year after year.

This is quite different from the usual cutting of scions by nurserymen. Many of these men obtain their scions from the blocks of nursery stock previously propagated and not from bearing trees. This common practice is not a desirable method, as the tendency would be to produce trees away from the idea of fruiting. However, there are nurserymen and orchardists that do practice a selection or pedigree system of producing nursery stock. These men have noted the peculiarities of individual-bearing trees, and when one tree of this variety excels, or one tree of another variety excels after several years of bearing, scions are cut from these choice trees and used for reproduction (grafting). The progeny is, as well, closely watched and careful notes taken, and soon trees are sold which have known parentage just as much as some of our registered horses or cows.

From the above facts it is easily recognized that pedigree trees should be more highly recommended for planting than any other trees. This is especially so if the great law "Like begets like" is as constant as it has appeared to be in this same systematic work among animals.

When to order. Owing to the fact that the average nurseryman digs his trees in the fall and seils them through the winter and spring, it is undoubtedly best to have one's orders in the hands of the nurseryman very early, either in the late summer or early fall. By so doing, it is possible to obtain some of the choicest stock, and this practically insures the grower in obtaining trees for future planting.

Where the order is placed later it is often found that certain varieties are all sold out, and of course these are always the varieties most wanted.

This early ordering helps the nurseryman greatly, as it informs him fully just how many of each variety should be dug. It also places him in a position to give an order the very best attention, as he will generally have more time during the winter to work up these orders, subsequently packing and shipping them in the very best manner, as well as just when one may wish to have them.

To sum up, make out your list and order early.

From whom to order. The transient tree agent has helped in various ways to bring about a better understanding of fruit trees and business. Go through any section of the country and one will see the results of traveling tree agents. In a certain section of Vermont, for example, trees of varying ages were studied as to variety, with the result that different tree agents' influence was shown. One year it was Montreal Peach apple planted throughout that section, a few years later the Ben Davis, at another time the Fameuse, again the Alexander, later the Dutchess and Yellow Transparent, each variety representing the work of some tree agent for one year.

Oftentimes, though, the unscrupulous agent has worked more injury than good. Generally, none of these agents represents a truly reliable nursery, and unless the nursery is reliable, who cares to buy trees of unknown value? Therefore, the best persons

from whom to order apple trees are near-by, trustworthy men who can back up their statements with the goods. Next to these would be placed the reliable firms in various sections of the United States who do not overstate their products and who have some rating in the business world. Practically all others are frauds, and the trees will be of questionable value.

What to do with the trees when received. When received from the nurseryman the bundle of trees should be immediately removed from the box or taken out of the burlap bagging and the binding twine severed. Following this, they should be planted as quickly as possible. However, if this planting is not convenient, the trees may be "heeled in."

The process of heeling in is very simple, consisting of digging a hole in the ground about 18 inches deep and placing the roots of the trees in the bottom of this excavation, having the trunk of the tree make an angle with the surface of the ground of about 45 degrees. Pack the moist soil tightly about the roots, covering them about 4 to 6 inches deep, then place another layer of loose trees against this dirt and at the same angle as the first layer. Place the dirt on as before, then another layer of trees, and so on until all the trees are heeled in. If the soil is inclined to be dry, or if the work is hurried, it would be well to pour several pails of water onto this soil after the trees are all heeled in. This water will pack the earth tightly about the roots, preventing drying out.

The trees may be taken out from this heeled-in position as wanted for planting.

Trees received in the fall may be kept quite satisfactorily over winter, in some sections, by this heeled-in method.

CHAPTER V

WINDBREAKS

The popular mind is much confused over the question of windbreaks. This is not to be wondered at, because even growers have not clear, definite ideas on this much-criticized subject. It is undoubtedly true, if actual benefit could be seen in all cases from planting windbreaks, that more general planting of trees for the purpose of checking severe winds would be common.

Object of windbreaks. The primary object in the planting of a windbreak is to protect the trees from injury from the unobstructed winds, especially the prevailing winds which are so common in about every locality.

Besides this, there are other benefits that are a direct outcome of this protection. Sometimes strong winds are able to remove some of the light topsoil if not checked by tree growth. Not only may some of the soil be removed but large amounts of moisture may be evaporated from the soil by the passing of this high wind over the surface. This loss of moisture may be a great detriment to the future development of the apple trees, as it may so deplete the supply of moisture in the soil that growth may be hindered to a considerable extent.

There are many other benefits that may be cited as a result of windbreaks planted near an apple orchard. These, however, will be brought out more fully under the advantages of windbreaks.

Advantages and disadvantages of windbreaks. *Advantages.* According to the best information on the subject of windbreaks, the following advantages are cited:

1. Winds partake of the temperature of bodies over which they pass; therefore, a wind passing over a cold body of water or snow would have about the same temperature as this matter. If this wind were unchecked, it might cause great injury in an apple orchard through which it passed. The first advantage, then, is protection from cold.

2. Not only does wind take up lower temperatures from matter it passes over, but it is subject to rise in temperature, as well. Wind passing over very dry, hot land would partake somewhat of the same temperature. Then if this wind should pass through an unprotected orchard, a large amount of moisture would be taken from the soil, thereby tending to increase the injury from drought.

3. Unprotected sections of land are often subjected to loss of snow in winter by the blowing away of the snow. Leaves and other protecting matter may also be blown away by a free, sweeping wind. This removal of the protective bodies, such as snow, leaves, and so forth, from the soil would result in deep freezing of the soil in winter and loss of moisture by evaporation in summer. With the installation of a properly constructed windbreak, both of these injuries would be averted.

4. During the winter there are frequent heavy snowstorms or storms where ice is formed upon the trees. If to this load of ice is added the high winds, great danger is wrought by the breaking of the limbs of the apple trees. Windbreaks would serve as a preventive in cases of a like nature.

5. Many times in the fall the estimate of the apple crop in a certain locality is placed very high, owing to the loaded condition of the trees. Later there occurs one of those sweeping, destructive windstorms, and the unprotected trees lose, to a large extent, their bumper crop. Windbreaks properly placed and made up of the necessary varieties of trees would have a great influence upon lessening the number of windfall during the time just previous to harvesting.

6. As one passes through the country and notices the apple trees, a particular fact is in evidence. Orchards on exposed places have a tendency to "cant" the trees in one direction or another. In one section the trees may lean toward the northeast, denoting that the prevailing wind is from the southwest; in another section the trees may bend toward the southeast or some other direction. In each case the trees show that the strong prevailing winds from the opposite direction have caused them to bend their trunks and heads. The result of this bending is crooked trees. In a great many instances, apple trees in these orchards would have grown straight if the proper windbreak had been planted at the time of "setting" the orchard.

7. During the blossoming period unobstructed high winds often do considerable damage to the proper pollination of the blossom, first, by blowing away a large amount of the pollen, and, second, by bringing about a condition which is not favorable for insect work. Without proper pollination, there is lack of fruit setting. A good windbreak would check the high wind enough so that insect life would be very active in helping to carry pollen. At the same time, there might be just enough wind allowed to pass through the windbreak to aid greatly in the spread of this



FIG. 12. Effects of wind on old trees

Windbreaks properly placed would have prevented this. (Courtesy of M. C. Burritt)

pollen from blossom to blossom. The result would be that with this improved condition there might be more certainty of a full setting of fruit upon the trees.

8. The pruning of apple trees in the late winter or early spring, especially if performed on windy days and in exposed places, is often dangerous for the pruner and harmful to the trees. Frequently the high winds make it impossible to work among the trees during these periods.

Harvesting is also made very difficult in its season if the trees are exposed to the full sweep of the wind. Few pickers can work advantageously on a swaying ladder or among branches that are

constantly moving. Spraying, too, is almost impossible on windy days, and it is a question whether at such times in some unprotected orchards this kind of work is not effort and money wasted.

Still other operations in the orchard are greatly hampered by free, unobstructed winds, but many of the difficulties may be overcome if some attention is given to the establishment of windbreaks.

9. Since few, if any, birds like to build their homes in windy, unprotected places, it has been found that the planting of windbreaks near orchards increases the number of birds inhabiting the trees. With the increase in birds a decrease in insect injury to the trees is generally apparent.

10. It is not necessary to make the windbreak an unsightly, disreputable affair. Common sense in the selection of trees for planting and a careful arrangement of them will result in making the windbreak an addition to the farm and home that will increase their attractiveness and desirability.

Disadvantages. Most of the disadvantages of windbreaks result either from a lack of attention to details or from a limited knowledge of the subject. It may be possible in the future to bring about a more general knowledge of windbreaks by the spread of literature and by object lessons in many orchards throughout the country. The following points need special mention :

1. Trees which act as a wind stop instead of as a windbreak often prove injurious by preventing the free circulation of air, thus rendering the orchard colder. Sometimes the density of a windbreak will cause the same trouble, but this can easily be prevented by planting fewer trees and these of a more open character, and can be remedied by chopping down some of the trees already planted.

2. If the windbreak has been planted directly across a slope, it may check the drainage of cold air, which is naturally downhill, and thus cause some injury to the trees through frosts. Harm from frosts is particularly liable to occur during the fall or the early spring period. Generally, such injury is local and is confined to the area nearest the windbreak, where the cold air collects and reduces the temperature.

This question of proper location of windbreaks or proper outlets for cold air is one whose remedy is at once apparent.

3. Since the trees in a windbreak require sunlight, water, food, etc. to maintain life, it is evident that these substances must be found in the neighborhood of the windbreak. Therefore, if apple trees are planted too close to the windbreak, they must compete with the latter for the essential life elements. All observations and records have shown that apple trees planted close to a windbreak are not so thrifty as those planted at some distance. These less thrifty trees produce apples which are smaller and lacking in color, and therefore less desirable as to quality.

4. Under Advantages, birds were said to increase when more sheltered conditions obtained. It is found that insects and diseases also increase under the calmer orchard conditions. Many of the insects are beneficial, but the ravages of the destructive insects and diseases are sufficiently great to prove a menace. The injury done by insects and diseases is more marked near the windbreak. Modern methods of spraying, however, tend to control these pests, and where the orchard is carried on as a business proposition, very little if any inconvenience from them need be experienced.

Where to plant the windbreak. The best position for the windbreak in relation to an apple orchard is on the side toward the prevailing winds. It is the west and the north winds that are the most injurious, especially in sections near the ocean or large lakes and on the prairies.

When planning the windbreak some attention should be given to air drainage. Cold air flowing downhill must not be obstructed, and where two lines of windbreak trees meet, care should be taken to prevent the formation of pockets in which cold air may settle. If attention to air drainage is not given, injuries from frost may result. Where the orchard is very large it may be advisable to plant several lines of windbreak trees at the distance apart that will give the best protection. As already pointed out, it is generally conceded best not to plant the windbreak too close to the orchard, because of the danger of injuring the nearest trees. About 300 feet from the first row of apple trees seems to be the proper distance.

The trees—how to plant. In California and other extreme Western states it has been found that species of the following trees are the ones to be especially recommended for windbreak purposes :

Eucalyptus	Monterey pine
Schinus	Locust
Monterey cypress	Maple

In some sections of these states the larger-growing deciduous fruit trees, such as the following, have been used with good results :

Fig	Chestnut
Apricot (seedling)	Walnut
Almond (seedling)	

In the prairie, or plain, region other trees seem to be more desirable than those used farther west. The cottonwood, the Norway poplar, and the Carolina poplar are often used where quick growth is required. However, these trees, because of their open growth, are short-lived when planted thickly, and of but little value if planted otherwise. Certain strains of the balm of Gilead are more satisfactory, as they are not only quick growers but more dense as to limbs and foliage.

The box elder is very hardy and makes a dense, heavy growth. It is a rapid-growing tree while young, but is short-lived and therefore generally used with the elm or the ash.

The silver, or soft, maple makes a rapid, heavy growth, and its lower branches keep vigorous and healthy. With a favorable environment and a reasonable amount of soil moisture, it attains good size and long life.

The oleaster, or, as it is more commonly known, the Russian wild olive, is particularly valuable on poor, dry soils or on alkaline soil. It is, however, comparatively short-lived, especially the top, and never grows to very large size. Its value lies in its adaptability to difficult locations and in its thorny character, which makes it a good stock fence or hedge.

The green ash has a dense, heavy top, attains fair size, and is somewhat cosmopolitan as to soils, thus making it desirable for combination with other trees.

The American, or white, elm will give permanence, height, stability, and beauty to any windbreak. It is therefore a very valuable tree for this purpose.

The best single deciduous tree for a shelter belt, according to the general opinion, is the common gray or white willow. In twenty years it will attain a very dense growth and a height of from 40 to 50 feet. It is easily and cheaply started from cuttings, and will do well on all soils except the very dry or alkaline.

Of the evergreens, Norway spruce, which is hardy and needs protection only when young, is decidedly the best, although not yet very generally planted in the plain region. Box elders may be set out among the spruces to protect the young plants from the sun. Being more effective in a single row than three or more rows of deciduous trees, the Norway spruce has become the most popular windbreak tree wherever it has been tried.

The Western yellow, or bull, pine, which makes a dense, heavy growth, is becoming recognized as a valuable shelter tree. It grows readily under adverse conditions, such as very dry soil and extreme temperature changes.

The jack pine, a native of the plain region, is a rapid-growing tree when young, quite cosmopolitan as to soil, but especially valuable on sandy soil, and perfectly hardy.

For certain purposes the windbreak may take the form of a high or a low hedge. One of the best hedge plants is the buckthorn, another is the oleaster. Either of these will make a desirable low windbreak or stock fence.

In starting a hedge, the land must be carefully prepared the season before by breaking up a strip about 8 feet wide. In the spring plants from 12 to 18 inches high should be set a foot apart in the middle of the cultivated strip. The land should be cultivated or mulched for two years, at the end of which time the plants may be cut back to between 2 and 6 inches of the ground. They will then form a dense, bushy hedge that can be readily trimmed into any shape. The hedge may be kept always fresh and vigorous by the removal of the older canes. It will thrive better if not allowed to grow too wide at the top.

It is often stated that "a single tree or row of trees planted on the open prairie cannot succeed so well as a mass of trees." This

is true of all trees suited to grove or windbreak purposes. Trees growing in a mass protect each other and furnish the shade that keeps the soil mellow and moist, at the same time preventing the growth of grass and weeds. The broader the belt of trees the better are the results. On the other hand, if the shelter belt is made more than about 2 rods wide, it will be necessary to plant a single row of willows 4 or 5 rods to the north to prevent the snow from piling in and breaking down the trees that are a part of the windbreak.

In certain sections of the South it is a common practice to leave some of the original forest to serve as a windbreak. Where the belt is from 2 to 4 rods wide and thick from the ground up, this protection is satisfactory.

In the North and East where windbreaks have been planted, it has been found that the Norway spruce is the most satisfactory tree. Sometimes a mixed shelter belt of maples and Norway spruce is used. This mixing is advantageous, since trees like the spruce may become ragged if exposed to the full force of the wind, and the maples serve as an effective break.

Other trees which may be recommended for the northeastern sections are the Austrian, Scotch, and white pines, the Lombardy poplar, and native deciduous trees.

In summarizing the suggestions for selecting trees for windbreaks we need only say: (1) use the trees that are most common in your particular locality, especially if these trees are healthy and thrifty; (2) take care that the trees selected are not preyed upon by insects and diseases common to the apple tree; (3) plant the windbreak in belts, with the trees in single rows or mixed, according to the density desired and the amount of protection necessary to break the force of the winds prevailing in your locality.

When to use windbreaks. No hard and fast rules can be laid down as to when to use shelter belts. All exposed orchards would be benefited by a properly built windbreak. Each orchardist must decide whether his location requires such a protection. In general, it is safe to say that a site having a western, southern, or northern exposure would be helped by a natural forest or an artificial shelter belt on the side toward the prevailing cold winds.

CHAPTER VI

THE USE OF STABLE MANURE IN THE ORCHARD

Before planting the orchard. After the location of the orchard has been selected and before the trees have been set out, it is advisable to treat the land for a few years by a systematic cropping and manuring plan. The advantages of such a plan will be apparent in the improved physical condition of the soil, which in turn will have a marked influence for good on the growth of the orchard during its early life.

If manure is available, it would be well to apply to the soil from 10 to 40 tons per acre each year for two years or more previous to the planting of the trees. If the land selected is in sod, the manure may be spread broadcast upon this growth either during the winter or early in the spring, whichever time is more convenient. Plowing and fitting are then in order as soon as practicable in the spring. Some hoed crop, such as corn or potatoes, should be used the first year, and the second year a different crop, such as squash, beans, etc., can be substituted.

In the spring of the third year, after a heavy application of manure has been spread broadcast, the trees may be set. There is no good reason why some other crop or one of those already mentioned should not be planted at the same time.

Use of manure after the trees have been planted. Generally speaking, after the trees have been planted it is not advisable to use manure each year, especially during the early development of the trees. It has been found that when heavy applications of manure are made yearly for the first ten or twelve years, there is an overstimulation of wood growth throughout the growing season and continuing into the fall. This is very injurious to the trees, for the young wood is in too immature, tender a condition to withstand severe cold, and the result is often the winter killing of the tender shoots and sometimes the destruction of the whole tree. If manure

is used not oftener than once in three, four, or five years during the first twelve or fifteen years of the tree's life, better results will, as a rule, be obtained.

After trees have passed twenty years of life in an orchard, there seems to be greater need of the stimulating effects of the nitrogen contained in manure. Very old trees and trees that have been neglected seem to respond quickly to the invigorating effect of plenty of manure plowed under. Many horticulturists therefore strongly recommend that one of the first steps in the renovation of neglected apple trees should be the plowing under of from 10 to 40 tons per acre of stable manure.

CHAPTER VII

PREPARING LAND FOR AN ORCHARD

Plowing. If trees are to be planted in the spring, it may be of some advantage to plow the land in the fall, for the fall-plowed soil dries out more quickly, thereby advancing the season of harrowing, and thus making it possible to commence the spring planting earlier. When it is realized that the growth of the apple tree may begin earlier in the spring than is usually supposed, and that during July the normal season for the maturity of wood begins, it will readily be seen that fall plowing and early fitting of the soil help the trees in their first year of permanency to become more fully developed during their natural season of growth. Spring plowing, on the other hand, offers the great advantage of allowing a cover crop to be grown on the land during the winter, thereby checking the great loss by erosion. This crop is plowed under in the spring, and is beneficial in several ways, especially in improving the physical condition of the soil.

There are many plows offered for sale from which the orchardist may select one or more that will meet the requirements of his particular case. Many men prefer the common landside plow with a long point and rather sharp moldboard. A plow of this type turns the soil in good style, laying each furrow slice upon the edge of the preceding furrow, and has a tendency to break up somewhat the furrow as turned. Some prefer a plow similar to this, but with a shorter point and a less abrupt moldboard.

Where the orchard site is a hillside the plow often selected is the walking hillside, or swivel, plow. This is made with a moldboard and point that can be swung in such a way as to give either a left-hand or a right-hand plow. This permits plowing back and forth across the land, furrow after furrow in order, with all the furrows turned the same way.

The riding reversible sulky plow offers the same advantages as the walking hillside plow, at the same time permitting the operator

to ride. Either plow may be used on level land, but the hillside plow does not do very satisfactory work on the more level stretches.

Both the riding and the walking sulky plows, either single or in gangs, offer advantages for quick, thorough work, and are used by many orchardists who have comparatively level sites.

Another plow, or system of plowing, that is receiving much attention at present is the gang of four, six, or more plows drawn by a tractor. This method is bound to increase in popularity, especially in sections where the plowing is more or less level and



FIG. 13. The modern plowing outfit

Tractor at work preparing land for a young orchard

easy and where large orchards are to be established. The chief advantages of this strictly modern method of plowing seem to be that the work can be completed more quickly, that the cost per acre is less, that the work can be done better because of the uniformity of furrow turning, and that the working day can be longer. The principal disadvantages are that the outfit is expensive, and that it is not always in working order. The first difficulty may be overcome by organization or community buying. The second will be lessened as time passes, by improvements in the machines.

How to plow. With plows such as the landside and the gang, one method of plowing is to proceed around the plot of ground,

turning the furrows out and leaving a dead furrow in the center of the plowed area. Another method, which is employed many times with the larger gang plows like the tractor, is to proceed across the field, turning the furrows to the right, make a long turn at the end of the field without plowing, and then plow back across the field. This will leave several dead furrows, as well as some "backfurrows," which are formed by the furrows plowed against each other.

With the landside plows — either the single or the small gang — the land may be laid off into long strips and backfurfrowing begun at once. The backfurfrowing consists in plowing a furrow across the field, with equal unplowed space from 2 to 4 rods wide on each side. The second furrow is made by plowing back against the first, thereby turning up more or less of a ridge. Another furrow is then made back of the first, followed by one backing up the second, and so on until the strip is plowed.

When all the strips are finished, the headlands, or ends of furrows, should be plowed by beginning at one corner and going across the ends of the former furrows, throwing the furrow slice toward the plowed ground. If desired, this finishing may be done while plowing the backfurrow strips.

With the reversible plows the work is generally commenced on one side and the furrows all turned in the same direction, leaving but one dead furrow at the end. However, these plows may also be used in following the plan just described.

Good plowing consists in making the furrows uniform, whether flat or on edge, and in all cases the efficiency of the work is increased by straight furrows.

Rolling. Before harrowing the land it is sometimes advantageous to roll the furrows, especially when a sod or a cover crop has just been plowed under. Rolling aids in firming the soil, thereby increasing the chance of capillarity; at the same time it has a tendency to fine somewhat the larger lumps of soil and the furrow slices.

After the soil has been plowed, rolled, and harrowed, it is rolled and harrowed again. A finer-prepared field results from this treatment.

A planker is often substituted for the roller, the claim being that the former is more of a grinding tool than the latter and does

practically the same work. Many prefer it because of its low cost as well as its greater grinding qualities. Both are good tools if properly used, the planker being more highly recommended for the average operator, because the injuries to the soil, if not judiciously used, are not so great as in the case of the roller.

Harrowing. After spring plowing is well along or finished, harrowing may begin. If fall plowing has been practiced, harrowing should begin as early in the spring as the condition of the soil will permit. Early harrowing results in earlier conservation of moisture.



FIG. 14. A modern implement

Up-to-date soil-working both before and after the orchard is planted

Where the soil is plowed sod, clayey, lumpy, or hard, the disk harrow will give the greatest satisfaction. On soil which has little or none of these qualities the spring-tooth harrow is recommended. This harrow is particularly valuable on land that is stony, especially when the stones are large. As a still finer working tool the spike-tooth harrow, the old A-harrow, or the old square harrow may be used. In some cases, on soil fairly free from stones, the Acme harrow is useful, particularly when a level, very fine surface is desired. Other tools more common in certain sections of the country may be used with good results.

Use of fining tools. It is generally advisable to use first either the plain or the cutaway disk harrow the way the furrows have been plowed, lapping half the width of the machine on each round. After the field has been harrowed in this manner, it should be cross-harrowed, also lapping half the width of the machine. If the field is not fitted to suit the orchardist, disk harrowing diagonally across the field in one or two directions, lapping half the width of the machine, may be practiced.

Following the disk harrow, the spike-tooth harrow may be used in a like manner until the soil is fitted to suit the individual. If very fine work is essential the Acme harrow may follow the spike-tooth.

As in the case of the plow, each individual should select the harrow best adapted to his location and soil. Good tools, worked properly, give satisfaction.

CHAPTER VIII

LAYING OUT AN ORCHARD

Within the last few years many plans for laying out orchards have been suggested. There are advocates of the "Wellhouse plan," the "Olden plan," the "Parker Earle plan," and the like, each of which offers many advantages for particular locations. The size of the orchard to be laid out and the contour of the land will largely determine the choice of plan.

Large orchards. For the laying out of a large orchard on land that is quite level, some helpful suggestions are to be found in the methods described by Van Deman¹ and Yeomans,² two well-known New York fruit men. A brief summary of these similar methods follows.

A base line is laid out along the side of the field, generally on the straightest side, such as that bounded by a road, a wire fence, a stone wall, or the like. Stakes are set at both extremities of this line, and a perpendicular to it is erected at one end. The erection of this perpendicular may be accomplished by means of a common carpenter's square, sighting along both limbs and having one limb coincide with the base line. A right angle may also be established by the surveyor's method, as follows: Measure 30 feet along the base line and set a stake, *A*; then with a distance of 40 feet on the tape line and *A*, or the extremity of the base line, as a center, mark off a segment of an arc in the direction which the perpendicular will take, as *B*; and with *A* as a pivotal point and a distance of 50 feet on the tape line, mark off another segment of the circle at *B*, cutting the previously made segment. Set a stake at the intersection of the two segments. The perpendicular can be established by sighting over this newly placed stake from the original stake at the end of the base line. Next, measure off on both

¹ H. E. Van Deman, orchardist, Rochester, New York.

² T. G. Yeomans, orchardist, Walworth, New York.

the base line and the perpendicular the distances the first tree is to stand from these two lines, and set stakes. Then measure from these stakes distances equal to the distance which the trees are to stand apart, 25, 30, 40, or 50 feet, whatever the case may require. In a like manner set stakes on the other two sides of the field and in both directions across the field about halfway between the

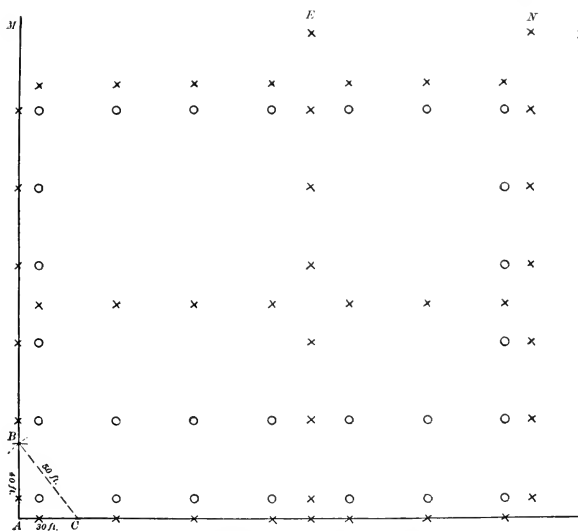


FIG. 15. Method of staking an orchard

In a rectangular field this method is applicable

opposite sides. By this means several series of three stakes will be set in the field, the intersections of the lines of which will mark the position of all the trees in the field. The *Garden Magazine* has published an excellent article¹ by Mr. H. M. Martin, of New York, which would be of equal interest to the large and the small orchardist.

¹ Copyright by Doubleday, Page & Company.

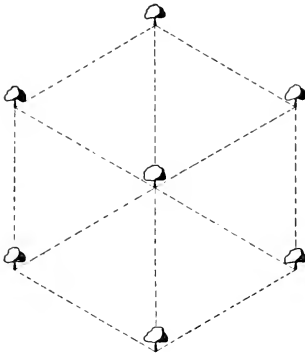


FIG. 16. The hexagonal system

Trees arranged equidistantly in all directions, forming a series of equilateral triangles, or a hexagon, with a tree in the center

and Hubbardston, 45 feet for the Baldwin, Greening, etc., and in many cases 50 feet is not too great. Yet one cannot afford to plant trees so far apart and wait for them to come to full bearing; he must occupy the space between the permanent trees with secondary crops. The best way is to plant shorter-lived fruit trees as fillers, which must be cut out as soon as they begin to crowd the others. It takes courage to cut out thrifty bearing trees, but it must be done.

Before the orchard is set, a planting plan should be carefully made, showing the position of each tree. There are three main systems of planting: the square (or rectangular), the quincunx, and the hexagonal. An orchard laid out according to the square system would consist of a series of squares with a tree at each corner of the

GETTING THE MOST IN AN ORCHARD

NOTE. A majority of orchards are planted on a plan that is most wasteful of space, nearly one fourth of the land being unproductive. The various ways are analyzed on the basis of an acre.

It is manifestly necessary, in order to get the fullest returns from an orchard, to have every inch of available space occupied to the best advantage during the early years of the tree's growth and plenty of room left for the complete development of the mature tree, yet it is a fact that one quarter of the space is actually wasted in the great majority of orchards. Full-grown apple trees should be at least 40 feet apart for such varieties as the McIntosh

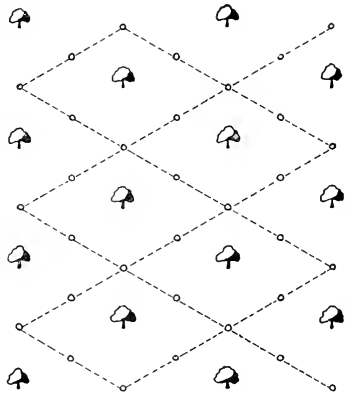


FIG. 17. The hexagonal system

(Orchard thinned by cutting alternate rows diagonally, according to dotted lines)

intersecting squares. This is the most common method, but it is the most wasteful with reference to use of land. A tree, if unhindered in its growth, may be expected to develop equally in all directions and may be represented by a circle. Figure 21 shows how these circles touch each other when the trees are full grown. The shaded space is unoccupied, but amounts to almost 23 per cent of the area.

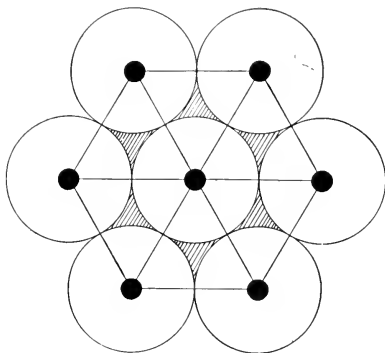


FIG. 18. Area of occupancy, and waste space in the hexagonal system

Trees have an equal exposure to light and air, with only 10 per cent of area unoccupied. Fifteen per cent more trees per acre may be planted than by the square system at the same distance apart

Because of this large amount of waste in the square system of planting, a tree was put in the center of the square, forming the quincunx group. In this way about double the number of trees per acre may be set out. But they cannot all reach their full growth. The continuous circles intersect, showing how the center tree interferes with the growth of the trees at the corners of the squares. It is better to remove the center tree before it reaches this stage of development. The dotted circles show the amount of development each tree reaches before it is interfered with by its neighbors. The orchard may be considered, therefore, as a system of squares running diagonally across

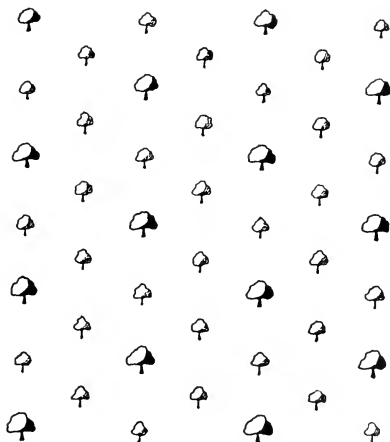


FIG. 19. The hexagonal system
Orchard planted with permanent trees and one set of fillers

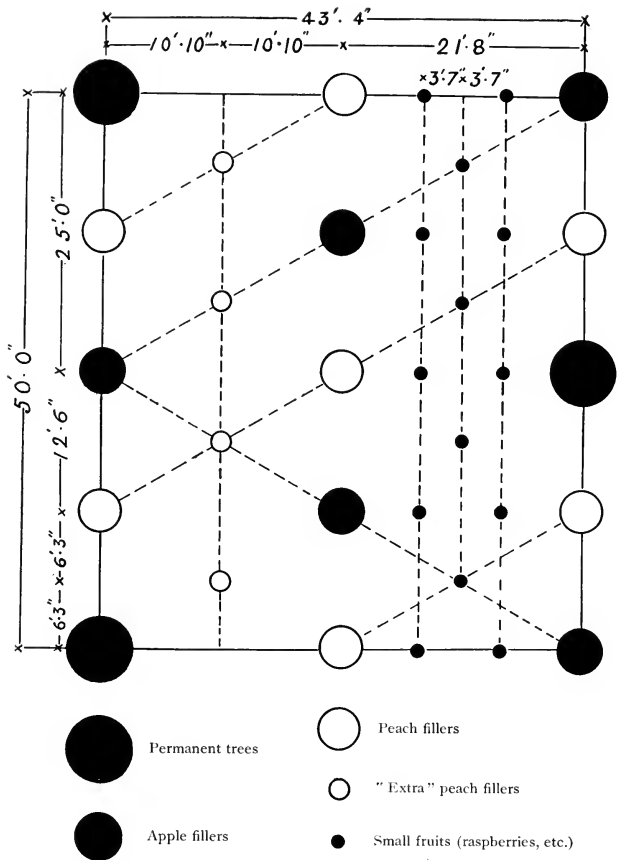


FIG. 20. Hexagonal system

Diagram of intensive use of fillers; 320 trees per acre or 160 trees and 550 bush fruits (berries or grapes)

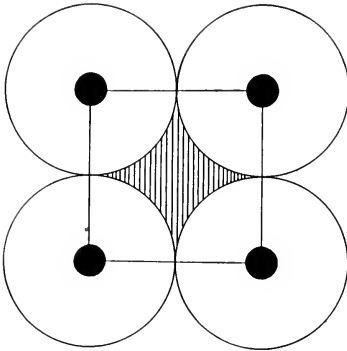


FIG. 21. Diagram of square system

Showing area occupied by trees, and waste space. The large circles show the limit of growth of the trees; the shaded portion is waste area, forming 23 per cent of the total area. This method gives unequal exposure to light and air

the field, and the waste space is still, in reality, 23 per cent.

The least unoccupied area is attained in the hexagonal system. When trees are planted in this way, only 10 per cent of the area is unoccupied, and the trees are distributed evenly over the field. All trees are equidistant, forming a series of equilateral triangles. About 15 per cent more trees per acre can be planted by this method than by the square system, yet with the same distance between trees.

THE USE OF FILLERS

The use of early-bearing and shorter-lived trees as fillers in an apple orchard is

strongly recommended. By such means the orchard should have paid for itself and yielded a good income before the permanent trees come into bearing. Either peaches or early-bearing apples, such as the Wagener or Wealthy, may be used. Some strongly advocate the use of dwarf apples, but others consider that they do not come into bearing much earlier than the standard varieties. Results of experiments at the New York State Experiment Station, Geneva, are unfavorable to the use of dwarf trees from this standpoint.

In setting out an orchard by the square system the permanent trees

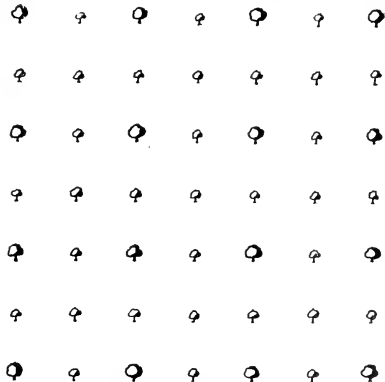
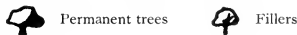


FIG. 22. Square system

Orchard planted with permanent trees and fillers



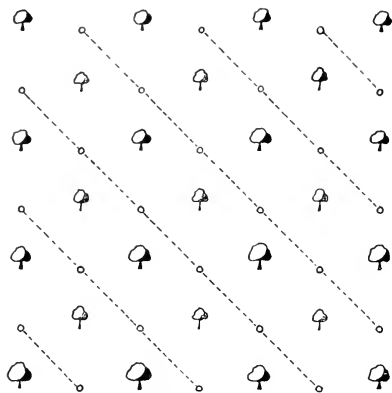


FIG. 23. Square system — first thinning

Cut out alternate rows diagonally as indicated by dotted lines. The trees now form a quincunx system

present condition is really on the quincunx plan. The central tree may be removed by cutting out the alternate rows at right angles to the fence line. By setting the permanent trees 45 feet or more apart, peach fillers could be planted on the corners of squares 11 ft. 3 in. apart, dividing the original squares into sixteen small ones, which could be gradually thinned to the stages already given.

The quincunx system offers a better means of using fillers. Fig. 27 represents the orchard with permanent trees in quincunx groups, and two sets of fillers. Standard apple fillers should be set halfway between the permanent trees, forming the corners of squares running diagonally across the field and of the same size as the diagonal

should be set 40 feet apart for the Hubbardston and McIntosh; for Greening and Baldwin preferably 45 or 50 feet. Standard apples of early-bearing varieties, such as the Wealthy or Wagener, could then be set halfway between the permanent trees, forming squares half the size, in which the larger trees represent the permanent ones, the smaller the fillers. In thinning, the alternate diagonal row should be cut out first. This leaves the tree in the center of the square, which can stand some years longer. But the orchard in its

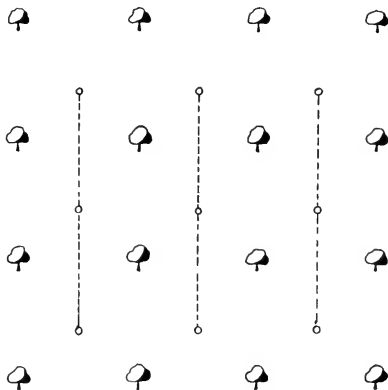


FIG. 24. Square system — second thinning

Remove alternate rows as indicated by dotted lines

squares of the permanent trees. Peaches should be set halfway between the permanent trees on the diagonal rows. These trees would be the first to come out, and should be cut out by removing the alternate perpendicular rows.

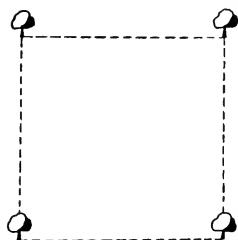


FIG. 25. The square system
A tree at each corner of a square

This leaves the permanent trees and the apple fillers. When the apple fillers begin to crowd, cut them out by removing the alternate rows diagonally.

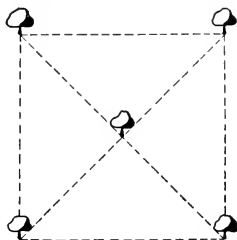


FIG. 26. The quincunx system
A tree at each corner of a square, with a fifth tree in the center of the square, forming the quincunx group

The greatest number of trees per

acre, and the most evenly distributed, occur

by using the hexagonal system. The only difficulty is that, in thinning, the distance between the trees is doubled. Fig. 19 shows the arrangement of permanent trees, and one set of fillers planted according to this system. Fig. 17 shows the method of removing the fillers, by taking out the alternate rows running diagonally across the field in both directions.

Fig. 20 shows a method of planting 320 fruit trees per acre, or 160 fruit trees and 550 bushes of small fruits, by the hexagonal plan. With such an intensive system of planting, the permanent trees should be at least 50 feet apart. The large dots (solid black) represent the permanent apple trees, set 50 feet apart. The smaller dots (solid black) represent standard apple fillers, set halfway between the permanent trees, making the apple trees 25 feet apart. The larger circles (unshaded) are peach trees, set halfway between the apple trees in the perpendicular

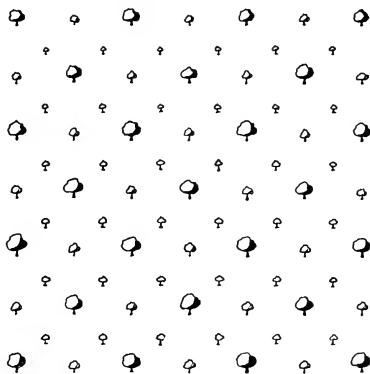





FIG. 27. The quincunx system

Orchard planted with permanent apple trees, standard apple fillers, and peach fillers

-  Permanent trees
-  Standard apple fillers
-  Peach fillers

rows. In this way, there are 20 permanent trees, 60 apple fillers, and 80 peach trees per acre. The smaller circles (unshaded) are extra peach trees put half-way between the trees already set, which would make 320 trees per acre. In this way the orchard would accommodate 240 peach trees per acre. But instead of the extra peaches, small fruits may be planted, as shown by the smallest dots, arranged in three rows between the rows of apple trees. In this way 550 bushes of small fruits per acre may be accommodated, leaving plenty of room for cultivation. They should be removed before they begin to crowd the trees; but, since there is almost 11 feet left between them and the trees, they will have plenty of time to bring in considerable money before they are cut out.

The following table shows the number of permanent trees and permanent trees with one set of fillers, together with the distances apart of permanent trees and fillers, planted according to the three different systems. The figures in parentheses after the quincunx system show the distance of the center tree of the group from the corner trees of the square.

NUMBER OF TREES PER ACRE ACCORDING TO THE DIFFERENT SYSTEMS OF PLANTING

SYSTEM	DISTANCE APART		NUMBER OF TREES PER ACRE	
	<i>Permanent</i>	<i>Fillers</i>	<i>Permanent</i>	<i>Permanent, fillers</i>
Hexagonal	30 ft.	15 ft.	55	220
Square	30 ft.	15 ft.	48	194
Quincunx	30 ft. (21.2)	15 ft.	97	194
Hexagonal	32 ft.	16 ft.	49	196
Square	32 ft.	16 ft.	42	168
Quincunx	32 ft. (22.6)	16 ft.	85	168
Hexagonal	33 ft.	16.5 ft.	46	184
Square	33 ft.	16.5 ft.	40	160
Quincunx	33 ft. (23.3)	16.5 ft.	80	160
Hexagonal	35 ft.	17.5 ft.	41	166
Square	35 ft.	17.5 ft.	35	140
Quincunx	35 ft. (24.7)	17.5 ft.	70	140
Hexagonal	40 ft.	20 ft.	31	124
Square	40 ft.	20 ft.	27	108
Quincunx	40 ft. (28.3)	20 ft.	54	108
Hexagonal	45 ft.	22.5 ft.	25	100
Square	45 ft.	22.5 ft.	22	86
Quincunx	45 ft. (31.8)	22.5 ft.	43	86
Hexagonal	50 ft.	25 ft.	20	80
Square	50 ft.	25 ft.	17	68
Quincunx	50 ft. (35.4)	25 ft.	34	68

The comparative ease with which tillage, spraying, and other operations may be carried on in the orchards planted according to the different systems may be seen by the following table, showing the distances between the rows of permanent trees, with two sets of fillers, running north and south, east and west, and diagonally across the field.

DISTANCES BETWEEN ROWS ACCORDING TO SYSTEM
OF PLANTING

DIS- TANCE OF PER- MANENT TREES	DIRECTION OF ROWS	SQUARE SYSTEM			QUINCUNX SYSTEM			HEXAGONAL SYSTEM		
		Permanent	Fillers		Permanent	Fillers		Permanent	Fillers	
			1	2		1	2		1	2
45 ft.	N. & S.	45	22.5	11.25	22.5	11.25	5.62	39	19.5	9.75
	E. & W.	45	22.5	11.25	22.5	11.25	5.62	22.5	11.25	5.62
	Diagonal	31.8	15.9	7.95	31.8	15.9	7.95	39	19.5	9.75
40 ft.	N. & S.	40	20	10	20	10	5	34.6	17.3	8.6
	E. & W.	40	20	10	20	10	5	20	10	5
	Diagonal	28.3	14.1	7	28.3	14.1	7	34.6	17.3	8.6

The distances between the rows of permanent trees and fillers for trees at 50 ft. hexagonal system are given in Fig. 20.

The greatest distances between the rows east and west are gained in the square system, although the diagonal distance is less in this than in the hexagonal. The quincunx system diminishes by half the distance between the rows of the square system running north and south, but the diagonal distance is the same. The hexagonal system gives considerably more room for orchard operations than the quincunx system, the rows running north and south being the same distance apart, and about seven eighths the distance of the north and south rows of the square system. The rows running east and west in the hexagonal system are at the same distance apart as the similar rows in the quincunx system.

Cultivating an orchard diagonally requires considerably more turning than carrying on operations parallel with the rows. This distance between rows is the greatest in the quincunx and least in the square system (compared with the other directions in the same system). In the hexagonal system the distance north and south and diagonally is the same, with the east-and-west distance the least. Ordinarily, therefore, orchard operations could be most easily carried on north and south in the hexagonal system.

If fillers are used, much more room is obtained between the rows by planting according to the hexagonal system than according to the quincunx, as well as a larger number of trees. If a very intensive system of fillers is used, the permanent trees must be placed far enough apart to permit of cultivation between the fillers. It is for this reason that the trees are placed 50 feet apart in Fig. 20.

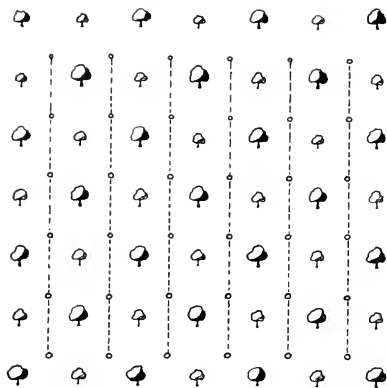


FIG. 28. Quincunx system — first thinning
Remove peach fillers, as shown by dotted lines

later to squares twice the size of those when first planted, thus allowing a gradual transition from close planting to trees far apart. It is perhaps the easiest of all systems to cultivate.

The quincunx group allows about double the number of trees per acre that the square of the same size accommodates; but these figures are misleading, for the real distance of the trees is shown by the figures in parentheses in the table, page 66, which is the size of the squares running diagonally across the field. Comparing the number of trees per acre of the quincunx system with the number of trees according to the hexagonal system, using this latter figure as the correct distance, it is clearly evident

When the small fruits are used the closest rows are 6 ft. 3 in. apart running east and west, 3 ft. 7 in. apart north and south, and 4 ft. 2 in. diagonally.

To facilitate all orchard operations a row should be left out for a street at convenient intervals throughout the orchard.

SUMMARY

The square system of planting an orchard is the most wasteful of space, accommodating the smallest number of trees per acre, but by planting with fillers may be thinned first to a quincunx form, and

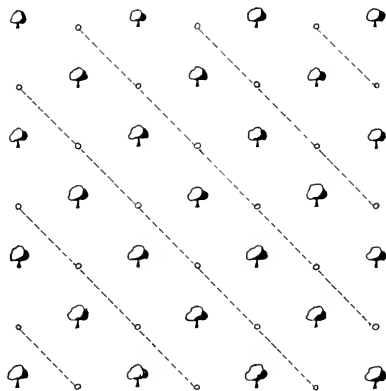


FIG. 29. Quincunx system — second thinning
Remove apple fillers by taking out alternate rows diagonally, as shown by dotted lines

that the hexagonal system stands in the lead. The great advantage in the hexagonal system is that each tree has a chance to develop equally in all directions, and has an equal exposure to light and air. The one disadvantage is that there is no good system of thinning fillers gradually: but the large number of trees which may be used as fillers sufficiently pays for the extra space caused for a few years by doubling the distance between trees in removing fillers. It is an especially good system for intensive methods of culture and can be easily cultivated.

The location and site of the orchard, the available capital and training of the orchardist, as well as economy of space in planting and perfect development of the tree, should be considered in choosing the planting system. In commercial fruit districts where the land is very expensive it will be of advantage to use the hexagonal system, with very intensive culture. On the other hand, the problem of the abandoned farm with poor land on hillsides where cultivation is difficult would be better solved by using the square system.

If the owner of a proposed large orchard does not care to bother with the actual laying out himself, surveyors may be employed. This, in fact, is the most practical method of laying out large orchards, although other methods to suit individual preferences or ideals may prove satisfactory.

Smaller orchards. When an orchard is small it is generally due to lack of space, although financial or other reasons may be the cause. Generally speaking, if the reason is lack of space it is highly important that more attention should be given to getting as many trees as possible in the orchard.

Home orchard. In laying out an orchard for the home, stretch a line, such as a wire, across the piece of ground from the corner

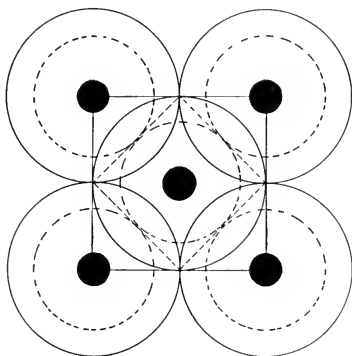


FIG. 30. Area of occupancy in the quincunc system

The central tree crowds the others, as shown by the intersection of the large circles. The dotted circles show the degree to which each may develop symmetrically. This reduces the plan to a square system with waste space of 23 per cent and trees closer together, allowing twice as many per acre

where the first tree will eventually stand to the opposite side of the piece ; measure off on this wire the number of feet intended for the space between trees and solder to the wire at this point a small piece of tin or wire ; measure for the next tree in a like manner, and so on to the end of the line. Digging the holes and planting may be accomplished while the line is in place. Remove the line to where the next row of trees is to be set out, stretch it tight, plant the trees immediately, and so on until the piece is all planted.

If the hexagonal method is followed, a wire may be used with an iron ring in each end or with ends twisted, being from end to end, when stretched tight, the exact length required between trees. Place a stake where the first tree will stand ; then with the wire measure from this stake in the direction of the proposed base line of trees ; place another stake, and from this locate the next, and so on. Sight along the stakes, or stretch a garden line from one end to the other, to make sure that they are in a straight line. Come back with the wire to the first stake and, with the first and second stakes as centers, make intersecting arcs, and place a stake at the point of intersection. From this new stake, measure with the wire in the direction parallel to the base line and make an arc ; then with stake three on the base line as a center, make an intersecting arc and place a stake. Carry on this measuring until the work is finished.

In all cases look over your work and see that each stake lines up with the other stakes in at least three ways. It will then be correct.

CHAPTER IX

PLANTING

Fall versus spring planting. There is much difference of opinion among the authorities on apple growing as to the best season for planting apple trees. The late fall is advocated by some, while others are equally certain that the early spring is better. The chief reasons advanced in favor of late fall planting are that roots of trees set at this season become thoroughly established in the soil, and that the cut surfaces on the roots become calloused during the winter months, with the result that new roots are pushed out very early in the spring. On the other hand, dry falls and dry winters will prove

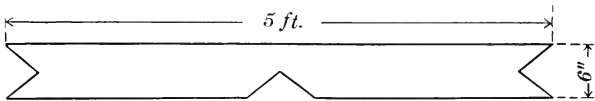


FIG. 31. A planting board

A very useful contrivance in setting an orchard

fatal to many of the fall-set trees, and the stand will therefore be imperfect. In the eastern and northern part of the country, spring planting is usually preferred.

Trees for planting should not be taken from the nursery row till the leaves have fallen, and this is usually so late in the fall that the weather is not suitable for planting. As previously stated, it is advisable to purchase trees in the fall, so as to obtain a better assortment and to have them ready for planting in the spring as soon as the weather permits. Then if soil and weather conditions are favorable in the fall after the stock arrives, the trees may be safely and profitably planted where they are to remain permanently, instead of being heeled in. If left till spring, the planting should be done as soon as the ground can be worked without injury. If the conditions in the fall are not right, spring planting is undoubtedly the safer course.

Planting board. The planting board, a device made to assist in planting apple trees, is not so well known as it should be. Its construction is simple — a board $\frac{3}{4}$ inch thick, 5 or 6 feet long, and 6 inches wide, with a V-shaped notch about 3 inches deep sawed into each end, and the same kind of a notch exactly midway between the end notches. A board of this kind is shown in Fig. 31, and its use illustrated in Fig. 32. In addition to this board, two stakes between 12 and 18 inches long, called guide stakes, will be

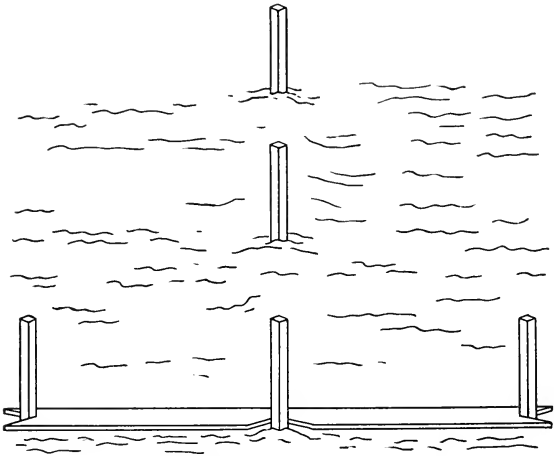


FIG. 32. Method of using the planting board

The tree will be located exactly at the middle stake

necessary. There are many modifications of this type, but the principle is practically the same in all. The purpose of the planting board is to locate the tree after the digging of the hole, which naturally necessitates the removal of the stake. To accomplish this the board is placed on the ground with the central notch adjusted to the stake that indicates the proposed position of a tree. The guide stakes are then driven into the ground at the ends of the board, fitting snugly into the end notches. The board is removed while the hole is being dug, and replaced when the operation has

been completed. The tree is then set in such a position that its stem or trunk passes through the central notch corresponding to the location of the stake.

Another device for locating trees, commonly employed in the West, is a triangle made by nailing firmly together three strips, each $\frac{1}{2}$ inch thick, 2 inches wide, and 6 feet long, allowing a projection of 3 inches at the corners of the triangle thus formed. One projecting corner of the triangle is placed firmly against the stake which marks the position of the tree, and a stake is driven in each of the other two corners. The triangle is removed, the hole dug, and the tree brought into exact position.

The planting boards are serviceable not only in putting the trees in their exact positions but also in giving the planter a good idea as to whether the trees are being set at the right depth. Without their use, trees may be placed in the holes and the earth filled in about them before it is discovered that the holes are too shallow or too deep.

Hand digging and planting. The work of planting by hand may be most expeditiously accomplished with four men, or two men and two smart boys, one operating the planting board, another digging the holes, a third bringing the trees and holding them in position, and the fourth shoveling in the soil. Boys may be used to operate the planting board and to hold the trees. The man or boy who operates the planting board, after adjusting the stakes for the first hole, goes on to the second, adjusts a second pair of guide stakes, returns with the board to the first hole, where the other boy locates the tree; he then pulls up the guide stakes and takes them with the board to the third tree stake. It may sometimes be better to have two similar planting boards available, one for each boy. While the first boy is back at the first tree, the hole is being dug for the second tree, and by the time he sets the guide stakes for the third tree, it will be time to locate the second.

The boy who holds the tree while it is being planted gives it a shake with an up-and-down motion, to scatter the soil among the roots. Often the fingers may be used to help spread the dirt effectively among the finer roots. When half the soil has been shoveled in, the boy firms it with his feet. This first soil placed

around the roots of the tree should be the topsoil, which the digger has placed at one side of the hole, the poor subsoil having been thrown on the other side. The second boy then goes after another tree, leaving the man who does the filling in to give the final treading and to put a loose layer of soil on the surface. The holes are dug just broad enough to accommodate the roots and just deep enough to allow the trees to be planted to the same depth that they stood in the nursery row, or possibly one or two inches deeper.

Where there are few stones and nothing to impede the progress of the workmen, a third boy may be advantageously used to bring the trees, as they are required, or to do some other part of the work. If two or three gangs are working on different rows, one boy may supply trees to both gangs.

In planting, care should be used not to expose the roots to the drying effect of the air. It is an excellent plan, although not always necessary, to puddle the roots; that is, dip them in a thin mud or paste of clay. In this way they are protected for a longer period against the drying effects of the wind and sun.

It is not well to plant trees when the soil is wet, for handling it when in this condition changes its physical properties, and a baked soil is the result. No fertilizer should be put into the holes when the tree is planted.

In setting the trees it may be well to slant them slightly toward the direction from which the prevailing winds come. One well-known orchardist recommends that, in order to insure as perfectly shaped trees as possible, they be planted so that the lowest branch points in that direction.

Plowing out and planting. If conditions permit, the field can be marked out and the soil partly removed with a plow. The general plan of Van Deman and Yeomans, as described on page 58, may be employed with the addition of two stakes, as follows:

If the plowing is to start at M (Fig. 15), in the direction of N , let someone set a stake in line with the three original stakes, but beyond N at E , so that when the driver has passed the middle stake at E , he will still have two stakes by which to keep in line. Stakes are set for the other rows in the same manner. The furrows, which are to be made in one direction only, may be

gone over several times. Perhaps the subsoil plow may be of some advantage, especially in preparing the land deeper for the planting of the trees.

If planting follows the plowing immediately, three or four men, or men and boys, can be used to advantage — one to distribute the trees and prune the roots; another to hold the trees and line them up in one direction, and later to stamp in the soil over the roots; and a third to line up the trees in the other direction and shovel the soil around them.

As soon as the trees are planted, the furrows may be filled in with the aid of the plow, care being taken not to injure the trees or throw them out of line, or they may be left to be leveled by cross-cultivation during the summer.

Digging holes by dynamite. Recently the use of dynamite for digging holes has become more common, but it is not always advisable to employ it. Generally speaking, where the soil is hard or the subsoil is clayey or hard and impervious, dynamite may well be used, but it is not needed for sandy or open topsoil or subsoils. To obtain the best results from dynamite, the operator should have a clear understanding of the principles of blasting.

The following discussion of the principles of blasting and the use of dynamite is based on that of the E. I. Du Pont de Nemours Powder Company.

Principles of blasting. When dynamite explodes, it is changed into a very large volume of hot gases, which exert a strong pushing force equally in every direction, because they require a much larger space than the dynamite which produced them. If the dynamite is shut up in a space just large enough to hold it, that is, if it is closely confined before it is exploded, the gases, in escaping, force out and carry along with them the material which shuts them in.

These gases, pressing equally in every direction, will escape principally where there is the least pressure opposed to them, that is, along the lines of least resistance, and will force out the material confining them more in that direction than in any other. If the back pressure is about the same at the top and on all sides, then they will carry with them, or break up as they escape, a large amount of the material which shuts them in; but if one place in the earth or rock around them is much weaker than all the rest,

then the gases will force their way through this weak spot and will escape without doing as much work as they should.

It must be remembered then that in order to have a charge of dynamite do good work it must be so placed that the holding-in pressure is as nearly as possible the same at the top and on all sides of it. If a charge of dynamite explodes properly, the change into gases is almost instantaneous, although some kinds of dynamite explode — or “detonate,” as it is often called — more rapidly than others.

Dynamite is exploded by a detonator. There are two styles of detonators — one known as a blasting cap, and the other as an electric fusee (pronounced *fu-ze'*). Both are small copper cylinders about $\frac{1}{4}$ inch in diameter and from $1\frac{1}{2}$ to $2\frac{1}{8}$ inches long, which contain a small quantity of a very powerful explosive. This explosive is quite sensitive to heat and shock, and a hard, sharp blow may explode it; therefore detonators must be carefully handled.

The heat to detonate a blasting cap is provided by the spark from a piece of fuse, one end of which has been pushed into the open end of the blasting cap, and fastened there by crimping the blasting cap on it with a cap crimper. When the other end of the fuse is lighted, it burns through slowly, and when the fire reaches it the blasting cap explodes.

Preparing caps and fuse. Placing the detonator in the cartridge of dynamite is called priming it, and the cartridge with the detonator in it is called the primer cartridge or primer. When the charge consists of more than one cartridge the primer should generally be loaded last or next to the last.

The first steps. The first step in the preparation of the primer, when using fuse and blasting cap, is to examine your dynamite and see that it is not frozen. Frozen dynamite is hard and rigid; when thawed it is soft. Next examine your fuse; see that it is not stiff and brittle; if in this condition, it is advisable to warm it slightly before a fire until it becomes pliable. Take your cap crimpers and cut the required length from the roll; the cut should be made squarely across and not diagonally. Sometimes in the cutting the end becomes flattened, thereby making the end of the fuse too large to enter the blasting cap. This end should



FIG. 33. Punch hole in side of cartridge with round, pointed handle of cap crimper

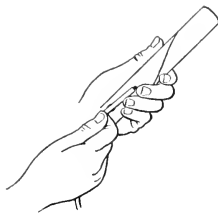


FIG. 34. Or else fasten fuse to cartridge by punching a hairpin through cartridge on both sides of fuse



FIG. 35. Crimp the blasting cap to fuse securely with Du Pont cap crimper

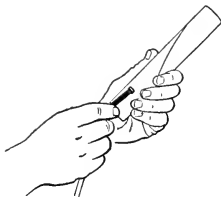


FIG. 36. Insert blasting cap and fuse in cartridge

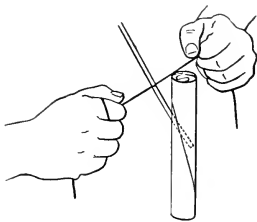


FIG. 37. Tie string to fuse

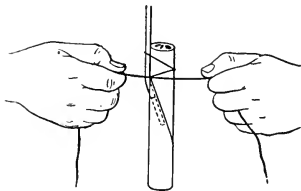


FIG. 38. Tying the fuse securely to the cartridge



FIG. 39. Bend hairpin points up

be squeezed round with index finger and thumb, and then inserted carefully into the detonator, well down to the explosive charge. *Do not twist it about.* The charge is very sensitive and friction may explode it. Although this operation is not dangerous, yet great care should be exercised. After the fuse is inserted into the detonator as above described, take the cap crimper and crimp the detonator to the fuse. The crimp should be made near the end which the fuse enters, so as not to disturb in any way the explosive charge which the blasting cap contains. *Do not use common pincers, knife, or the teeth* in this operation. If the work is wet, then smear the joint with tallow, wax, or soap. *Do not use oily grease,* as the oil might penetrate the fuse wrapping and spoil the powder.

The next step. The next operation is the insertion of the cap into the dynamite cartridge. This may be done by punching a hole diagonally into the side of the cartridge, inserting the blasting cap into it, and tying the fuse to the side of the cartridge with a piece of twine. Electric fusees may be inserted and fastened in the same manner.

Having primed the cartridge in the manner described, insert it in the borehole on top, or next to the top of the rest of the charge if more than one cartridge is used, and push it carefully home. Putting the explosive into the borehole is called charging or loading the borehole. It is generally best in dry ground to slit the paper shells lengthwise in two or three places with a sharp knife before putting the cartridge into the borehole, as a slit cartridge will spread out in the borehole better. The primer should not be slit. Push the cartridges, except the primer cartridge, firmly into place with a *wooden stick* so that they will expand and fill up their part of the hole, for crevices or air spaces may lessen the power of the explosive. Expanded cartridges also occupy less of the length of the borehole and make possible a heavy charge at the bottom of the hole. The primer is loaded last, or next to the last, and is pushed down only hard enough to touch the preceding cartridge. Each cartridge must touch the one previously loaded, for if there is any space between the cartridge caused by falling dirt or stones, or by the sticking of a cartridge in the borehole, a part of the charge may fail to explode.

Never force a primer into a borehole, because the detonator which it contains is sensitive to shock and might explode if too much force is used.

Tamping. After the charge is pressed home, as directed, put in two or three inches of fine dirt or damp sand, and with a wooden stick press it gently on top of the dynamite. Then fill up two or three inches more of the hole, packing it in a little more firmly. After five or six inches covers the charge, it may be pressed firmly into place without danger of premature explosion. The tamping material should be packed as firmly on top of the charge as can be done without moving the electric fusee or blasting cap in the primer, but it is not safe to tamp by a blow any stronger than can be given by hand. Fill the borehole up with tamping until even with the surface. The firmer and harder the tamping can be made (without overlooking the above precautions) the better will be the results. If the borehole is not properly tamped, the charge is likely to "blow out," or at least some of its force will be wasted.

Do not use iron or steel bars or tools for tamping, because the metal tools may detonate the explosives. Use only a wooden tamping stick with no metal parts.

Firing. Exploding the charge is called firing, and can be done either by caps and fuse or electrically by electric fusees and a blasting machine. When cap and fuse are used, cut the fuse long enough to enable you to retire to a safe distance. Fuse burns on an average of two feet per minute.

Never light the fuse or operate the blasting machine until you have warned everyone near that you are about to fire, and until you are thoroughly satisfied that there is no one sufficiently near to be injured by the material thrown into the air by the blast.

What to do in case of misfire. Never try to dig out the old charge. Make, charge, and prime a new borehole far enough from the first to make sure the tools will not touch the first charge.

Always fire just as soon as possible after tamping. In fact, priming, charging, tamping, and firing should be done as quickly as it is possible to do them thoroughly, because wet or slightly damp ground may injure the dynamite or even the detonator to some extent, and in cold weather dynamite may become chilled or

frozen and thus be made insensitive. When viewing a blast it is always advisable to look out carefully for falling material which may be thrown farther than anticipated, and a position should always be taken that will bring the sun and wind at your back. In any case the sun should *not* be faced, as in doing so it is naturally difficult to discern material flying through the air. Look up in the air, rather than at the stump or boulder being blasted.

Never investigate a misfire immediately. It sometimes happens that the charge does not explode exactly when it should, but does so a little later. This rarely if ever occurs when firing electrically, but is not so infrequent when fuse is used, because careless tamping sometimes tears or abrades the fuse so that it will burn very slowly. A misfire with fuse should *not* be investigated for at least half an hour, and it is much better to wait a full hour. When firing electrically, be sure that all your connections are perfect, and do not connect the leading wire to the blasting machine until everything else is ready for the blast. This will prevent some inexperienced person from accidentally operating the blasting machine and exploding the charge before the blaster has had time to reach the safety line.

Digging holes with dynamite. In a large orchard or field a blasting machine may be used to detonate the charges. If only a few trees are to be set, the blasting should be done with fuse and blasting caps. Let the depth of the holes for setting your cartridges be governed by the state of the soil. Make a hole with auger, sharpened wood dibber, or crowbar, well down into the subsoil.

In very tight soils, as in California hardpan, a whole cartridge of 20 per cent or even 40 per cent may be necessary. These heavy charges should be tamped.

The usual charge is half a cartridge of 20-per-cent dynamite per hole, primed with cap and fuse. If the soil in which the tree is to be planted is of a hardpan, shale, or very compact clay, holes should be tamped; otherwise no tamping is necessary.

The common practice is to plant the trees shortly after the holes are blasted. Some orchardists, however, believe best results will be obtained when holes for spring planting are blasted in the fall.

This affords about six months' time for the air, moisture, and sunlight to work on the subsoil and mellow it.

If trees are planted immediately after the blast, care must be taken to poke down the upheaved soil at the bottom of the hole or settle it well with water. If this is not done, the dirt may shrink away from the roots of the tree, leaving it suspended in air or water, and thus killing it. This is undoubtedly the cause of the death of the few dynamite-set trees reported as failures. A little care in settling the dirt will prevent this trouble.

For the best results, throw out a bushel or more of the clay that has been broken by the shot, and fill with some organic matter that will slowly decompose as the years go by, mixing and cutting in well with a sharp shovel or spade. Leaf mold, forest topsoil, fence-corner settlings, old bones, scrapings from under an old house or outhouse, or any such matter is good. Now that the roots can go down and out in an area broken and pulverized for many feet on all sides, the tree will make a rapid and healthy growth and come to bearing earlier and live many years longer. It will also be better able to resist drought and insects, for the much-talked-of "insect-resisting tree" is not a tree immune from insects, but one that is healthy and vigorous enough to overcome their baneful attack.

TABLE OF CHARGES AND AMOUNT OF 20-PER-CENT DYNAMITE REQUIRED PER ACRE FOR PLANTING TREES

Distance between Trees, Square Method	Trees per Acre	Dynamite per Acre, using $\frac{1}{2}$ Cartridge per Tree	No. 6 Blasting Caps per Acre	Fuse ¹ per Acre, using $2\frac{1}{2}$ inches per Ton	Cost per Acre
15 ft.	196	49 lb.	196	490 ft.	\$11.62
20 ft.	110	28 lb.	110	275 ft.	6.68
30 ft.	49	13 lb.	49	122 ft.	3.00
40 ft.	25	7 lb.	25	63 ft.	1.55

No matter how the holes are dug, in planting the tree the principle is the same. Good fertile soil should be selected for immediate contact with the roots, and clods or lumps should be avoided. Tamp the soil thoroughly around the plant—perhaps the fingers would

¹ It is necessary to have as many feet of fuse per hole as the hole is deep.

be best to press the soil among the finer roots. Have the tree set as mentioned previously (p. 73), just a little deeper than it stood in the nursery. It may be well to allow the soil around the tree to slope slightly toward it. The final shovelful should be spread around the tree without firming, in order to establish a dust blanket or mulch which will prevent loss of moisture by evaporation.

Watering. The common belief that apple trees should have a liberal supply of water at transplanting time is not well founded. The soil is in best condition for transplanting when just moist enough for easy working. This is sometimes spoken of as a "mellow" condition or a "good state of tilth." Any addition of water to the soil during the process of transplanting must be harmful. Planting when the earth is sticky cannot be commended, but if water is ever to be added, it may possibly be when work must continue even though the earth is too adhesive to permit proper working among and about the roots. By a long series of experiments it has been demonstrated that the best way to supply water to transplanted apple trees is to make the earth about the roots so compact that there will be no recognizable air spaces. This is why firm packing of the fine earth around the roots is of the greatest value. The earth particles must be in a state of fine division, and each particle must be surrounded by an adherent film of water, or the water supply will not be sufficient. It is well known that when soil is stirred while saturated with water it afterwards tends to "bake"; that is, to form a hard, unyielding mass, very difficult to pulverize. It is then in no condition to hold film water, and the trees will suffer.

CHAPTER X

PROPER PRUNING

Could all fruit trees be treated by the same plan or set of rules, pruning would be a simple operation. But the different fruits have different habits of growth, and trees of the same variety differ in their development even under similar conditions. No two trees are alike in all respects. Pruning, then, to be well done should meet the needs of each tree.

The knowledge a pruner should have. If the many thousands of fruit trees set out each year are to develop properly, they must be pruned annually. The development of a tree depends largely on the cultivation given, the amount of plant food supplied, and the character of the pruning. Of these factors in the life of the tree, pruning is the most economical and the most neglected. But the pruner, to do his work well, must have some knowledge of the character of growth of the different varieties to be pruned and of the principles that underlie such work. The application of these principles must be worked out for each tree by a study of its individual needs.

Why we prune. There are many reasons for pruning. The primary result to be secured is such an improvement of the tree that it will produce better fruit and more of it. The time is past when we can set out trees and leave them to shift for themselves, and expect finally to be rewarded by abundant harvests of high-grade fruit.

If we go into orchards where little or no pruning has been done, we find limbs crowded closely together, dense tops, branches dead or dying and in all states of weakness. We find the sunlight shut out, — although sunshine, probably more than anything else, influences the color of the fruit, — poor air circulation, large numbers of insects and fungi, and a large amount of inferior fruit. We prune, then, to change these conditions, although we must remember that

pruning is but one of the important factors in the success or failure of the orchard — spraying, cultivation, and the application of plant food must each receive its proper share of attention.

If we wish to make a tree more vigorous we remove a portion of the top by pruning when dormant, so that the growth may be concentrated in a smaller number of branches, thus developing a



FIG. 40. A very young tree

Three months after the tree has been placed in the orchard

stronger tree and permitting the nourishment to pass to parts where it will do the most good. We also prune for other reasons — to secure a low or a high head; to control the arrangement of the framework or scaffold limbs of the tree so that they will not break under a heavy weight of fruit; to avoid sunscald by having the top low and the trunk well protected from the sun's rays by the branches above; to develop a leader or to form an open-centered tree, as desired; to facilitate the operations of spraying and harvesting.

When to prune. There is no one time that is always under all circumstances best for pruning. Conditions vary, and the time of pruning depends largely on conditions. In some cases pruning is begun before the tree is set, by shortening in straggling or injured roots. It should begin with the first year of the set tree and be continued annually. It is poor policy to let the pruning go for the first few years and later find it necessary to prune heavily. Systematic light annual pruning is much more satisfactory than an occasional

severe pruning. Whenever a branch is removed a wound is made, and so far as the healing process is concerned, the best time to prune is toward spring, just before the beginning of growth. If the cut is made in the fall or early winter, there can be no healing until growth starts, and the cut surface may be exposed a long while to the action of the weather or to the attacks of insects or fungi.

Summer pruning may occasionally be practiced in midsummer or late in July, but it must be kept in mind that it is always a weakening process. Sometimes, however, with overvigorous, rank-growing, nonproductive trees, it tends to check overgrowth, with a resulting tendency toward the formation of fruit buds. We cannot, however, say that the mere operation of pruning will result in fruitfulness. The production of fruit depends upon many factors, — of which pruning is but one, — such as character of soil, variety, tillage, plant food, spraying, or on a combination of several of these factors.

Root pruning. A certain amount of root pruning before the trees are planted seems to be necessary to get the best results. Long, straggling roots should be cut off, but it should be remembered that when apple trees leave the nursery row their root surface is usually only about half what they possessed normally. In addition to the heavy nursery pruning, it is generally advisable to thin out all crowding and interlacing roots, and to remove all broken ends of the remaining roots, leaving clean cuts. This latter point, however, is not being emphasized as much now as formerly.

The Stringfellow method of pruning roots is practiced in the South, but hardly at all in the North. This is a very severe system, consisting in the practically complete removal of all roots except small stubs. The opportune time for this pruning is on the arrival of the trees in the fall. When the trees do not arrive until spring, the pruning may be done just before planting.

Pruning the top. With the root system so severely cut back, the balance of the tree between the top and the roots has been very much upset. In most climates, if trees are left without the tops being pruned, many will perish, because their much shortened root systems cannot give the necessary support. The top of the tree, therefore, must be pruned back to enable it to withstand the shock of transplanting. The actual pruning can be done after planting.

The head should be started low for several reasons. Many young trees are killed each year because their trunks are exposed to the drying afternoon sun. The trunk may be affected by the direct rays of the sun or by the reflection from hot, dry soil or snow. Sunscald in the summer is much more prevalent on high-headed trees than on low ones. The low-headed trees also have the advantage of being more conveniently and cheaply handled as regards pruning, thinning, spraying, and picking the fruit. Then there is less likelihood of damage to the fruit from windstorms. It is possible, however, to start the head too close to the ground for easy cultivation and for the use of burlap bands for the control of the codling moth. A trunk between 20 and 24 inches from the ground to the first limb seems to be about right. Therefore, in planting one-year-old whips, cut them back to about 30 inches from the ground, which will give a space of 10 or 12 inches between the starting points of the lower and the upper limb for the distribution of the scaffold limbs. In this cutting back, make a slanting cut just above a sound bud, which will develop by this pruning into a lateral branch.

It is also desirable to begin the shaping of the orchard tree at this early date. The form of the tree will depend somewhat on the ideals of the grower. There are two distinct types seen in the fruit sections of the country — the open-headed, or vase-shaped, tree, and the pyramidal tree, which is pruned with a leader. The open-headed tree seems to be constantly gaining in popularity, and is by far the commonest form found in the newly planted sections. The ideal for this type is a spreading tree with an open center. When the center is kept open and the branches are thinned out so that sunlight is admitted freely, much fruit is borne on the central branches, as well as on the outside limbs, and fruit spurs are found all along the branches extending nearly to the main trunk of the tree.

Pruning to this vase shape can be overdone, however. Trees cannot all be pruned in the same manner, without regard to variety characteristics. Under the same treatment the Jonathan and the Ben Davis make very shapely trees, and the Rhode Island Greening becomes too spreading. The Rhode Island Greening being naturally a spreading type should not be allowed to spread

excessively during its early growth. Therefore, some of the more upright branches should be selected for the framework of the tree during its first two years.

In pruning for the open-headed tree the endeavor should be to have from three to five scaffold limbs, evenly distributed around the tree, which form a vase-shaped top with an open center. These main branches should be distributed within a space of 10 or 12 inches on the trunk, thus making a strong framework for the tree. If they are in a cluster, the resulting unevenness of weight is liable to split the tree apart.

Pruning one-year-old tree.

Most orchardists leave the shaping of the young tree and the selection of the scaffold limbs until the first year's pruning; that is, trees set out in the early spring receive their first real pruning as orchard trees the next March, the simple heading back having been done at the time of planting. The trees should be gone over, however, at least once during the first summer

(about the first of July) to remove all sucker growth from the roots and all low branches growing less than 20 inches from the ground. At the time of the first March pruning, it will be found that from five to ten lateral branches have started from the main trunk. As already stated, select from three to five of these for the scaffold limbs, removing the others as close to the young trunk as the cut can be made. Head back these scaffold limbs, which are to form the framework of the tree, about half of their growth, leaving them between 15 and 18 inches long. This has a tendency to increase their diameter rapidly and thus make a strong framework.



FIG. 41. Pruning the young tree

In the spring of its second year the young tree is slightly pruned; wire screen at base, to protect tree against mice ravages

If the scaffold limbs are allowed to remain unpruned, they will become long and willowy and will be easily broken with the first heavy crop of fruit. The cutting back of the scaffold limbs induces the growth of lateral buds, which form branches and help to produce a stalky young tree. In heading back these branches



FIG. 42. Northern Spy

An ideal young tree in its second summer from setting

the orchardist should cut back to the buds which point in the general direction he wishes the branch to take. The proper starting of the young trees at this time will largely do away with the need of props in the future orchard.

In pruning an upright-growing tree so that it will spread more than it would naturally, the pruner should cut to the outside buds and branches. The reverse should be done if one wishes to correct the sprawling, spreading habit of certain varieties and cause them to grow more upright.

Second-year pruning.

This season's pruning is similar to the first year's.

Remove all the side branches that have started from the scaffold limbs except two or three of the strongest laterals. Care should be taken to select not only strong, vigorous lateral growths, but those which will make the tree well shaped and symmetrically balanced. If possible, select laterals that are distributed along the scaffold limbs rather than those that come out in a crotch, for the latter are more likely to break down under heavy stress. It is also essential to avoid

having these branches cross each other. Cut out all sucker growth in the center, and if two parallel branches are too close together, remove one. These selected laterals should now be headed back about a third or a half of their growth, leaving them 15 or 18 inches long.

Third- and fourth-year prunings. The framework of the young trees should now be well formed and henceforth require less attention. The trees should, however, be moderately pruned each year rather than neglected for several years and then severely pruned. Less heading back will be necessary each year. Sunshine is essential for the development of the fruit buds and the proper coloring of the fruit. Therefore, all sucker growth in the center of the tree should be removed for the good of the other branches. This growth, situated as it is in the more or less shaded sections of the tree, would not develop fruit spurs to any extent if allowed to remain.

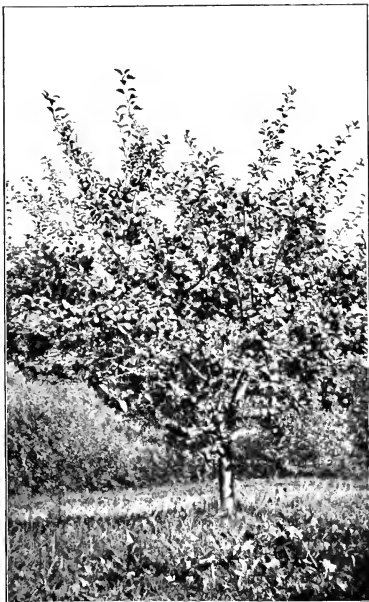


FIG. 43. An extra fine young tree, well pruned

Trim out all branches that rub together or grow crosswise. Remove one of any two parallel branches which have a tendency to whip together, injuring themselves and their fruit, or which are so crowded that it is desirable to try to grow only one good branch within the space. If the tree is growing too tall and upright the excessive growth may be cut back to lateral branches, causing the tree to assume a more spreading form.

By the time the apple tree is four years old, if it has been well handled, the orchardist may begin to prune to promote fruit production. Less severe cutting will aid materially in bringing this about.

The effect of pruning. Frequent cutting back or pruning of the branches of the apple tree while it is young has a tendency to prevent the growth of long, bare branches which are so characteristic of old orchard trees. It has a tendency, as well, to prevent the tree from growing too tall, thereby reducing the cost and difficulty of spraying the tree and harvesting the fruit. Less propping is necessary with the low-headed trees well pruned than with trees having long framework branches. Since the main structural branches of the former are larger in proportion to their length, and the load of fruit is carried nearer the trunk, the trees are therefore better able to carry any amount of fruit that may develop.

Influence on "off" years. Judicious pruning not only facilitates the work of cultivation, spraying, and harvesting, but also determines to a great extent the fruiting habits of the tree; in other words, it is possible by proper pruning so to modify the quantity of fruit-bearing wood of a tree that it will be practically impossible for the tree to retain more fruits in any given season than the root system is capable of supplying with a proper amount of nourishment. Annual crops are more common and biennial crops less frequent when such a balance between the fruit-bearing wood of the tree and its root system is maintained. It is without doubt true — as apple-growers are coming to believe — that the biennial crop in many apple orchards is largely due to the fact that during the crop year the trees are allowed to overbear, thereby reducing their vitality so that they cannot carry a satisfactory load of apples the succeeding year.

What to do with thinnings. Sections of the tree removed by pruning are often useful in the house. Being a hardwood, the apple limbs and twigs make a hot fire of lasting quality. They are especially well suited to the open fireplace, making one of the prettiest of fires, and giving off an agreeable odor while burning.

CHAPTER XI

COVER CROPS

An orchard cover crop is a crop that is grown among the trees in the orchard, during the normal seasons of tillage, for the purpose of serving as a mulch and helping to provide plant food. Technically considered, an orchard cover crop is a crop that is grown for the benefit of the trees during the late summer and fall, and is left on the ground through the winter and worked into the soil in the spring. It is not a crop at all in the sense that it is to be removed from the land like grain or forage ; neither should it be confused with a permanent sod of grass. The growing of cover crops in the late summer and early fall presupposes some sort of cultivation during the spring and early summer.

Benefits derived from cover crops. Some of the benefits to be derived from the growing of a cover crop in the orchard are summarized below :

1. A heavy growth of herbage will have a tendency to prevent deep freezing of the soil, especially in those sections where the bare ground is exposed to low temperatures either through lack of snow or through the action of the winds in blowing the snow away.

2. The roots of plants and their growth aboveground help to keep the soil from being washed or worn away. This retention of the soil aids greatly in preventing the roots of the apple trees from being exposed and injured by freezing.

3. When the mass of plant material, either green or dead, that has been grown for a cover crop is plowed under, it adds to the soil that very important factor, humus-making material. By this means the physical condition of the soil is in time greatly improved.

4. Stiff clay soils are so much improved by a few years of cover crops plowed under that they are subsequently much easier to work. As a result, the time and cost of doing the necessary work is lessened.

5. The tillage and cultivation of clay soils is also made easier by the plowing under of cover crops. This is because the humus which has been incorporated in the soil lessens the puddling and cementing of these soils.

6. Light soils are also benefited by the addition of humus-making material, in so far as they are rendered more retentive of moisture, and therefore suffer less from drought. The action of the humus on these looser, light soils is seemingly that of making them more compact, while the tendency with the clay soils, as has just been pointed out, is to loosen or lighten them.

7. The decay of vegetable matter in the soil helps to break down the plant food that is already in the soil but not available to the plant. By the action of this decay and the consequent action of organisms in the soil, plant food is set free.

8. Where legumes, such as the clovers, vetches, etc. are used for the cover crop, not only is the food which the plants took up from the soil returned to it by the decay of the plants, but the nitrogen which the plants assimilated from the air is also given up to the soil. This is an addition of a costly plant food.

9. Where windfalls are of value a heavy mulch on the soil will serve as a cushion, thereby preventing the soiling or bruising of the fallen fruit.

10. Cover crops make young, late-growing trees better able to stand severe winters, by causing them to mature their wood properly in the fall.

Other advantages are frequently claimed by orchardists, but those just given will serve to illustrate the principal recognized benefits.

Bad effects of cover crops. The effects of cover crops are not all good. It has been found that such crops reduce the soil moisture during the fall and in some cases keep the soil dry until winter sets in. They also retard the growth of trees somewhat, and in certain instances, for example, the rye crop may cause great injury to the orchard in times of drought. From a hasty survey of the subject it would seem that the good effects of cover crops are often counterbalanced by their ill effects, and that if we are to avail ourselves of the advantages, we must be prepared to put up with the disadvantages.

Classification of cover crops. Horticultural writers commonly separate cover crops into two classes — leguminous and nonleguminous. The first are the nitrogen gatherers — plants which, through the agency of the bacteria in their roots, add to the store of nitrogen in the soil. Some of these are beans, peas, vetch, cowpeas, soy beans, etc. Cover crops of the second class add no nitrogen to the soil ; they simply return to it when they decompose what they took from it in growth. Plants of this class are rape, buckwheat, millet, cane, oats, and the like. This classification has come into use largely because the literature of horticulture is for the most part from the East. The classification is no doubt the best one for regions where the fertilizer problem is all-important. But in the West the question of orchard fertilizers is generally insignificant in comparison with the moisture problem ; Westerners, therefore, must consider cover crops just as they do other culture problems — from the standpoint of soil moisture and winter injury.

All cover crops dry the soil more or less during the late summer and early fall. Some crops are killed by the early frosts and no longer keep the ground dry, but act something as a litter mulch does in checking evaporation from the soil. Other crops are uninjured by early frosts and continue growth until severe freezing weather kills them, thus keeping the soil dry late into fall. Still others live through the winter, and early in the spring begin again to dry the soil.

Some cover crops mat down, thus forming a fair mulch for winter protection, but do not hold the snow ; others stand erect, and, although furnishing little direct winter protection, by catching the drifting snow give excellent indirect protection to tree roots.

Erect snow-holding versus prostrate mulch-forming cover crops. Certain plants are sometimes recommended for cover crops, because on the approach of winter they mat down and protect the soil like a mulch. There is no doubt that mulches of any coarse material are an excellent means of preventing deep freezing of the ground and the consequent injury to tree roots, but no crop known to the writer will, when sown in midsummer, form a mulch of sufficient depth to prevent freezing, however thoroughly it mats down. Observations that have been made indicate that cover crops are less effective as soil mulches than as snow holders. Nothing known

to the writer is superior to a blanket of snow for protection against deep freezing. Therefore the cover crop which holds snow the best is usually the best protector for tree roots. This may not apply to all parts of the United States nor to all winters. Periods of extreme cold unaccompanied by snow are experienced in all apple-growing sections of the country occasionally, and in some sections frequently. Some sections not only have comparatively little snow, but what there is usually comes with considerable wind and drifts badly, leaving much of the ground bare. For these reasons the cover crops should be those that will catch what little snow falls and keep it evenly spread over the ground.

Many crops such as soy beans, cowpeas, corn, etc. have been given a trial, with the following results. Early in winter it was found that soy beans had few leaves left and stood perfectly erect, furnishing almost no protection to the soil. Cowpeas, though they still held their leaves, stood too erect to afford much protection. The field peas held their leaves well and had matted down neatly, forming a good mulch. Corn was also found to have remained very erect, as was also the case with cane and millet. Later in the winter it was noted that the snow was held very well by corn, cane, millet, soy beans, and cowpeas, while field peas and rye, though good covers, lay too flat on the ground to catch the drifting snow. The almost bare stems of such plants as soy beans, which still stood erect, held the snow much better than a plant like field peas, which retained its leaves but matted down too close upon the ground. The stalks left standing after a crop of corn grown in the ordinary way has been harvested make a very efficient snow holder, but furnish little protection to the ground at times of intense cold unaccompanied by snow.

Frost-killed versus frost-resistant cover crops. In the East, to furnish protection from washing and freezing, crops such as rye, clovers, vetch, etc., that live through the winter, are preferred as cover crops. In the West, in regions having somewhat dry falls, cover crops that are killed by the early frosts are preferable to those that live until severe freezing weather comes, or all winter. The crops that seem to be best for the Western states are millet, corn, and cane. They start growth promptly when sown in midsummer, choke out the weeds, and dry the ground during the early fall;

they are killed by early frosts, and not only make a good direct winter cover, but indirectly protect the soil by holding the snow fairly well. Corn makes a poorer growth during a dry fall than cane or millet. When sown rather late, not more than two months before the first frost, corn and cane are apt to break down and lie too flat upon the ground to hold snow well. When sown earlier they stand up better, but are too heavy and coarse to work into the ground well the next spring. Millet makes a good cover if it can get six weeks of growth before frost. It stands nearly erect and thus holds the snow well, and is so leafy that it affords fair winter protection even without snow. It sometimes grows so large that it is difficult to work into the ground with a disk, but can be covered well with a plow. It puts the land in excellent physical condition. The orchard plat that has had a cover crop of millet every season for five years produces a much heavier growth of millet than it did at first. The main drawback to using this crop is the fact that when the early frosts are delayed much more than two months after it is sown, it ripens seed so abundantly as to be a nuisance the next season. When sown between the middle and the last of July it has ripened seed twice in the last six years. The large German millet is to be preferred to the smaller kinds. A crop that behaves like millet in all other respects but ripens later would be an almost ideal cover crop for this section. Japanese millet ripens later, but whether it would be as satisfactory as German millet in other respects has not yet been determined.

The best cover crop. This question can be answered, if at all, only when we know the conditions under which the cover crop is to be grown. We do know, however, what a cover crop should accomplish. It should start growth promptly, to insure an even stand and to choke out weeds. It should grow vigorously, to provide a heavy winter cover, and, in the case of late-growing trees, to dry the ground so as to hasten their maturity. It should be heavy enough to furnish direct protection against freezing and thawing of the ground, and should stand sufficiently erect to hold snow against the force of strong winds. If a cover crop can be found to satisfy these conditions, it will prevent the washing away of the surface soil on all but the steepest slopes, and by the formation of humus in its decay will improve the physical condition of the soil and aid

in the conservation of moisture during the summer. A further requirement, in the case of poor soils or of old and feeble trees, is that the cover crop be a leguminous one, so that it will add to the store of nitrogen in the soil and thereby increase the vigor of the trees.

General management. If the orchard is plowed early in the spring and worked up by frequent harrowing so that the surface is as fine as possible, the crop will be ready to plant between July 15 and August 15, according to the crop used and the location of the orchard. A drill may be used in sowing, or the seed may be broadcast by machinery or by hand. After the seed is sown, rolling, followed by a light harrowing, will hasten germination, especially in the case of the smaller seed, which need not be sown so deeply as the larger kinds. No more work on the soil is necessary till spring, when the cover crop should be plowed under as soon as the land can be worked, and clean cultivation be continued until July or August, when another crop is sown.

Management of a young orchard. A system of cover-crop rotation in a young orchard has been used by the author with marked success, and an account of it may prove of value to those interested in the subject of cover crops by suggesting other rotations or cropping systems.

The first and second years the cover crop was rye; the third year medium clover was sown; the fourth and fifth years rye; the sixth year medium clover; the seventh year the crop of the previous year was left down; the eighth year rye was sown; the ninth and tenth years medium clover; the eleventh year vetch and rye; and the twelfth year buckwheat. The crops were sown each year between July 15 and July 30. The amount of seed used in each case was slightly more than that recommended for these crops under field conditions:

4 bu. rye per acre
30 lb. medium clover per acre
50 lb. vetch, 3 bu. rye, per acre
2 bu. buckwheat per acre

This system takes for granted that the land is in fair tilth and not set up on too sharp an angle. Rye is recommended for a cover

crop in the younger stages of the orchard's life for two reasons: first, because it pumps out the moisture from the soil better than any other crop, thereby causing the young trees to mature their year's growth earlier and incur less winter injury; second, it is a sure crop, giving a good mass for a soil cover and greatly improving the physical condition of the soil by adding to it a large amount of slowly decaying humus.

Clover and vetches are better adapted for cover crops in an orchard which has arrived at or is near its bearing period. The reason for this is that they pump less water from the soil and do not injure the older trees by overstimulation so much as they do the young ones. They add greatly to the fertilizer content of the soil, thus improving its physical condition without decreasing the actual cost of plant-food materials.

Where a catch crop is sown, the cover crop is planted in the tree-clear space 6 feet wide the first year and is increased in width each year. This is because the catch crop occupies the rest of the land late in the season, which of course interferes with the planting and growing of the cover crop. Beginning with the eighth year the catch crop should be discontinued and clean culture be practiced from this time on, as the young trees require all the space in the orchard for their best development.

To lengthen the twelve-year system, for the thirteenth year start again at the eighth year and continue up to the twelfth year. Allow the cover crop of clover planted in the ninth year (the fourteenth year) to remain through the next (the fifteenth) year, which will, of course, exclude clean culture that year. This rest is beneficial to both trees and soil, in some cases being the needed check to the formation of fruit buds, which would result in too large crops.

Shade crops. The use of shade crops in orchards has been strongly recommended by the experiment stations of the Far West. Many orchardists who have tried such crops have met with gratifying success.

The purpose of a shade crop is to shade the ground during the growing season, thereby keeping the moisture of the soil uniform and lowering the temperature somewhat. It is best adapted to the irrigated sections of the country, and should not be used to any extent until the trees come into bearing.

The crops used for shade purposes are principally legumes, such as alfalfa, red clover, alsike clover, crimson clover ; peas and vetches are also sometimes used. There are several methods of handling shade crops. One method is to grow the crops for perhaps two years, then plow the ground and keep it in clean tillage for at least a year, when it is reseeded to a shade crop. Another method is to cut one crop, which is sometimes put in the barn for fodder, but to allow the second to go to seed, this new seed giving a splendid growth after the land has been disked early in the spring. This system of reseeding is commonly practiced with the crimson and red clovers. Another method is to mow the crop frequently with the mowing machine and allow it to mat down and decay on the ground. Which system is the best will depend on climatic and soil conditions. The age of the orchard, the type of trees, etc. may also influence the choice of method. The time of planting the shade crop will depend largely on local conditions. In some sections seed can be sown in the early spring, from March to May ; in other regions July is a better time to seed.

A word of caution is necessary where shade crops are to be used. Watch your soil very carefully, and investigate its moisture content thoroughly. If the soil becomes very dry the orchard may be injured. When irrigating, be sure to allow enough water for thorough, deep work.

15# N is equal to 9# N₂

CHAPTER XII

FERTILIZING

Among horticulturists and fruit growers there is much difference of opinion as to the necessity and value of fertilizer applications to apple trees. Within a short time two sets of experiments in adjoining states have demonstrated opposite theories.

Advantages and disadvantages. Some of the reasons most commonly advanced against the use of artificial fertilizer for apple trees are as follows :

1. The long growing season.
2. The long preparation stage before fruiting.
3. The deep-rooting habit.
4. The well-known years of scarcity of fruit, called " off years."
5. The high water content of the fruit.

Some of these reasons seem to offer more advantages than disadvantages for proper fertilization. In the case of the long preparation stage before fruiting, where no rotation is practiced, the trees lock up in the wood and leaves considerable quantities of plant food, a fact which argues more for than against fertilization. As to the deep-rooting habit of apple trees, this has been greatly overestimated, and is not true of all locations nor of all soils. It has been found that the largest number of feeding roots are in the surface foot of soil ; there is, however, a great variation in soils, those which are loose and dry permitting penetration of the roots to a great depth.

It has been discovered that frequently the so-called off years may be largely done away with by proper applications of fertilizer and other necessary ingredients. The occurrence of off years would therefore seem to constitute evidence for the use of artificial fertilizers. As to the high water content of apples, the fruit averages fully 85 per cent of water, but in the development of the remaining 15 per cent of dry matter more pounds of actual plant

food are taken up from the soil by an average crop of apples than by a similar crop of wheat.

Mineral constituents. A fairly exact knowledge of the composition of the fruit and vegetative parts of the apple tree is desirable for many reasons. One needs to know how the various plant-food elements are made use of, and how their presence or absence in the soil affects the different parts of the apple. It is also useful to be able to detect by diagnosis malnutrition in the orchard, and to observe and interpret the results of plant-food applications. This knowledge, in connection with the known facts as to the approximate annual weights of fruit, wood, and leaves produced by a mature tree under average conditions, will enable one to determine with a fair degree of accuracy the annual draft on plant food exerted by a single tree or by an acre of trees.

The following table is obtained from a combination of the results of many investigations.

	DRY SUB- STANCE	NITROGEN	PHOSPHORIC ACID	POTASH	LIME	MAGNESIA	IRON	TOTAL ASH
	%	%	%	%	%	%	%	%
Wood . .	52.3	.63	.20	.37	1.6	.24	.03	3.35
Leaves . .	34.5	2.15	.45	1.35	2.48	.75	.125	8.7
Fruit . . .	15.4	4.3	.17	1.11	.08	.09	.02	2.35

By using the above table and the following average weights of the various parts of the tree, just how much of the component parts of a tree are nitrogen, phosphorus, potash, etc. can be easily ascertained.

	GREEN WEIGHT IN POUNDS	DRY WEIGHT IN POUNDS
Average wood and roots per tree .	108	57
Average leaves per tree	111	43
Average fruit per tree	700	105

From these figures the following table of pounds per acre of the different constituents is obtained. For convenience in figuring, the basis of weight has been made a yearly production,

in round figures, of 100 pounds each of wood and leaves and 700 pounds of fruit, with 35 trees to the acre.

	WOOD	LEAVES	FRUIT	TOTAL
Annual weights	3500	3500	24500	31500
Nitrogen	11.3	25.6	16.2	53.1
Phosphoric acid	3.6	5.3	6.4	15.3
Potash	6.6	15.9	41.5	64.
Lime	29.1	29.5	3.	61.6
Magnesia	4.4	8.9	3.4	16.7
Iron . . . . .	.5	1.5	.8	2.8

It is evident that important amounts of plant food are annually removed from the soil by an apple orchard, and that unless adequate returns are made, plant food will become a limiting factor in any vigorous and productive orchard.

Functions and effects of minerals. We shall attempt to show the various functions and characteristic effects of the more important of these minerals and of nitrogen in the apple plant. We do not yet have an exact knowledge of all the functions of these elements in the plant. Therefore the following summary is not complete, but the functions given are the commonly accepted ones.

Nitrogen. This element, with sulphur and phosphorus, serves chiefly in the formation of protein and protoplasm. It therefore occurs largely in the living areas — such as the cambium layers, leaf mesophyll, and growing tips — and in seeds and other food-storage organs. Like phosphorus, it migrates very strongly from the older, more mature, or dying tissues of plants to the living portions and toward the heads or upper portions. Like potash and soda, the assimilated nitrogen is apparently subject to considerable losses as maturity is reached and passed, due to migration and to the action of rain and dew.

In general, the effect of nitrogen applications is to produce a strong vegetative growth and to retard greatly the maturity and ripening of most plants.

Phosphorus. This element is an essential constituent of nucleoproteids and renders their formation possible. It is therefore necessary for cell divisions and for all new growth, and in its

absence these processes stop. Its absence also results in an accumulation of fats and albumin. Its presence has been shown to be necessary for the formation of lecithin and chlorophyll. Lecithin is a semisoluble substance regularly accompanying fatty matter, but physiologically superior to it because of its partial solubility; it probably aids in respiration, being the form into which fat must be changed to become combustible in the protoplasm.



FIG. 44. Commercial fertilizer used

These trees received nitrogen and phosphate and produced 721 bushels per acre in 1909. They are identical with the trees in Fig. 45, except for fertilization. (After Pennsylvania State College)

As might be expected, there is a large demand for phosphorus in the new growth, and consequently an enormous migration from the older portions to the younger. As with most other minerals, during maturity and the later stages of plant growth there may be a considerable loss of assimilated phosphoric acid, as a result of rains and dew.

In experiments made in England phosphoric acid was found to promote root development very markedly, but not exactly in proportion to its supply, as there is an unknown factor affecting results. It is very effective in promoting tillering and, consequently, bud formation in stem and roots.

Potassium. Some potassium salts are necessary for every living cell. They seem to be especially essential to starch formation. Potash also seems to be connected with protein formation—which may be a similar process—and with protein accumulations. Those parts in which carbohydrates are transported are also reported from many sources to be relatively rich in potash, though this does not prove conclusively any vital connection.



FIG. 45. No fertilizer used

These trees, adjoining those in the preceding figure, received nothing and produced 156 bushels per acre in 1909. Variety, Baldwin. Compare with Fig. 44. (After Pennsylvania State College)

Under normal conditions potash is likely to be of special importance as a fertilizer where carbohydrates are the important element in the crop; for example, sugar beets, mangels, and probably fruits.

There is a difference of opinion as to the relation of potash to the maturing of the plant, some maintaining that it hastens maturity and others that its usual effect is to prolong growth. Those holding the latter view consider it especially effective on the lighter soils and in dry seasons. The plant habit of closing up growth on the occurrence of malnutrition of any sort probably accounts

for some of the divergence of opinion. No marked effect either way has yet appeared in the author's apple experiments, though perhaps the tendency has been to hasten maturity.

It is worthy of note that where nitrate of soda has been used as nitrogen carrier in the Rothamsted¹ work, no sign of potash failure has been observed in twelve years. This is taken to indicate that sodium liberates potash in the soil.

While potash shows relatively little migratory tendency, it is nevertheless subject to marked losses as the plants mature (see the discussion of phosphorus).

Calcium. The use of lime in agricultural practice is very old. In many soils it is an important factor, and, because of the large demand of most plants for it, its need is often felt very early. The part that it plays in the nutrition of plants is variable—in some soils it merely modifies environment, while in others its action is physiological. Lime accumulates in plants chiefly in the leaves, and to some extent in the wood. Etiolated, diseased, or albino leaves contain much less lime than healthy green leaves, the difference in amount sometimes being more than half. Since it may be largely or entirely absent from young plant organs, it does not seem to be essential to the young plants, but is useful in certain special processes. In the older plants, however, it has apparently acquired such importance in these special functions that its absence may indirectly affect one or all of the vital activities and thus obstruct metabolism.

The special function that has been most clearly associated with calcium is concerned with the solution and transfer of starch as contrasted with the starch-building rôle of potash. The function of lime in acid neutralization in plants is now considered less essential than formerly, since the resulting calcium oxalates are found to be absent in many plants.

The functions of lime, in its soil-modifying capacity, are as follows: (1) It corrects acidity. Most plants prefer slightly alkaline soils, but the exact preference of the apple is not known. (2) It liberates other nutrients. The liberation should not be too fast, however, or losses may occur by leaching. This "whip" action has sometimes been considered the only function of lime.

¹ The Rothamsted Experimental Station, Harpenden, England.

(3) It tends to preserve nitrogen. (4) It flocculates heavy soils. (5) It has some fungicidal and insecticidal value. It is often effective against snails. (6) It corrects the toxic action of magnesium and also of many other bases when they become present in injurious amounts.

This sixth function of lime may frequently be an important one, and opens up a question that has not received the attention it deserves in connection with crop fertilization in general. This question



FIG. 46. Manure *versus* nothing

Row on left, receiving stable manure, third year, produced 373.8 bushels per acre. Row on right, receiving nothing, produced 27.9 bushels per acre. Variety, York Imperial. (After Pennsylvania State College)

is that of the toxicity of the salts of various bases, especially those of the heavy metals, when present alone in solution or when distinctly predominating in solutions otherwise weak. Related to this is the fact that the observed toxicity of these salts may often be reduced or entirely neutralized by the addition of other bases. This was first discovered in connection with magnesium and calcium about 1883, but it has since been found true of salts of various bases or metals, such as sodium, potassium, strontium, barium, iron, manganese, nickel, cobalt, silver, mercury and the NH_4 radical in ammonium compounds. The toxic action of these salts has been

found to exist above certain concentrations, often in a very marked degree, and the neutralizing power of other bases, especially lime, has been shown always to follow their addition. The strong toxic action of copper salts in solution has long been known and utilized in spray materials. The neutralizing action of lime additions in these cases also is significant and may be similar to its action in nutrient solutions.

As in the case of magnesia, the relation of lime applications to maturity in plants and to the fertilization of orchard fruits is apparently not definitely known.

Magnesium. This element is required in the development of all plant parts, but is considered especially important in the formation of seeds and proteins. Its distribution and importance is apparently similar to that of potassium. It can perform its proper function, however, only in the presence of calcium salts, since, with the exception of very few plants, it is strongly toxic in all other cases.

The action of magnesium is indirect; that is, it does not enter directly into the composition of plant parts or tissues, but apparently serves only as a carrier of the phosphorus needed in their formation. This theory is strengthened by the fact of the relatively easy decomposition of the secondary magnesium phosphate into territory and free phosphoric acid, a dissociation which would naturally immediately precede assimilation. Magnesia is found always to increase when rapid development is taking place, and comparatively little of it will serve for extended physiological operations, a fact which serves to corroborate the theory just stated.

In leaves and wood the magnesia content is always noticeably lower than the lime content, while the reverse is true of seeds and fruits (see tables, p. 100). Magnesium also migrates strongly to the growing parts, in general "following the proteids, like the phosphates." Its exact relation to fruit development is not known, though the results of the experiment in Massachusetts suggest its possible value in this connection. The relatively high amount present in fruits, as well as its apparent relation to phosphatic compounds, is also suggestive. It seems that nothing is known concerning its relation to the hastening or retarding of maturity in crops.

Iron. Very little is known of the part that iron plays in plant metabolism, although it is required in small amounts by all plants. It was formerly thought to be a constituent of chlorophyll, but this was shown by Molisch¹ not to be true. Its presence is, however, still considered indispensable to the formation of chlorophyll, its action apparently being one of conditioning the nature of protoplasmic activity. A small portion of the iron in plants is apparently held in the form of organic compounds, possibly entering into the structure of the chloroplastids.

As a fertilizer, Ville² reports that a spray of 2-per-cent solution of iron sulphate upon young apples and pears hastened the ripening and enlarged the fruits. To the writer this seems rather fanciful, though a serious attempt has been made to explain it on the ground of stimulation of the protoplasm and increased production of chloroplasts in the epidermis.

The value of iron applications to the soil in increasing the color of fruit, especially of apples, has been the subject of considerable discussion and some experimenting among horticulturists. The amount of iron in the annual draft of apple trees (as shown in the table on page 101) is worthy of note. But this mineral is probably always available in required amounts in any agricultural soil, so that additional applications could scarcely be expected to have any marked direct influence.

What to use. It is impossible to give definite advice in regard to the best fertilizers for all kinds of soils. The poorer soils need a greater amount than the more productive soils of all the ingredients mentioned, but especially of nitrogen. Requirements, however, will vary with the variety of apple grown or some other factor. Voorhees³ recommends a basic formula of equal parts of muriate of potash, acid phosphate, and fine ground bone, with the addition of nitrogen in the form of either barnyard manure or nitrate fertilizers, or secured through leguminous cover crops.

Professor Sears⁴ recommends a fertilizer consisting of 1 ounce of nitrate of soda, $\frac{3}{8}$ pound of high-grade sulphate of potash,

¹ Hans Molisch, scientist, Zeltgasse 2, Wien, Austria.

² Georges Ville, scientist and author, Le Grand Billbarteault, France (1876).

³ E. B. Voorhees, ex-director of New Jersey Agricultural Experiment Station.

⁴ F. B. Sears, pomologist, Massachusetts Agricultural College.

and $\frac{5}{8}$ pound of basic slag or acid phosphate per tree, to be applied each year during the first few years of a tree's life. For a bearing orchard he would use 500 pounds of basic slag or acid phosphate and 300 pounds of high-grade sulphate of potash per acre. Hale,¹ the peach king, uses for bearing orchards 1000 pounds of bone and 400 pounds of muriate of potash.

The mixture of bone and potash is a common one among fruit growers, although the proportions given by different growers may vary. Van Slyke² recommends the following formula :

Cottonseed meal	100 lb.
Raw ground bone	100 lb.
Acid phosphate	100 lb.
Muriate of potash	100 lb.

In the western part of New York, especially in the neighborhood of Buffalo and in the Oswego region, orchardists are making heavy applications of barnyard manure, — from 10 to 25 tons per acre, and in some cases more, — and claim that excellent results are secured.

Stewart,³ after years of study and experimenting, recommends a very good formula.

A GENERAL FERTILIZER FOR APPLE ORCHARDS
(AMOUNTS PER ACRE FOR BEARING TREES)

NITROGEN 30 POUNDS (N)	PHOSPHORIC ACID 50 POUNDS (P_2O_5)	POTASH 25 TO 50 POUNDS (K_2O)
Carried in 100 lb. nitrate and 150 lb. dried blood or in 150 lb. ammonium sulphate	Carried in 350 lb. acid phosphate or in 200 lb. bone meal or in 300 lb. basic slag	Carried in 50 to 100 lb. muriate or in 100 to 200 lb. of low- grade sulphate

This table means that a fertilizer carrying about 30 pounds of actual nitrogen, 50 pounds of actual phosphoric acid (P_2O_5), and

¹ J. H. Hale, prominent orchardist, Glastonbury, Connecticut.

² L. L. Van Slyke, chemist, New York Agricultural Experiment Station, Geneva.

³ J. P. Stewart, horticulturist, Pennsylvania State Experiment Station, State College.

from 25 to 50 pounds of actual potash (K_2O) should be applied on each acre of bearing trees. Where potash is not known to be lacking in the soil, the smaller amount may be used, and after a little testing it may even be found wise to omit it altogether. With the smaller amount of potash the essentials of the present combination are carried in 500 pounds of a 6-10-5 fertilizer or its equivalent. In the ordinary ready-mixed fertilizers the nitrogen is likely to be carried in ammonium sulphate, with which some liming may be necessary if many applications are made, and especially if leguminous cover crops or permanent covers are to be grown. In either special or homemade mixtures the various elements may be carried in any of the materials indicated in the table.

Time and method of application.¹ The time of application of the fertilizer we believe to be of distinct importance, especially in the case of nitrates. While our evidence on this point is by no means complete, we have found indications that nitrates can be applied too early in the season and thus be wholly lost to the trees. There is also evidence to support the theory that distinct harm may result from their application about fruit-setting time — especially in the case of the peach tree. We feel, therefore, that the nitrates should be applied not earlier than petal-fall in apples and probably not later than the middle of July. In general, about the middle of this period should be all right, though some of our most striking results have come from applications made as late as July 8.

In the case of the mineral ingredients, with their lower solubility and slower action, the time of application is less important. Some careful orchardists engaged in commercial work apply phosphates and potash to their peach orchards in the fall, and believe that this gives best results. Thus far, however, we have felt that the time of application for the minerals is of relatively little importance, since they are quickly fixed in the soil in any case, and do not leach readily. We therefore apply them with the nitrogen at the time considered best for the latter. Manure also can be applied at almost any time, except possibly late summer or the fall, without danger of loss or other ill effects. Attention should be given to chapter on manure.

¹ From the report of experiments conducted by J. P. Stewart, horticulturist, Pennsylvania State College.

The method of fertilizing that I have used for several years and recommend is as follows :

- | | | |
|--|---|---|
| First year $\frac{1}{2}$ cup per tree of formula | } | 100 lb. nitrate of soda,
200 lb. acid phosphate,
200 lb. muriate of potash. |
| Second year 1 cup per tree of formula | | |
| Third year 2 to 3 cups per tree of formula | | |
| Fourth year 3 to 5 cups per tree of formula | | |
| Fifth year 3 to 5 cups per tree of formula | | |
| Sixth year 8 to 10 tons manure per acre. | | |
| Seventh year 300 lb. bone meal, 200 lb. muriate of potash per acre. | | |
| Eighth year 25 bu. lime, 300 lb. bone meal, 200 lb. muriate of potash per acre. | | |
| Ninth year 300 lb. bone meal. | | |
| Tenth year 8 to 10 tons manure per acre. | | |
| Eleventh year 200 lb. bone meal, 100 lb. acid phosphate, 200 lb. muriate of potash per acre. | | |
| Twelfth year 200 lb. bone meal, 100 lb. acid phosphate, 200 lb. muriate of potash per acre. | | |
| Thirteenth year same as eighth. | | |
| Fourteenth year same as ninth. | | |
| Fifteenth year same as tenth. | | |
| Sixteenth year same as eleventh. | | |
| Seventeenth year same as twelfth. | | |
| Eighteenth year same as eighth, and so on. | | |

Since other formulas have been used with satisfactory results by orchardists in different parts of the country, it is evident that each person must determine for himself the requirements of his own orchard.

The actual needs of an orchard. If one really wishes to answer the question of how to fertilize his orchard, he can do so by following a simple test plan. One such plan of considerable merit is given by Stewart. A typical part of the orchard should be selected for the experiment, and should include not less than five average trees of the same variety and age for each plot. All the trees should be labeled and carefully measured at a fixed point on the trunk, and definite records of their growth and yields kept for at least three years. Often a good indication of the orchard's needs can be obtained in less than three years, but the experiment should cover this amount of time at least, and more if necessary.

The same time and methods of application and other precautions should be followed as previously described. The materials

are indicated here in amounts per bearing tree instead of per acre, and a corresponding reduction should be made for younger trees ; in other words, if only a third of the ground is to be covered, then only about a third of these amounts should be used.

The plan. For mature trees in bearing :

Plot 1. Check, untreated.

Plot 2. Nitrate, $2\frac{1}{2}$ lb. ; dried blood, $3\frac{1}{2}$ lb. ; acid phosphate, 10 lb.

Plot 3. Nitrate, $2\frac{1}{2}$ lb. ; dried blood, $3\frac{1}{2}$ lb. ; potash, 2 lb.

Plot 4. Acid phosphate, 10 lb. ; potash, 2 lb.

Plot 5. Check, untreated.

Plot 6. Nitrate, $2\frac{1}{2}$ lb. ; dried blood, $3\frac{1}{2}$ lb. ; acid phosphate, 10 lb. ; potash, 2 lb.

Plot 7. Same as No. 6 plus lime, 12 to 25 lb.

Plot 8. Manure, 400 lb.

Plot 9. Check, untreated.

An observance of the general precautions given above, together with the exercise of proper judgment on the part of the grower, is sufficient to carry this plan to a successful conclusion within a few years and definitely settle the fertilizer needs of any ordinary orchard. It should be remembered, however, that an orchard may not show the need of a fertilizer when young, but may develop this need later, especially when heavy bearing is reached. This means that cases which appear negative at one time may often need further tests and observations later.

Method of application. The best and most general method of applying the fertilizer seems to be to scatter it broadcast over the surface of the ground, taking care not to get it too close to the tree trunks, where there are few absorbent roots, and extending the applications well out beyond the spread of the branches. To conform closely to the distribution of the feeding roots, the rate of application should be heaviest in the central part of this area ; that is, under the outer two thirds of the spread of the branches.

The fertilizer may either be left on the surface, to be washed in by the rains, or be harrowed or lightly plowed into the soil. Sometimes the fertilizer is distributed with a grain drill or fertilizer distributor, but it is more often applied by hand, in the manner of some grains, from a pail held in the crook of the arm. The more convenient method of application should be used by the orchardist.

It should be remembered, however, that the fertilizer applied in any given season cannot affect materially the yield of that year, since the fruit buds are formed in the latter part of the preceding season. Important results should not be expected before the following season at the earliest, and may not be evident until considerably later.

Trees that have been neglected are apt to show results much quicker than those in thrifty condition. Probably the reason will be found in the limitedness of their previously available food supply, and in the sudden release from their state of starvation.

CHAPTER XIII

CULTIVATION

Statistics from the different parts of the country and surveys of the orchards throughout all the apple-growing regions show clearly that it is the clean-culture method of apple growing that predominates. Perhaps the reasons for this may be understood better after a study of the objects of cultivation.

Objects of cultivation. *Cultivation conserves moisture.* Undoubtedly the most important single function of cultivation is that of conserving the moisture of the soil. Let rain fall and the sun shine, and the soil forms a crust which allows the evaporation of moisture, thereby robbing the soil storehouse of its great treasure. It can be easily understood how this moisture is lost when the soil is likened to a collection of very small tubes, all ending at the surface of the soil, each tube containing water that is continually being brought up to the surface to replace that which is taken away by evaporation, either by the sun's rays or by the movement of the air. As soon as some tool breaks up the ends of these tubes, the movement of water almost ceases because of the soil blanket, which has been effectively placed between the evaporating medium and the tube ends.

Moisture is lost not only from the crust formed on the soil after a rain but also from the cracks or fissures which are often found in the soil and which increase the exposed surface. An orchard in such a condition is in need of serious attention.

Since all the mineral elements are taken from the soil in a liquid condition, lack of sufficient moisture in the soil prevents the plants from securing food through their roots. Therefore, no matter how rich the soil is in the necessary plant-food elements, — potash, phosphorus, iron, etc., and even the evasive nitrogen, — they are of no value to the plant unless sufficient moisture is at the same time available in the soil.

The orchardist who wishes to conserve the maximum amount of soil water must cultivate, and cultivate thoroughly.

Cultivation promotes drainage. Compare two fields during a rain, one well prepared and cultivated, the other in need of culture. The latter, because its soil is hard and not in good physical condition, absorbs very little of the rain, and soon a stream of surface water is flowing from the field and is lost to it forever. In contrast to this the soil of the well-cultivated field, being in a loose,



FIG. 47. A fine young orchard, well cultivated. (Bowker Fertilizer Company)

more or less porous condition, acts like a sponge and seems to be ever hungry for more water. It is only in the heaviest rains, such as cloud-bursts or long-continued downpours, that the cultivated field ever suffers loss of water. The water is largely retained and stored in the soil by proper cultivation following the rain, thus furnishing abundant moisture for the future development of the tree. Where the soil is underdrained the water passes slowly down to the drains and the excess is removed through this medium.

Surface-water loss means not only water loss, but soil, manure, fertilizer, and humus loss, all of which are required for tree and

fruit development. The farm must indeed be rich that can stand this drain upon its plant-making substance. Moral: *Cultivate and save.*

Cultivation releases plant food in the soil. The action involved in frequent cultivation is a grinding and turning of the soil particles. By this process portions of fertilizers so near the surface that they are not available to the tree roots are turned under and placed in a more suitable position, perhaps being dissolved by water or acted



FIG. 48. A fine old orchard

Modern practices were used in this orchard, located in Albion, in the midst of the apple region of western New York

upon by the root acids or broken down in some other way so that they may be absorbed.

Soil that has lain dormant for years is sometimes plowed up and fined by frequent cultivations, which exposes the particles of the newer soil to the action of air, root acids, bacterial life, and other agencies, thus finally making available the food elements and thereby increasing the total available food supply of the soil.

Cultivation improves the physical condition of the soil. The principal work of improving the physical condition of the soil by cultivation is in reducing the size of the larger lumps of earth, thus making the soil more porous and increasing the amount of air that can be admitted into it and also the amount of storage

space for water. The result generally is an increase in the other actions in the soil, such as bacterial action, liberation of plant food, and the like. If, in addition, coarse material, like manure and straw or cover crops, is plowed under, thorough incorporation of this material into the soil by means of cultivation will decidedly improve the physical condition of the land.

Cultivation kills weeds. From recent experiments carried on by the government it has been ascertained that destruction of the weeds in the neighborhood of cultivated plants is of the utmost



FIG. 49. Preparing facilities for conservation of moisture
A fine piece of soil mulch-work in a Western orchard. (Oregon Agricultural Experiment Station)

importance; in fact, in many cases it is the only requirement for a full crop that compares in importance with the thorough cultivation of crops. Since plants which we call weeds are robbers of the moisture and food of the soil and of sunlight, we can readily see that their elimination must be beneficial.

The clean culture necessary to conserve the soil moisture or to free plant food would quickly eradicate the weeds without added expense or labor.

Cultivation improves environment. All of the above objects may be summed up in one — improvement of the environmental

condition of the tree. As proper environment is the prime essential of cultivated plants, it seems justifiable to state that "cultivation is one of the fundamental conditions for successful and profitable production of apples."

Tools for cultivation. Several types of tools used in cultivation are so common that definite mention can be made of them, although particular advice for a particular location is impossible.

Plows. *Landside plows.* The common landside plow is perhaps more generally used than any other. With this the soil may one

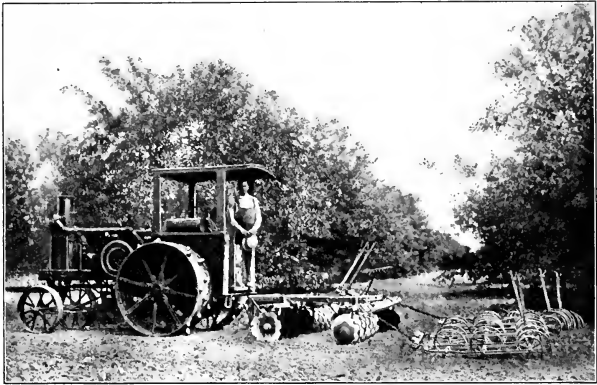


FIG. 50. Practical Western orchard cultivation

A tractor drawing double-action cutaway disk harrow and spring-tooth harrow—a quick, cheap, practical way to fit or cultivate an orchard

year be turned toward the tree rows and close to them with a dead furrow halfway between, and the next year be turned away from the trees by the backfurrow method; that is, by throwing the furrows together where the dead furrow was left the year before, which will leave dead furrows near the rows of trees. This method may be followed year after year. However, if the lay of the land permits, it may be better to plow east and west for two years and change to north and south for the following two years, then east and west again, and so on. By following this method the land will be kept even, or "true."

Sulky plows. Sulky plows — walking, riding, landside, and reversible — are being used wherever orchard conditions permit. They may be used in the method of plowing just described, or in plowing toward one row of trees and leaving a dead furrow at the next row, which is on the other side of the cultivated strip, the next year reversing the plowing.

Gang plows. Gang plows have been used in many large orchards to economize time. The size varies from 2 to 6 or more



FIG. 51. A good type of orchard tractor harrowing

plows to each gang, the increase in size being due to the introduction of tractors as the propelling power. Generally these gangs are used between the rows of trees, the furrows being turned in one direction, thus leaving a furrow toward the row of trees at the left and a dead furrow toward the row of trees at the right, or vice versa. The advantages of the tractor-gang plowing are a saving of time, more uniform work, and less expense.

A few orchardists have used the disk plow and found that where the land is fairly free from stone it is very satisfactory. These plows may be used in any of the methods of plowing given above, their great advantage being that they leave the turned soil in a more broken condition, thereby aiding the work of fining.

Harrows. *Disk harrows.* Disk harrows of various shapes and makes are getting to be much used as coarse harrows to follow plowing. In the plain disk harrow the disks are concave, their diameter varying, in different machines, from 12 to 16 inches. Each machine has a lever by which the angle of the disk with the line of draft may be increased or lessened as desired.

Cutaway disk harrows. Cutaway disk harrows are similar to those just described, but have the edges of each disk notched or

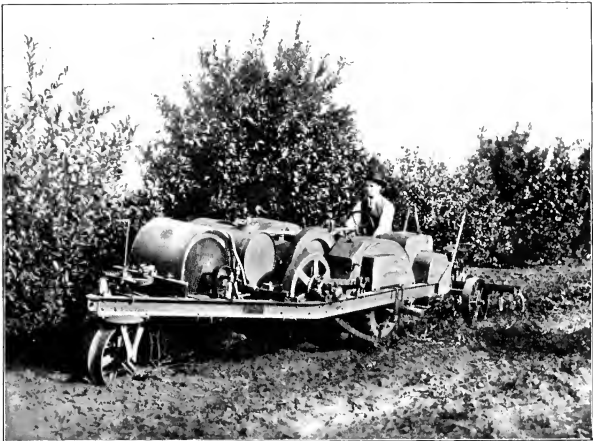


FIG. 52. Another good orchard tractor

In the larger orchards tractors are demonstrating their great practicability

cut in or cut away. This notching makes it possible for the disks to penetrate deeper into the soil and to do more real grinding than the plain disks.

Spading disk harrows. The spading disk harrow is a machine having disks so deeply cut in that they resemble blades. The working of this machine has proved satisfactory, especially on smooth, practically stone-free land.

All of these machines are built both in single action (that is, having one row of disks across the machine divided into two

gangs of half the disks) and in double action (having two rows of disks in four gangs). In the latter case the action and work of each machine is just doubled.

Spring-tooth harrows. On very rocky land no tool can equal the spring-tooth harrow for effectiveness. This harrow is also used on other kinds of soil, and often where another tool would give better results. It is much used in certain sections of the country, particularly in the northeastern states. Its action is of the drag or smoothing type, but by means of its springs the teeth, when they catch onto stones or stumps, are sprung back to place without any loss of efficiency.

Sulky harrows. Sulky harrows of the spring-tooth type and the more or less ridged type are used in many orchards and are quite satisfactory under certain conditions. It seems to the writer, however, that in general other tools would prove better.

Smoothing harrows. Smoothing harrows are of various types. The ordinary spike-tooth harrow offers many advantages to the orchardist, principally in the fact that its widespreading range permits of harrowing considerable land in a short time. Another advantage is its double character of grinder and smoother. On each machine there should be a lever or some other arrangement whereby the slant of the teeth can be regulated, for often the teeth should be set back so that only shallow surface tillage will be given, while at other times the teeth should be straight, so as to cut deeply into the soil.

Acme harrows. The Acme harrow is another of the harrows which smooth and grind the soil that has met with general approval by those who have used it. The machine is 6 or 8 feet wide and consists of a gang of blades turned something like the mold-board of a plow. The grinding is regulated to different depths and consists of turning the soil somewhat as the plow turns a furrow. This harrow can cover a large amount of surface in a day, and can be run quite close to the trees, thus saving hand labor.

The Kimball cultivator. The Kimball cultivator is another smoothing harrow that has met with approval, especially in the West. It is made in nine sizes—from the 4½-foot size for the small farm to the 17-foot size for the larger fields. The frame of the machine is of fir, the ends being provided with fenders, which

prevent the knives from striking the trees and allow much closer work around them. The blades are concaved on the upper side and straight on the lower, and have a peculiar turn which is of advantage to the working of the machine. In using the cultivator the driver stands in the center of the draftboard over the knives, and guides it by stepping to the left or the right, as the occasion requires. If anything adheres to or gathers on the knives, the driver steps forward on the draftboard and tilts the handle forward, thus raising the knives and freeing them of litter.

Other harrows are being used in various sections with success. In some places one-horse cultivators are used in cooperation with the harrows, especially near the trees. These cultivators are so well known that it is not necessary to mention them in detail.

Method and time of cultivation. As a rule the same general system of cultivation is followed throughout the country. Plowing usually takes place early in the spring, the orchardist waiting only

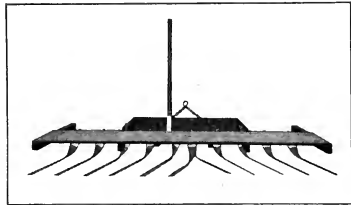


FIG. 53. The Kimball cultivator

A machine broad enough to work up close to the trees without bringing the horses into the zone where injury to limbs may result

until his soil is in condition. After the plowing, some of the coarser-working harrows are used, such as the disk or the spring-tooth. If good work is to be done, these machines are lapped half their width each time they are drawn across the plot. Sometimes the harrows are drawn first in the direction of the furrows, and then across the furrows. The smoothing type of harrow follows quickly, and the soil is further fined and a mulch of loose earth established. This mulch is maintained, until the cover crop is sown in August, by frequent cultivations, especially following each rain, and if no rain occurs, once in ten days or two weeks.

The young orchard. Cultivation in the young orchard may be different from that among the older trees. Plow deeply and near the young trees, in order to force the roots to go deeper. Cultivate close to the trees so as to prevent weed robbery. Sometimes

only 3 feet each side of the tree is given the young trees for growth the first year, the remainder of the land being devoted to some other crop. The second and following years, however, the space given them is increased until finally all the land between the trees is clean cultivated, which means a thorough cultivation of the entire orchard. This policy of allowing ample space for the growth of the trees will result in a thrifty development of each.

The older trees. As the trees increase in age and size the method of culture may change somewhat, but the principle is the same. Generally there are fewer weeds to contend with, owing to the shading of the soil by the trees, and for the same reason a catch crop cannot be grown profitably. If the orchard has been started properly, plowing may be continued quite close to the tree. It has been noticed, however, that either the older trees have a tendency to produce roots nearer the surface or the older roots grow upward, making the close plowing and harrowing somewhat difficult. In the author's experience this lack of close cultivation has not injured the trees, for the near-by soil is not being used by the feeding roots so much as the soil farther away. However, plowing or disking should be given early in the spring, and a good soil mulch should be maintained, as stated previously.

CHAPTER XIV

SOD CULTURE *VERSUS* TILLAGE

Orchardists who advocate sod culture, sod mulch, and the like — terms used to denote that an orchard is "seeded down" — do not in all cases agree as to just what further conditions should obtain. Some claim that the sod in the orchard should be of the old pasture type, with little or no annual growth, while others advocate a heavy growth of grass, all claiming that the grass should be cut and allowed to lie where it falls. Others want the cut grass raked up and piled under the spread of the branches. Still others advocate that some material such as coarse manure, straw, cornstalks, etc. be added to the cut grass. Some would like to have the sod used for pasturage — one approving of sheep in the orchard, another of cows and perhaps hogs. It is therefore difficult to decide upon one system of sod culture that will please all.

There are certain conditions under which any form of sod culture may succeed. In England and other countries where abundance of moisture in the form of rain is available, any system would undoubtedly prove successful, and in New England and some other parts of North America where the rainfall is large, some form of the system might prove satisfactory. However, in all sections there are doubtless some locations which would give more satisfaction than others. Then, too, the variety of the tree grown or the modification of the system used may make the difference between profit and loss.

It is gratifying to know that experiments in the comparison of the sod method and the modern clean-culture method are being carried on under the direction of some of the state experiment stations. Ohio seems to have been the leader in this movement, one well-known grower in that state being highly successful in growing apples under the (sod or grass-mulch) system. New York also has furnished a noteworthy example of the successful working

of this system, and Pennsylvania has placed itself on record to the same effect. Other states may be working along the same lines, but they have not had such marked results. In practically all the apple-growing states varied sod conditions are to be found.

Relative merits of the two systems. A comparison of the relative merits of the two methods from the available data may be helpful.

The foliage of the trees under the different methods shows marked differences, the color of the leaves on the trees under sod cultivation being light and of a yellowish tinge, suggesting drought or some other lack in the soil, while the "tillage" trees have foliage of that dark, rich-green color which indicates an abundance of moisture and food. The leaves show a difference not only in color but also in size and number, the sodded trees having fewer leaves and of smaller size than the clean-culture trees.

In regard to the comparative growth of twig and stock, the evidence seems to be slightly in favor of the clean-culture method. However, under a heavy sod mulch, when conservation of moisture would be very great, the growth of twigs and the increase in the size of the leaves might compare favorably with the results under clean-culture conditions.

The sod system seems to gain favor as regards certain important facts concerning the fruit. Young orchards grown under this method have a tendency to come into bearing much earlier than those grown under the clean-culture method. This is a decided advantage, especially when trees have been purchased that may not be exactly true to name. By reason of their early bearing, if the variety is undesirable the orchardist may be able to graft it over into some more valuable kind, thereby reducing his possible loss to a minimum.

The action of the grass in pumping the water out of the soil has a tendency to cause the fruit on the sodded trees to mature earlier, the difference sometimes being from seven to twenty or more days in favor of the trees under sod culture. The color of the fruit from the sodded trees is also generally better. Often this increased color adds materially to the profits from the sale of the fruit, especially in the markets where high-class dessert apples are wanted.

There seems to be little difference between the keeping qualities of the fruit in cold storage, but in common storage the difference is in favor of the sod-grown fruit.

By actual count, the size of the apples shows some difference, in most cases about a hundred more apples of the sod-grown variety than of the cultivated fruit being required to fill a barrel. The same difference was found where the apples were graded.

The wood on both young and old trees grown under the clean-culture method seems in better condition, of better color, and plumper than that on the sod-grown trees.

The experience of many orchardists interested in both methods seems to indicate that the most important factor is the conservation of moisture. Under clean culture with cover crops probably the maximum amount is saved. Under poor sod management most of the moisture is undoubtedly lost, but with good management and plenty of mulch material the loss of moisture may be lessened. It would be impossible, however, to stop the loss of water occasioned by the transpiration of grass. Moreover, in many cases so much water is necessary to promote the growth of grass that the amount remaining in the soil available to the tree is not great enough for the production of wood, leaves, blossoms, and fruit.

Experimental evidence. A summary of an experiment by the Geneva Experiment Station, New York, on a comparison of the tillage and sod mulch in an apple orchard is very interesting. This experiment was begun in 1903 in the orchard of Mr. W. D. Auchter, near Rochester, New York. In this orchard are $9\frac{1}{2}$ acres of Baldwin trees, 40 feet apart each way, set in 1877. Of these, 118 are in sod, 121 under tillage.

The Auchter orchard was chosen for this experiment because it was uniform in soil and topography and quite typical of the apple lands of western New York. The land is slightly rolling and is a fertile Dunkirk loam, about 10 inches in depth, underlaid by a sandy subsoil.

The tilled land was plowed each spring and cultivated from four to seven times. The grass in the sod plat was usually cut once, sometimes twice. In all other operations the care was identical.

The experiment is divided into two five-year periods. During the first period the orchard was divided in halves by a north-and-south line, during the second period by an east-and-west line. One quarter of the orchard, then, has been tilled ten years; another tilled five years and then left in sod five years; the third quarter has been in sod ten years; and the fourth quarter in sod five years, then tilled five years.

The following is a statement of results:

The average yield on the plat left in sod for ten years was 69.16 barrels per acre; on the plat tilled ten years, 116.8 barrels — difference in favor of tilled plats, 47.64 barrels per acre per year.

The fruit from the sod-mulch plats is more highly colored than that from the tilled land and matures from one to three weeks earlier than the tilled fruit.

The tilled fruit keeps from two to four weeks longer than the sodded fruit; it is also better in quality, being crisper, juicier, and of better flavor.

The average gain in diameter of the trunks for the trees in sod for the ten years was 2.39 inches; for the trees under tillage 3.90 inches — gain in favor of tillage, 1.51 inches.

The trees in sod lacked uniformity in every organ and function of which note could be taken. The uniformity of the trees under tillage in all particulars was in striking contrast.

The grass had a decided effect on the wood of the trees, there being many more dead branches on the sodded trees, and the new wood was not so plump or as bright in color.

The leaves of the tilled trees came out three or four days earlier and remained on the trees several days longer than on the sodded trees. They were a darker, richer green, indicating greater vigor, and were larger and more numerous than on the sodded trees.

The average cost per acre of growing and harvesting apples in sod was \$51.73; under tillage, \$83.48; difference in favor of sod, \$31.75. Subtracting these figures from the gross return leaves a balance of \$74.31 per acre for the sodded plats and of \$140.67 for the tilled plats — an increase of \$66.36 in favor of tillage. For every dollar taken from the sodded trees, after deducting growing and harvesting expenses, the tilled trees gave \$1.89. The results here given are quite convincing in favor of tilled orchards.

The effects of the change from sod to tillage were almost instantaneous. Tree and foliage were favorably affected before mid-summer of the first year; and the crop, while below the normal, consisted of apples as large in size as any in the orchard, the falling off in yield being due to poor setting.

The change for the worse was quite as remarkable and as immediate in the quarter of the orchard turned from tillage into sod; the average yield in this quarter was not half that of any one of the other three quarters.

The use of nitrate of soda in the sod plats greatly increased the vigor of the trees and was a paying investment, yet for the five-year period they bore out a trifle more than half as much as the tilled trees.

The very marked beneficial influence on the sodded trees of ground adjacent under tillage teaches that not only should apples not be grown in sod, but that for the best good of the trees there should be no sod near them.

Only in the amount of humus and nitrogen has the soil been appreciably changed by the two treatments. The quantities of humus and nitrogen in the plat tilled ten years are so much greater that it is safe to assume that the tillage and cover-crop treatment conserves these elements better than the sod-mulch treatment.

Grass militates against apples growing in sod in several ways which act together; for example:

1. Lowering the water supply.
2. Decreasing some elements in the food supply.
3. Reducing the amount of humus.
4. Lowering the temperature of the soil.
5. Diminishing the supply of air.
6. Affecting deleteriously the beneficial microflora.
7. Forming a toxic compound that affects the trees.

General statements are as follows:

Sod is less harmful in deep than in shallow soils.

There is nothing in this experiment to show that apples ever become adapted to grass.

Sod may occasionally be used in making more fruitful an orchard growing too luxuriantly.

Other fruits than the apple are probably harmed quite as much or more by sod.

The effects of grass occur regardless of variety, age of tree, or cultural treatment, and are felt whether the trees are on dwarf or standard stocks.

Because of their shallow root systems, dwarf trees are even more liable to injury from grass than standards.

Hogs, sheep, or cattle pastured on sodded orchards do not overcome the bad effects of the grass.

Owners of sodded orchards often do not discover the evil effects of the grass because they have no tilled trees with which to make comparisons.

It is only under highest tillage that apple trees succeed in nurseries, and all the evidence shows that they do not behave differently when transplanted.

Grass left as a mulch in an orchard is bad enough. Grass without the mulch is all but fatal, as it makes the trees sterile and paralyzes their growth. It is the chief cause of unprofitable orchards in New York.

The work of the Ohio Experiment Station in a comparison of different methods of culture as applied in the care of an apple orchard is also very interesting. They began the experiment in the spring of 1900, planting a block of 160 apple trees, eight rows of trees with twenty trees in each row. The trees were divided crosswise into four plots of forty trees each. Each individual plot is an exact duplicate of varieties and the order in which they stand. The soil upon which these trees are grown is quite uniform as to fertility and general character. The surface of the soil slopes gently toward the west, therefore affording good natural drainage. The plots are as follows :

No. 1 is a cover-crop plot, No. 2 a continuous clean-culture plot, No. 3 a sod-culture plot, No. 4 a sod-mulch or grass-mulch plot.

Plot No. 2, the continuous culture plot, after four seasons' trial, was abandoned as a practice not to be considered in connection with careful orchard culture, the reason being brought about by the erosion of tons of soil, exposing the roots of the trees in numerous places, breaking up the surface by yawning gulleys, and hindering the work of the team in passing through this orchard.

A summary of the remaining plots is found in the following five points :

1. The main root systems of apple trees under the different methods of culture were found to be at a surprisingly uniform depth, the greater portion of the roots, both large and minute, being removed with the upper six inches of soil.

2. The fibrous or feeding-root system of a tree under annual plowing and clean culture with cover crops practically renews itself annually, pushing up thousands of succulent, fibrous rootlets to the very surface of the soil, where they actually meet with the steel hoes or spikes of the cultivator or harrow, especially in seasons when moisture is abundant. Apparently but a small percentage of these rootlets penetrate the lower, more compact, colder soil, but they come to the surface soil in countless thousands of threadlike extensions to feed where warmth and air and moisture combine to provide the necessary conditions for root pasturage. As a matter of fact, these feeding rootlets are cleanly pruned away by the plowshare each succeeding year and without apparent injury to the trees or crops ; but they have succeeded in performing their function, and their places are occupied the succeeding season by a new generation.

3. The presence of a network or mass of fibrous rootlets upon the surface of the soil beneath a heavy mulch and in the heavier portions of the mulch itself is no indication whatever of the lack or absence of feeding rootlets in the upper soil ; and the partial or even total destruction of these surface feeders, which occurs during the hotter, drier months of summer and during the severe cold of winter, does not cause the trees to suffer in the least degree, as there was invariably found to be a wonderfully dense network of rootlets occupying not only the upper two inches of soil, but also the succeeding four inches of soil below that.

4. Inasmuch as the surface rootlets in or beneath a heavy mulch do not increase disproportionately to those beneath the surface soil, it becomes evident that the removal of the mulch, or even a change from heavy mulching to the clean-culture and cover-crop plan, would not be so disastrous as has been generally supposed.

5. Under the sod-mulch system of culture the trees have uniformly made a heavier, more vigorous growth than under any

other system of culture. This is no doubt due to the certainty and uniformity of the generous store of fertility right at hand—the concentration of an abundance of plant food where it is most available and the consequent presentation of conditions, beneath the mulch of vegetable matter, especially favorable to a healthy, unstinted, continuous nourishment of the trees.

General advice. The only good advice that can be given the orchardist is, "Learn for yourself." If the orchard is in sod, plow part of it up and keep a record of each part. If the orchard is under clean culture, seed some of it down and adopt the plan of cutting the grass and allowing it to remain where it falls. *Do not remove and sell the grass or hay. That is soil robbery.* It is practically impossible to produce good apples and good hay at the same time. Keep an honest record. Compare results for ten years, all the time watching similar experiments being carried on elsewhere and finding out the particulars in each case. If after a fair test one method is shown to be more profitable in all respects than the other, adopt that particular method.

CHAPTER XV

IRRIGATION AND DRAINAGE

In Western orchards the irrigation movement has made rapid progress, but the East has been very slow to adopt this practice — perhaps because the need there is not so great. However, some practical experiments along this line have recently been carried on in the Eastern states, and it is hoped that reports of these will be forthcoming later.

Water supplies for orchards.¹ Formerly most Western orchards were supplied with water through earthen ditches. These leaky, unsightly channels, by reason of their cheapness, would have been quite generally retained had it not been for the increasing value and scarcity of water. The average value of water for irrigation purposes has increased over 300 per cent since the census report of 1902, and in many localities there is even a great scarcity at certain times. These conditions have induced many water companies to prevent the heavy losses made in transmission, by substituting pipes for open ditches of earth or by making the ditches water-tight by an impervious lining.

The scarcity of water in natural streams has likewise induced orchardists to install pumping plants to raise water from underground sources. It was estimated that in 1909 twenty thousand of these plants were in operation in California alone. In other parts of the West reservoirs are being built to supplement the late-summer flow of streams which fail to provide enough water.

The few typical examples which follow will give the reader an idea of how orchards are supplied with water, and also of the customary manner of dividing land into tracts for irrigation and other purposes.

The Lewiston basin, western Idaho, is located where Clearwater River flows into Snake River, and varies from 700 to 1900 feet

¹ Adapted from *Farmers' Bulletin No. 404*, United States Department of Agriculture.

above sea level. A few years ago water was brought from neighboring creeks and stored here in a reservoir. The water required for orchard irrigation is conducted from this reservoir, under pressure, in two lines of redwood-stave pipes over the rolling hills which separate the reservoir from the orchard lands. Contour

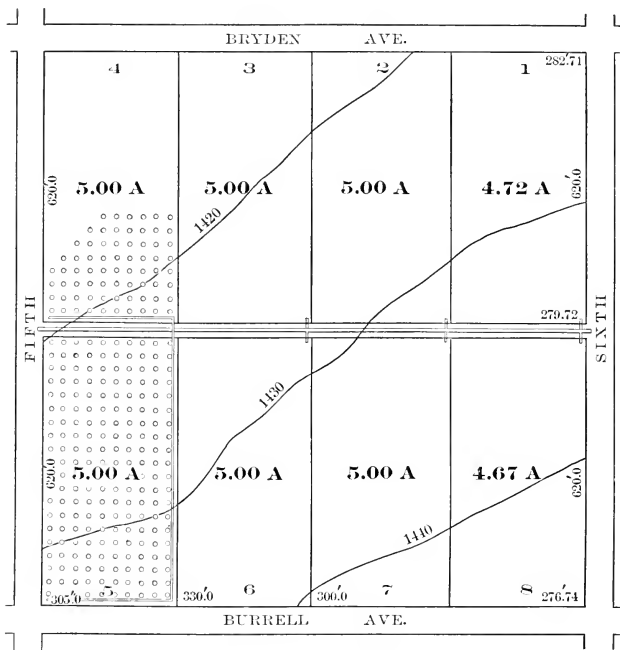


FIG. 54. Orchard tracts at Lewiston, Idaho

lines were established, and each section was divided into 40-acre tracts. These were further subdivided into eight 5-acre tracts, with a 20-foot alley through the center. The large conduits from the reservoir are connected with smaller lateral pipes laid in the alleys, and these in turn are tapped by 3-inch pipes, which furnish water to the 5-acre tracts.

The town of Corona, California, is hemmed in on all sides by lemon and orange orchards. The chief water supply for these groves comes from Perris basin, forty miles distant. The Temescal Water Company owns 3600 acres of water-bearing lands in this basin, and at favorable points pumping plants have been installed. These plants are operated by motors supplied with a current from a central generating station located at Ethanac. The discharge from each pump is measured over a rectangular weir having an automatic register. Small lined channels convey the water from the pumps to the main conduit, shown in cross section in Fig. 55. The concrete lining of this conduit, is composed of 1 part cement to 7 parts sand and gravel, and has a thickness on the sides of $2\frac{1}{2}$ inches and on the bottom of 3 to 4 inches. The lining is rendered still more impervious by the addition of a plaster coat $\frac{1}{4}$ inch in thickness, and composed of

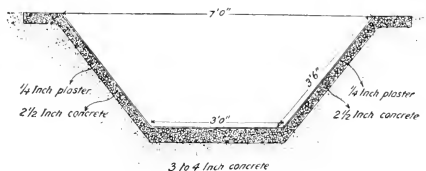


FIG. 55. Concrete-lined canal of the Temescal Water Company

1 part cement to 2 parts sand. The cost was $5\frac{1}{2}$ cents per square foot, or 55 cents per linear foot. The main conduit consists of about 30 miles of lined canal and 10 miles of piping 30 inches in diameter. As a rule the groves are laid out in 10-acre tracts, and piping of various kinds conveys the water from the main to the highest point of each tract, from which it is distributed between the rows in furrows.

A large part of the water used by the Riverside Water Company, California, is pumped from the gravelly bed of the Santa Ana River. From thence it is conveyed in a main canal to the orchard lands and distributed to the groves in cement and vitrified clay pipes. The owner of a tract, whether it be 10, 20, 30, or 40 acres in extent, receives his supply at the highest corner through a hydrant box. Each hydrant box not only allows the water to pass from the end of a lateral pipe to the head flume of the tract to be irrigated, but also measures the amount in miner's inches

under a 4-inch pressure head as it passes through. A section of the hydrant box, showing the adjustable steel slides to regulate the opening, is given in Fig. 56.

On the Gage Canal system in Riverside County, California, the water supply for the tiers of 40-acre tracts is taken from the canal in riveted steel pipes, which are from 6 to 10 inches in diameter. These larger mains are connected with 4-, 5-, and 6-inch lateral pipes of the same material, which convey the water to the highest point of each 10-acre tract. This general arrangement is shown in Fig. 57.

The ditches conducting water from gravity canals to orchard tracts do not differ from the supply ditches for other crops.

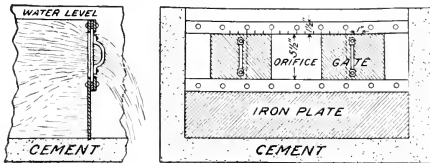


FIG. 56. Section of hydrant box, showing device of measuring miner's inches. (Riverside Water Company)

Location of the trees. In setting out any orchards which are to be irrigated, the elevation of the surface of the land ought first to be ascertained. This is usually done

by making a contour survey, which divides each tract by level lines into a number of curved strips or belts. With these lines as a guide the proper direction for the tree rows can readily be determined. Where the trees are watered in basins or checks, flat slopes are not so objectionable, but in furrow irrigation a slope of about 2 inches to 100 feet is necessary to insure an even distribution of water. When streams are to be run in the furrows, the slope of the furrows may be increased to 8 or 10 or even 12 inches to 100 feet. On slopes varying from 10 to 40 feet to the mile, therefore, the tree rows may be located, at the proper distance apart, down the steepest slope. Under such conditions the trees are commonly planted in squares.

Where the slope is so steep that difficulties are likely to be encountered in distributing water, the equilateral, hexagonal, or septuple method of planting (as it is variously termed) should be adopted. In this method the ground is divided into equilateral

triangles with a tree at each vertex, the trees forming hexagons and also groups of sevens if the center tree of each hexagon is included; hence the name "equilateral," "hexagonal," or "septuple." The chief advantage of this mode of planting is that it provides three and often four different directions in which furrows may be run. There are other advantages — the ground can be cultivated in different ways and about one seventh more trees can be planted to a given area than is possible in the square method.

In the past the trees of the irrigated orchards have been planted too close. This is clear even to the casual observer who may visit the deciduous orchards of the Santa Clara valley, California, or the apple orchards of the Hood

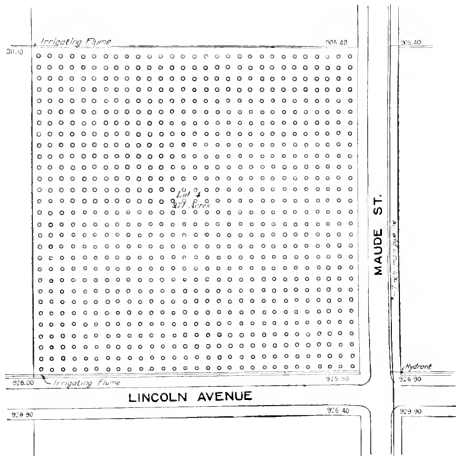


FIG. 57. Orchard tract under Gage Canal, Riverside, California

River district in Oregon. Under irrigation systems apple trees should be spaced from 30 to 36 feet apart. On the Pacific coast the tendency toward wide spacing has induced many growers to insert peach fillers between other slower-maturing trees, such as the apple. A common practice is to set the trees in 18-foot squares, peach trees alternating in every other row with the standard apple trees; the remaining rows consist of Winesap apple trees which are used as fillers. As the permanent trees grow and begin to crowd the fillers, the peach trees are removed. If more space is required, the Winesaps are taken out, leaving the apple trees in 36-foot squares.

METHODS OF IRRIGATION

Furrow irrigation. The usual method of irrigating orchards is by means of furrows, which vary in depth, length, and distance apart, but do not for this reason require different kinds of treatment. The division of this subject is due rather to the means employed in carrying water from the supply ditch to the furrows. In some cases the distribution is effected by making openings in an earthen ditch, in others by inserting wooden or iron spouts in the ditch



FIG. 58. Head-ditch constructor

The use of an A-scraper in building head ditches

banks, while in many others flumes having the desired number of openings, or pipes with standpipes, divide the supply among the furrows. These different means of transportation will be described under their respective headings.

Earthen head ditches. Permanent ditches at the head of orchard tracts should be located by a surveyor. The proper grade depends chiefly on the soil. If the soil is loose and easily eroded, a slight grade is best. On the other hand, the grade must be such that the velocity of the water will be sufficient to prevent the deposition of silt and the growth of water plants. In ordinary soils a grade

of $2\frac{1}{2}$ inches to 100 feet for a ditch carrying 2 cubic feet per second is not far out of the way. The amount of water to be carried varies from $\frac{1}{2}$ cubic foot to 2 or more cubic feet per second. A ditch having a bottom width of 24 inches, a depth of 6 inches, and sloping sides ought to carry $1\frac{1}{2}$ cubic feet per second on a grade of $\frac{1}{2}$ inch to the rod or 3 inches to 100 feet. Such a ditch may be built by first plowing four furrows, and then removing the loose earth with shovels or a narrow scraper or by throwing it up on the sides and top of the ditch by means of a homemade implement resembling a snowplow. Canvas dams, metal tappoons, or other similar devices are inserted in the head ditch to raise the surface of the water opposite the furrows. The chief difficulty in this method of irrigation is in securing an even distribution of water among a large number of furrows. A skilled irrigator may adjust the size and depth of the ditch-bank openings so as to get a fairly uniform flow in the furrows, but constant attention is required to maintain it. If the water is permitted to flow for a short time unattended, the distribution is likely to become unequal, with the result that parts of the ditch bank become soft, and, as the water rushes through, the earth is washed away, permitting larger discharges in some furrows but lowering the general level of the water so that other openings may have no discharge. Some orchardists of San Diego County, California, insert in niches cut in the bank, pieces of old grain sacks or tent cloth, over which the water flows without eroding the earth. Another device is to place in the ground, at the head of each furrow, boards pointed at the lower end and containing a narrow opening or slot through which the water passes. Shingles are also sometimes used to regulate the flow in the furrows.

Short tubes in head ditches. In recent years short tubes or spouts have been used in many of the head ditches of orchards to divert small quantities of water to the furrows. These tubes are usually made of wood, but pipes made of clay, black iron, galvanized iron, and tin are occasionally used.

For nurseries and young trees especially, but also for mature trees, a cheap and serviceable tube may be made from pine lath — the kind used for plastering. The 4-foot lengths are cut into two equal parts, and four of these pieces are nailed together to form a tube. One of these tubes, when placed with its center 2 inches below

the surface of the water in the head ditch, discharges nearly $\frac{3}{4}$ miner's inch of water, and if placed 4 inches below the surface will discharge more than 1 miner's inch. In southern Idaho the lumber mills manu-

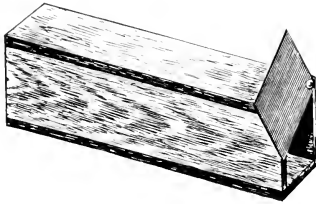


FIG. 59. Wooden box placed in tank of head ditch

facture a special lath $\frac{1}{2}$ inch thick, 2 inches wide, and 36 inches long for this purpose. If these tubes when thoroughly dry are dipped in hot asphalt, they will last much longer. In some of the deciduous orchards of California a still larger wooden tube or box is used. That shown in Fig. 59 is made of four pieces

of $\frac{3}{4} \times 3\frac{3}{4}$ inch redwood boards of the desired length. The flow through this tube is regulated by an inexpensive gate consisting of a piece of galvanized iron fastened by means of a leather washer and a wire nail.

The orchardist who lives near a manufacturing town or city can often purchase for a small sum pieces of worn out or discarded piping from $\frac{3}{4}$ inch to 2 inches in diameter. When such pipes are cut into suitable lengths they make a good substitute for wooden spouts.

Tin tubes $\frac{1}{2}$ inch in diameter and of the proper length are satisfactory. They are preferred in compact soil where the furrows must be near together.

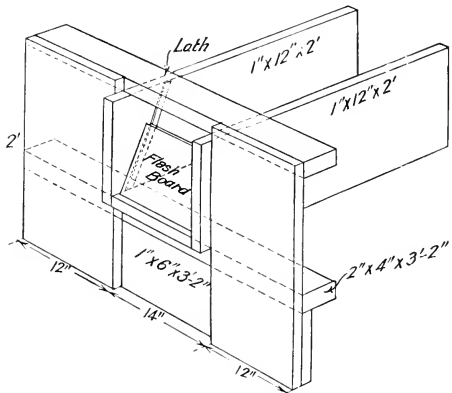


FIG. 60. Wooden check in head ditch

In making use of tubes of various kinds to distribute water to furrows, it is necessary to maintain a constant head in the supply ditch. This is done by inserting checks at regular intervals, which vary with the grade of the ditch, but the average spacing is about

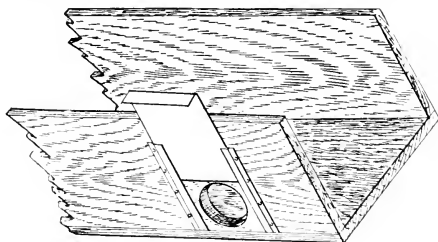


FIG. 61. Section of wooden head flume, showing opening and gate

150 feet. In temporary ditches the canvas dam is perhaps the best check, but in permanent ditches it pays to use wood or concrete. An effective wooden check is shown in Fig. 60. In this the opening

is controlled by a flashboard, which may be adjusted to hold the water at any desired height and at the same time permit the surplus to flow over the top to feed the next lower set of furrows.

Head flumes. Formerly head flumes for orchards were built of wood, but the steady increase in the price of lumber and the decrease in the price of Portland cement have induced many fruit-growers to use the latter. When built of wood, the length of the sections varies from 12 to 20 feet, 16 feet being the average. The bottom width runs from 6 to 12 inches, while the depth is usually between 1 inch and 2 inches less. Red-wood lumber $1\frac{1}{4}$ inches thick is per-

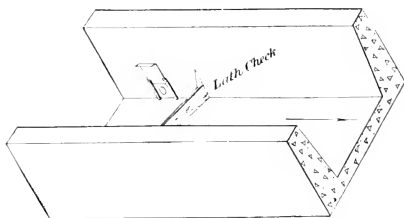


FIG. 62. The use of a low check in a head flume

haps the best for the bottom and sides, and joists of 2×4 inch pine or fir are commonly used for yokes, which are spaced with 4-foot centers. Midway between the yokes, auger holes are bored, and the flow through these openings is controlled in the manner

shown in Figs. 61 and 62. A 2-inch fall to every 100 feet may be regarded as a suitable grade for head flumes, but it often happens that the slope of the land is much greater than this, in which case low checks are placed in the bottom of the flume at each opening, as shown in Fig. 62.

A head flume composed of cement, sand, and gravel costs, as a rule, about twice as much as a wooden flume of the same capacity, but the early decay of wood, especially if it comes in contact with earth, makes the cement flume cheaper in the end. By means of a specially designed machine, which is patented, cement mortar composed of 1 part cement to about 6 parts coarse sand is fed into a hopper and forced by lever pressure into a set of guide plates of the form of the flume. Such flumes are made in place in one continuous line across the upper margin of the orchard tract. After the flume is built and before the mortar has become hard, small tubes from $\frac{3}{4}$ inch to $1\frac{1}{2}$ inches in diameter — the size depending somewhat on the size of the flume — are inserted in the side next to the orchard. The flow through these tubes is regulated by zinc slides, as shown in Fig. 62. Flumes of this kind are made in five sizes, the smallest being 6 inches on the bottom in the clear and the largest 14 inches.

At a slightly greater cost a stronger flume can be built by the use of molds. The increased strength is derived from a difference in the mixture. In the machine-made flume the mixture of 1 part cement to 5 or 6 parts sand is lacking in strength, for the reason that there is not enough cement to fill all the open spaces in the sand. In using molds medium-sized gravel is added to the sand, and the result is a mixture that resembles the common rich concrete. These flumes can be built of almost any size, from a bottom width of 10 inches to one of 40 inches and from a depth of 8 inches to one of 24 inches, but when the section is increased beyond about 240 square inches, it is better to slope the sides outward and adopt the form of the cement-lined ditch. At present the cost of rich concrete in place would be about \$9.00 per cubic yard for the larger flumes and \$10.50 for the smaller sizes. In ascertaining the quantity of concrete required in each linear foot of flume, it will be necessary to know exactly the size and thickness of the sides and bottom of the flume. In reality the amount depends on these factors.

For large head flumes and laterals many fruit growers first carefully prepare an earthen ditch which has carried water for at least one season and afterwards line the inner surface with cement concrete.

Several years ago 3200 linear feet of head ditches, 14 inches on the bottom with 18-inch sides and a 2-inch lining, were lined for \$26.50 per foot. The cement cost \$2.85 per barrel, gravel 75 cents per yard, and labor \$1.75 to \$2.50 per day.

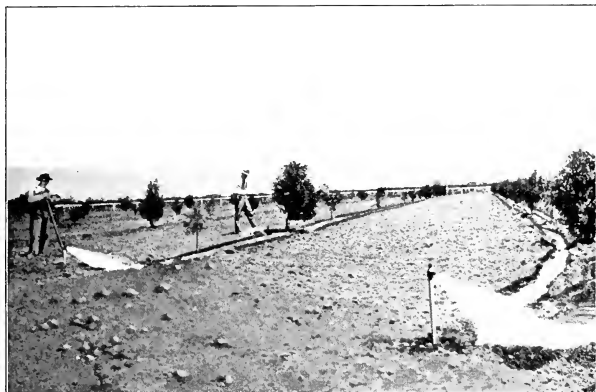


FIG. 63. Iron standpipe irrigations

Method of irrigating from iron standpipes connected with pressure pipes

Pipes and standpipes. Head flumes, being placed on the surface of the ground, interfere with the free passage of teams in cultivating, irrigating, and harvesting the crop, and dead leaves from shade and fruit trees often clog the small openings. These and other objectionable features have induced many fruit-growers of southern California to convey the water in underground pipes and distribute it through standpipes placed at the heads of the rows of trees. Both cement and clay pipes are used for this purpose. The former are usually molded in 2-foot lengths, with beveled lap joints, and consist of a mixture of 1 part cement to 3 or 4 parts fine gravel and sand. The most common sizes are 6, 8, 10, and 12 inches in

diameter. The thickness of shell in the 12-inch pipe is $1\frac{1}{2}$ inches, while that in the 6-inch pipe is a trifle more than 1 inch. Piping of this kind, when well made and carefully laid, will withstand a head of between 10 and 16 feet. The clay pipe is similar to that used in cities for sewers, and, having stronger joints, withstands a greater pressure ; but it costs more.

A line of pipe is laid, about 2 feet below the surface, from the feed main and measuring box across the head of the orchard, and

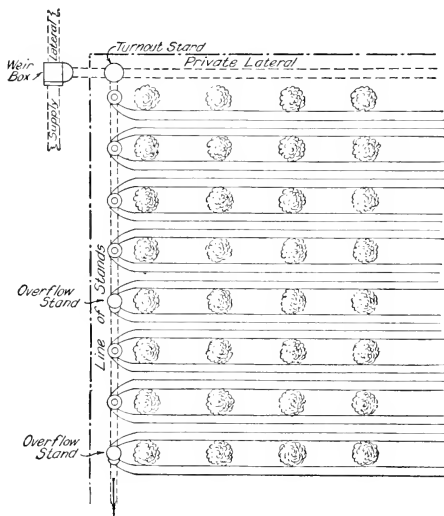


FIG. 64. The use of pipes in furrow irrigation

as each row of trees is passed a standpipe is inserted. The general plan is shown in outline in Fig. 64. Various devices are employed to convey the water from the pipe to the surface of the ground at the head of each tree row and divide it evenly among the furrows. One of the most common consists of a series of standpipes, the top of each set rising to the same elevation. At each change of elevation special standpipes are used, and in these are inserted gates provided with overflows. The manner of distributing the water from a standpipe to the furrows of any one row is shown in Fig. 65.

Occasionally a high-pressure pipe is substituted for that of cement and clay. This is tapped at the head and in line with each row of trees, and small galvanized-iron pipes are inserted. These standpipes are capped by an ordinary valve, which regulates

the flow of water to the surface of the ground at the head of each tree row and divide it evenly among the furrows. One of the most common consists of a series of standpipes, the top of each set rising to the same elevation.

the flow to each row of trees. This method is shown in operation in Fig. 63, where a young orchard is being irrigated from $\frac{3}{4}$ -inch galvanized-iron standpipes connected with a 3-inch wooden pipe.

Making furrows. The length of the furrow is often governed by the size of the orchard. The rows of citrus trees seldom exceed 40 rods in length, but, as a rule, the apple orchards of the Northwest are larger. Even in large tracts it is doubtful if it ever pays to run water in furrows that are more than 600 feet long. Where the soil is open and water is readily absorbed, short furrows should be used, otherwise much water is lost in deep percolation on the upper part of the tract. Professor H. Culbertson, San Diego, after a careful investigation of this subject, has reached the conclusion that on sandy or gravelly soil having a steep slope the proper length of furrow is 200 feet, while on heavier soils and flatter slopes the length may be increased to 600 feet.

The grade of the furrows varies with the locality. In flat valleys it is often impossible to obtain a fall greater than 1 inch in 100 feet, while on steep slopes the fall may reach 20 inches in 100 feet. On ordinary soils a grade of 3 or 4 inches is to be preferred, and where the fall exceeds from 8 to 10 inches in 100 feet the trees should be set out in such a way as to decrease the slope of the furrows.

The number of furrows in orchards depends on the age of the trees, the space between the rows, the depth of furrow, and the character of the soil. Nursery stock is irrigated by one or two furrows and young trees by two, three, or four. A common spacing for shallow furrows is $2\frac{1}{2}$ feet, while deeper furrows are made 3 or 4 feet apart. The general trend of orchard practice is toward deep rather than shallow furrows, a depth of 8 inches being common.

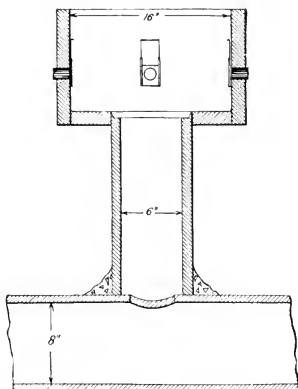


FIG. 65. Section of standpipe outlined in Fig. 64

The furrowing implement most commonly used by the orchardists of California consists of a sulky frame to which are attached two or three double moldboard plows. Those who prefer a small number of deep furrows use a 12- or 14-inch corn lister. In Fig. 66 is shown a furrowing machine made by attaching an arm to a cultivator and fastening two shovels to the arm. The space between the furrows is $4\frac{1}{2}$ feet and the depth is regulated by the lever arm of the cultivator.

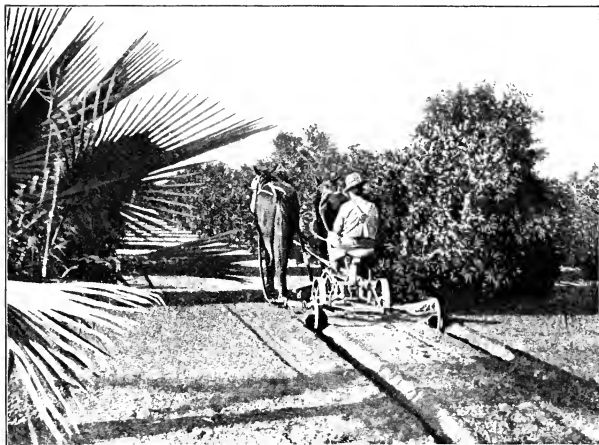


FIG. 66. Furrow-making

Making furrows in an orchard for the purpose of irrigating

Applying water to furrows. In Idaho 200 or more miner's inches of water are turned into the head ditch and conducted into the furrows by means of wooden spouts. On steep ground much smaller streams are used. The length of the furrow varies from 300 feet on steep slopes to 600 feet and more on flat slopes. The time required to moisten the soil depends on the length of the furrow and the nature of the soil. In this locality it varies from three to thirty-six hours.

An orchardist who owns 20 acres of bearing trees near the Sunnyside Canal in the Yakima valley, Washington, waters his

orchard four times each season with 14 miner's inches (.35 cubic foot per second). He makes three furrows, 40 rods long, between the rows. The total supply is applied to half the orchard (10 acres) at a time and is kept on for a period of forty-eight hours.

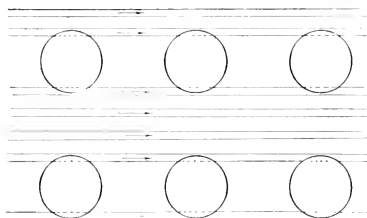


FIG. 67. Furrow irrigation, showing dry spaces

A man in Hood River, Oregon, irrigated 3 acres of apple trees in furrows 350 feet long, spaced 3 feet apart. About a miner's inch of water was turned into alternate furrows from a wooden head flume and kept on for about forty-eight hours. After the soil had become sufficiently dry, it was cultivated, and in eight or ten days the water was turned into the remaining rows.

For the most part the furrows are made parallel to the rows of trees. An arrangement of this kind is satisfactory in young orchards, but as the trees reach maturity their branches occupy more of the open space between the rows and prevent the making of furrows near the trees. This is shown in Fig. 67, where a space of from 6 to 12 feet square, according to the size of the trees, is not furrowed. This space usually becomes so dry that it is worthless as a feeding ground for roots. In order to moisten these dry spots a larger

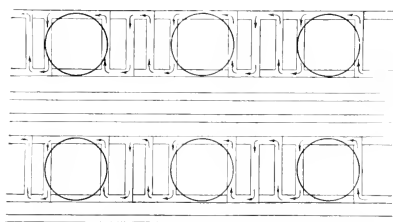


FIG. 68. Cross furrowing the dry spaces

¹ Formerly horticulturist in Montana Experiment Station.

stream is often carried in the two furrows next to each row of trees and the surplus led in short cross furrows to the other main furrows, as shown in Fig. 68. Sometimes, however, diagonal furrows are used to moisten these dry spaces. The latter method is best adapted to grades of 5 inches or more to every 100 feet.

One method of irrigation and its cost is as follows: The implement used to make furrows consists of three shovels attached to a beam mounted on a pair of low wheels. The driver sits on a riding seat and by operating a lever can regulate the depth of the furrows. A man and two horses will furrow out 10 acres a day. For a distance of 150 feet from the top of the orchard the furrows are made straight. They are then zigzagged to within 60 or 70 feet of the bottom, where the last three rows of trees are irrigated by basins which catch the surplus water. The depth of furrow is 6 inches, the length 800 feet, and the distance apart 3 feet. A head of 50 miner's inches (1 cubic foot per second) is used on 10 acres. The streams when first turned into the furrows average about 2 miner's inches, but as the water approaches the lower end they are reduced to 1 miner's inch or less, and this flow is continued between twelve and twenty-four hours. The items of cost for 10 acres are as follows:

Making furrows and basins	\$6.50
Irrigating	3.00
Fifty inches of water, 24 hours, at 40 cents an hour	9.60
Rent of water stock	12.00
Total	\$31.10

The basin method. In some orchards irrigation is carried on by means of ridges formed midway between the rows, at right angles to each other, thus dividing the tract into a large number of squares with a tree in the center of each.

When the ground is hard or covered with weeds a disk plow is run between the rows and the loosened earth is formed into ridges by a ridger. If the soil is light, sandy, and free from weeds the disking is not necessary. Ridgers are made in various ways of wood and steel or some combination of both. A common kind (as shown in Fig. 69) consists of two deep runners between 14 and 18 inches high, 2 inches thick, and from 6 to 8 feet long, shod

with steel, which extends part way up the inner side. The runners are 4 or 5 feet apart at the front end and from 16 to 24 inches at the rear, and are held in position by the crosspieces on top, by a floor, and by straps of steel. The height of the ridges varies with

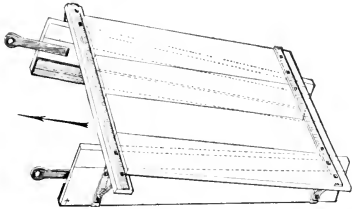


FIG. 69. Ridger used in basin irrigation

depth of water to be applied, from 4 to 9 inches; their elevation above the surface of the water when a basin is flooded should be several inches.

Several methods of flooding basins are practiced. In one a ditch is run from the supply ditch at the head through alternate row spaces, so that the basins on each side are flooded in pairs, beginning with the lowest. This plan is shown in outline in Fig. 70. In another method water is allowed to flow through openings into each basin of a tier in a zigzag course from the top to the bottom of the orchard, the upper basins receiving the most water. With gravity canals, where water is abundant, the water is turned into the upper basin until it is full and overflows into the next, and so on down the tier. The irrigator then begins at the lower end and repairs the breaks, leaving each basin full of water.

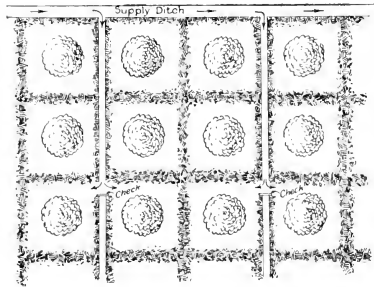


FIG. 70. Basin method of irrigation

The check method. Where the check method is practiced, it frequently happens that the land planted to fruit trees is that on which alfalfa has been grown. In plowing down the alfalfa and setting out the trees, the levees undergo little change and the checks can be flooded if it is considered best. A better plan is to furrow

the floor of each check. The water is admitted through the check box which was used for the alfalfa, and conducted into a short head ditch, from which it is distributed to the furrows. The chief objection to this method is that the checks are too small for orchard tracts in furrow irrigation.

Time to irrigate. The best orchardists believe that frequent examinations of the stem, branches, foliage, and fruit are not sufficient to determine the true condition of the trees. The roots and soil should also be examined. The advice of such men to the inexperienced is: Find out the position of the greater part of the feeding roots, ascertain the nature of the soil around them, and make frequent tests of the moisture of the soil. In a citrus orchard of sandy loam, samples are taken at depths of about 3 feet and the moisture content determined by exposing the samples to a bright sun for the greater part of a day. It is considered that 6 per cent, by weight, of free water is sufficient to keep the trees in a vigorous condition.

Dr. Loughridge¹ found an average of 3.5 per cent in the upper 2 feet and an average of 6.16 per cent below this level in an orchard that had not been irrigated since October of the preceding year. It had received, however, a winter rainfall of about 16 inches. On examination it was found that most of the roots lay between the first and fourth foot. These trees in June seemed to be merely holding their own. When irrigated July 7, they began to make new growth. A few days after the water was applied the percentage of free water in the upper 4 feet of soil rose to 9.64 per cent. The results of these tests seem to indicate that the percentage, by weight, of free moisture in orchard loams should be between 5 and 10 per cent.

Many fruit growers do not turn on the irrigation stream until the trees begin to show such signs of suffering as a slight change in color or a slight curling of the leaves. In waiting for these signals of distress both trees and fruit are liable to be injured. On the other hand, the man who pours on a large quantity of water whenever he can spare it, or when his turn comes, is apt to cause more damage to the trees by an overdose of water.

¹ R. H. Loughridge, assistant professor of agricultural geology and chemistry in the University of California, in experiments at Riverside, California.

Number of irrigations necessary in a season. For nearly half the entire year the fruit trees of Wyoming and Montana have little active, visible growth, whereas in the citrus districts of California and Arizona the growth is continuous. A tree when dormant gives off moisture, but the amount evaporated from both soil and tree in winter is relatively small, owing to the low temperature, the lack of foliage, and feeble growth. A heavy rain which saturates the soil below the usual covering of soil mulch may take the place of one artificial watering, but the light shower frequently does more harm than good.

The number of irrigations needed depends on the capacity of the soil to hold water. If it readily parts with its moisture, light but frequent applications will produce the best results; but if it holds water well, heavy applications at longer intervals are best, especially when loss by evaporation from the soil is prevented by the use of a deep soil mulch.

In the Yakima and Wenatchee fruit-growing districts of Washington the first irrigation is usually given in April or early in May. Then follow three or four waterings at intervals of twenty or thirty days. At Montrose, Colorado, water is used three, four, or five times in a season. At Payette, Idaho, the same number of irrigations is applied, beginning about June 1 in the ordinary seasons and repeating the operation at thirty-day intervals. As a rule the orchards at Lewiston, Idaho, are watered three times, beginning about June 15. From two to four waterings suffice for fruit trees in the vicinity of Boulder, Colorado, the last irrigation being given on or before September 5, so that the new wood may have a chance to mature before heavy freezes occur. In the Bitter Root valley, Montana, young trees are irrigated earlier and oftener than mature trees. Trees in bearing are, as a rule, irrigated about July 15, August 10, and August 20 of each year. In San Diego County, California, citrus trees are watered from six to eight times, and deciduous trees three or four times a season.

Duty of water in irrigating apple orchards. The duty of water per acre as fixed by water contracts varies from $\frac{1}{40}$ to $\frac{1}{400}$ cubic foot per second. In general the most water is applied in districts that require the least; that is, wherever water is cheap and abundant the tendency seems to be to use large quantities, regardless

of the requirements of the fruit trees. In Wyoming the duty of water is seldom less than 1 cubic foot per second for 70 acres. In parts of southern California the same quantity of water not infrequently serves 400 acres; yet the amount required by the fruit trees of the latter locality is far in excess of that of the former.

In recent years the tendency throughout the West has been toward a more economical use of water, and even in localities

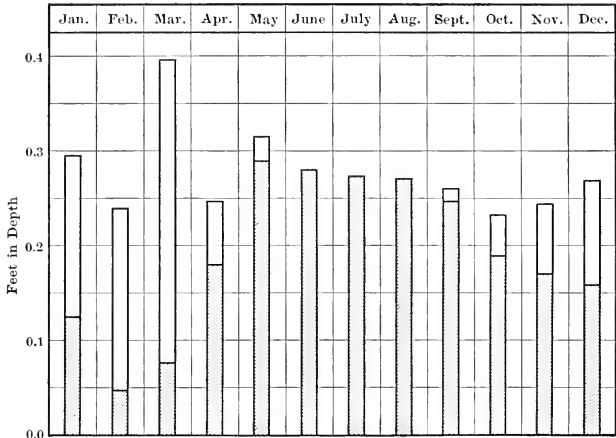


FIG. 71. Duty of water

Average duty per month under Riverside Water Company, December 1, 1901, to November 30, 1908

where water for irrigation is still reasonably low in price, it is rare that more than $2\frac{1}{2}$ acre-feet per acre is applied in a season. This is the duty provided for in the contracts of the Bitter Root Valley Irrigation Company of Montana, which has 40,000 acres of fruit lands under ditch. Since, however, the water user is not entitled to receive more than $\frac{1}{2}$ acre-foot per acre in any one calendar month, it is only when the growing season is long and dry that he requires the full amount.

In the vicinity of Boulder, Colorado, the continuous flow of 1 cubic foot per second for 105 days serves about 112 acres of

all kinds of crops. This amount of water, if none were lost, would cover each acre to a depth of 1.9 feet. In other words, the duty of water is a trifle less than 2 acre-feet per acre.

In 1908 the depth of water used on a 21½-acre apple orchard at Wenatchee, Washington, was measured and found to be 23 inches. The trees were seven years old and produced heavily. This orchard was watered five times, the first time on May 13 and the last on September 23. In San Diego County, California, 1 miner's inch ($\frac{1}{50}$ of a cubic foot per second) irrigates from 6 to 7 acres near the coast, where the air is cool and evaporation low, but twenty miles or more inland the same amount of water is needed for about 4 acres.

On the sandy loam orchards of Orange County, California, it has been demonstrated that 2 acre-inches every sixty days is insufficient to keep bearing trees in good condition. The rainfall of this locality averages less than 12 inches per annum, but about 95 per cent of the total falls between November and May, inclusive.

The most reliable, and in many ways the most valuable, records pertaining to duty of water for orchards have been obtained by the water companies of Riverside County, California. Here more or less irrigation water is used every month of the year.

WATER USED UNDER THE RIVERSIDE WATER COMPANY'S SYSTEM (1901-1908)

MONTH	AVERAGE DEPTH PER ACRE IN FEET	AVERAGE RAINFALL IN FEET	TOTAL WATER APPLIED IN FEET
December	0.159	0.109	0.268
January . . . . .	.123	.170	.293
February . . . . .	.046	.190	.236
March . . . . .	.078	.316	.394
April . . . . .	.177	.068	.245
May . . . . .	.291	.023	.314
June . . . . .	.274	.003	.277
July . . . . .	.272	.002	.274
August . . . . .	.269		.269
September . . . . .	.243	.015	.258
October . . . . .	.189	.043	.232
November . . . . .	.169	.073	.242
Total	2.29	1.01	3.30

Evaporation losses. A light shower followed by warm sunshine may refresh the foliage of fruit trees, but its effect on the soil is likely to be injurious. A brief, pelting rain followed by sunshine forms a crust on the surface of most soils, and if this is not soon broken up by cultivation it checks the free circulation of air in the soil and also tends to increase the amount of water evaporated. It has been found that the amount of moisture held by the soil, the temperature of both soil and air, and the rate of wind motion are the chief factors in the evaporation of water from soils.

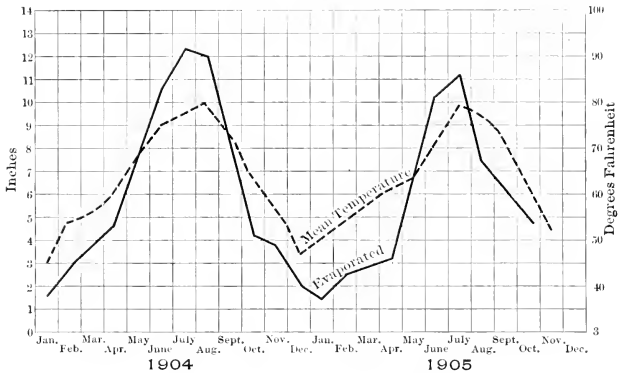


FIG. 72. Temperature and evaporation

Relation between temperature and evaporation from a water surface at Tulare, California

The results of experiments have shown that when water is applied to the surface of orchard soils the loss by evaporation is very great so long as the top layer remains moist. Even in light irrigations this loss in forty-eight hours after the water is applied may amount to from 10 to 20 per cent of the total. In order to reduce this loss and to moisten the soil around the roots of trees, the practice of running small streams of water in deep furrows has become quite common. In applying water in this way the topsoil remains at least partially dry, the bulk of the water soon passes beyond the first foot, and the surface can be cultivated soon after the water is turned off.

The effect on evaporation of a layer of dry, granular soil when placed above moist soil has been shown by a series of experiments. The soil received an irrigation of 6 inches in depth over the surface, and in the tanks which had no mulch, over a third of this amount was evaporated in thirty-two days, while less than 1 per cent was evaporated in the tanks which were protected by a 9-inch mulch. Similar experiments carried on at Wenatchee, Washington, in June, 1908, showed the following losses in twenty-one days: no mulch, $14\frac{1}{3}$ per cent of water applied; 3-inch mulch, 4 per cent; 6-inch mulch, 2 per cent; 9-inch mulch, 1 per cent.

From these tests it is evident that Western orchardists can prevent the greater part of the evaporation losses by cultivating orchards to a depth of at least 6 inches as soon as practicable after each irrigation.

Percolation losses. In the preceding paragraphs attention has been called to the large amount of water that is vaporized from warm, moist soils, but the loss considered here is of a different character. In all modes of wetting the soil, but more particularly when deep furrows are used as distributors, a part of the water is liable to sink beyond the deepest roots. As a rule, the longer the furrow the greater the loss from this cause. Where the furrows were about an eighth of a mile long it was found, after an irrigation, that in some parts of the orchard the soil was wet to depths of between 20 and 26 feet, while in other parts the moisture had not penetrated beyond the third foot.

One of the best ways of finding out whether much water is lost by deep percolation is to dig cross trenches as deep as the feeding roots go. The moisture which passes the deepest roots in its downward course may be considered wasted.

Winter irrigation. When water is used before or after the regular irrigation period, or, what is in many cases the same, before or after the growing season, it is termed winter irrigation. Over a large part of the arid region the growing season is limited by low temperatures to one hundred and fifty days or less, and when the flow of streams is utilized only during this period, much valuable water runs to waste.

It was for the purpose of utilizing some of this waste that the orchardists of the Pacific coast states and Arizona began the practice

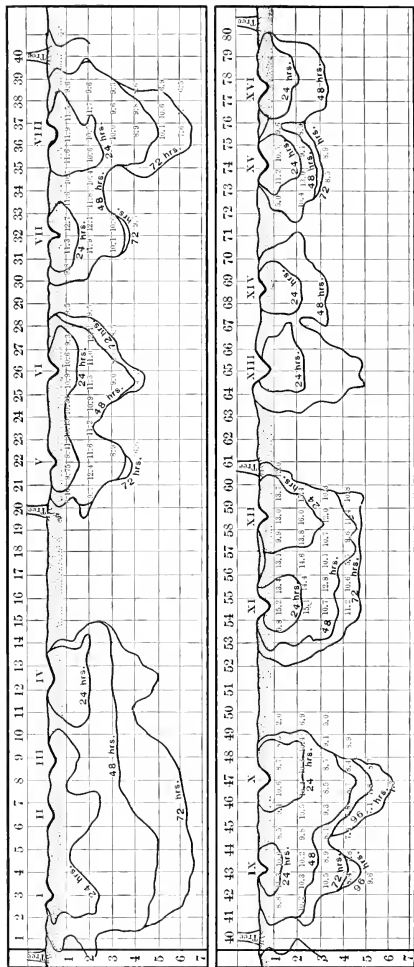


FIG. 73. Percolation studies

Outlines of percolation under sixteen furrows in orchards under the Gage Canal Company, Riverside, California

of winter irrigation. The precipitation usually occurs in winter in the form of rain, and large quantities of creek water are then available. This water is spread over the orchards in January, February, and March, when the deciduous trees are dormant. The most favorable conditions for this practice are a mild winter climate, a deep, retentive soil which will hold the greater part of the water applied, deep-rooted trees, and a soil moist from frequent rains.

In the colder parts of the arid region winter irrigation is likewise being practiced with satisfactory results. The purpose is not only to store water in the soil but to prevent the winter-killing of trees. Experience has shown that it is not best to apply much water to orchards during the latter part of the growing season, for this tends to produce immature growth, which is easily damaged by frost. In many of the orchards of Montana, no water is applied in summer irrigation after August 20. However, owing to the prevalence of warm Chinook winds, which not only melt the snow in a night but rob the exposed soil of much of its moisture, one or two irrigations are frequently necessary in midwinter.

Drainage in irrigated orchards. The loss of water is not the only effect of deep percolation. The water which escapes in this and other ways usually moves through the soil rather slowly until it reaches some underground body of water at a lower level. If orchards have been planted at these lower levels when the subsoil was dry, the rise of the ground-water level should be carefully watched. The small post-hole auger is one of the most convenient tools to use in making test wells to keep track of the behavior of the ground water. Before the deepest roots of the fruit trees are submerged, artificial drainage ought to be provided, otherwise the ground water will at first lessen the yield and finally destroy the trees.

The drainage of orchard tracts is usually accomplished in more or less distinct and separate stages. When the ground water begins to be a menace the natural ravines in the vicinity are cleared of weeds and other rubbish and deepened. If the ground water continues to rise, the open drains are deepened and extended or else the excess water is withdrawn through covered drains. Open drains in orchards occupy valuable land, obstruct field work,

and are expensive to maintain. Some of these objections can be lessened, if not removed, by locating such drains along the lower boundary of the tract. When this plan is followed, covered drains are frequently laid among the trees and discharged into the open drains. Sometimes the source and direction of the waste water that is water-logging an orchard can be traced beneath the surface. In this event it is well to try to intercept its passage before it reaches the trees. This can be done by an open drain, but a covered pipe drain of the required size is preferable. Where durable lumber is cheap, box drains may be used; where lumber is high it will be more economical to use pipe drains made of either clay or cement. For pipe drains ranging from 4 to 8 inches in diameter, clay is most often used; for sizes 10 inches and over, cement. The clay or tile drains are made 1 foot in length, but for the larger sizes of cement the length may be increased to 2 or even 3 feet.

The drainage of irrigated lands differs in many respects from that of land in the humid states of Iowa, Illinois, and Ohio. In irrigated districts the drains are larger and are laid deeper. While 4-inch tile drains may be used in places, 6-inch drains are to be preferred, and should be considered the smallest desirable size. The depth at which they are laid ranges from 4 to 7 feet, and a depth of 5 or 6 feet is required for orchards. A grade of 5 feet to the mile is about the least that should be used, and wherever practicable it should be increased to 10 feet to the mile.

In laying drains that are likely to become clogged with silt or roots, or both, a small cable is laid in each line, and at distances of 300 to 500 feet sand boxes are placed so as to facilitate cleaning the tiles with suitable wire brushes.

Drainage in unirrigated orchards. The question usually asked is, What should I gain by drainage? To become a successful orchardist every fruit-grower should be familiar with the reasons for soil drainage. Drainage removes from the soil the surplus water, which, if allowed to remain, would be very injurious to the plant because it excludes the air which contains oxygen — an element that helps to make plant food available. Drainage also removes the injurious salts which, if allowed to accumulate, often make land unproductive.

The heavy clay and sticky soils of the valley lands can be brought to a higher state of fertility if properly drained. When these soils have an excess of water, they are cold and cannot be worked until late in the spring. Drainage, by making the soil warmer, lengthens the season both for plant growth and for work. It has been observed also that these clay soils when too wet run together and later become dry bakes. This can be easily remedied by good artificial drainage, which makes the operations of tillage easier and, by improving the soil, renders the crops less liable to drought.

Of the several methods of draining an orchard in vogue at present, underdraining with tile has proved to be the most satisfactory. Open ditches are quite common, and good results have been obtained in some places by using wood, stone, brush, cement, or brick for draining the field, but the tile is superior to all of these.

In the sections of the country where stones are numerous, a system of stone drains may be constructed—a main at one side or through the middle, with laterals every few rods, according to the nature of the land to be drained and the amount of water. It is necessary first to dig ditches having a slight pitch to the bottom, in order to make the water run. Not less than 6 inches to 100 feet would be advisable. Then fill the ditch about one foot deep with small stones about the size of a baseball. Over these place larger stones, and then a layer of brush or coarse weeds. Upon these weeds or brush place the dirt, rounding it slightly. This will make a good cheap drain for a small tract.

For large areas drain-tile ditches are advisable, with mains of 6, 8, or more inches inside diameter, situated at the side of the orchard or at regular intervals through it. For laterals smaller pipe of the 3- or 4-inch size can be used, between 2 and 5 rods apart, according to requirements. Attention must be given to the slope of both laterals and mains, so that the water will be carried off. The depth of the drains is also important. It is usually best to place them at a depth of not less than 3 feet nor more than 9 feet. However, soil conditions vary, and a greater depth may sometimes be necessary to meet the problem in hand.

Many orchards are conspicuous examples of the lack of drainage; the trees have more or less dead tops and show a general unhealthy condition, and give little or no satisfactory return.

CHAPTER XVI

INTERCROPPING

Many orchardists either do not have the financial backing to enable them to wait until their trees bear fruit or do not deem it good business to make their orchard a nonrevenue-returning investment, and therefore resort to intercropping.

Intercropping may be advantageous in some cases and result unfortunately in other cases. Generally, because of its present commercial value, the catch crop is made of first importance, but this is a mistake. No matter what catch crop is used or what kind of fruit tree is planted as a filler, everything must be considered of secondary importance to that of growing a first-class apple orchard. For this reason it is often not advisable for a fruit-grower to undertake the utilization of the spare land while the orchard is young. However, when intercropping is thoroughly understood and conscientiously carried out, there seems to be no good reason why it cannot be practiced to advantage in the orchard.

What crops to use. There are many crops that can be successfully grown in the orchard as an intercrop. These may be divided into four classes :

1. *Fruit trees.* Fruit trees such as apple, peach, plum, pear, and cherry may be used as fillers with the permanent trees.

It is thought by some orchardists that the best practice is to interplant an apple orchard with apple trees. The permanent trees are usually of a slower-maturing type, such as Northern Spies, Rhode Island, Baldwins, and so on. The fillers used are such varieties as Wealthy, Fameuse, McIntosh, Red Astrachan, Oldenburg, which come into fruit much earlier than the permanent trees. About the twentieth or twenty-fifth year they should be cut out, so that the permanent trees may not be injured by competition with them. We realize that it is much easier to advise an orchardist to cut down the filler trees than to perform the task. It requires

determination to go into the orchard and cut down trees that are producing, in some cases, their maximum crop, but for the good of the future apple orchard it must be done.

Some fruit-growers go so far as to advise using the same variety for fillers and permanent trees ; that is, Ben Davis with Ben Davis, Baldwin with Baldwin, etc., having the permanent trees 40 feet apart and the intercrop arranged so that there is a tree every 20 feet. The filler trees are kept "cut back" by pruning, so that they do not infringe so quickly on the space required by the permanent trees. Sometimes it is wise to give the permanent trees a start of a year or two before the fillers are planted. The author's experience, however, has shown it to be best to plant the fillers first and the permanent trees later, this method giving quicker and longer returns from the fillers.

Some orchardists prefer either the peach or the plum as a filler for the apple orchard. These trees have a tendency to fruit early and are usually of little real value by the time the permanent trees need the space which they occupy. In some cases where the plum and the peach have been used, it has been possible to pay for the whole investment to date with one or more full crops from them. Not everyone likes these trees for filler purpose, however, one reason being that their requirements are in some respects different from those of the apple tree, which means two different orchards on the same land at the same time. This may mean extra care, extra expense, and, at times, unsatisfactory results. However, if there is a market for this class of fruit and the fruit-grower has intelligence enough to manage the two propositions at the same time, there is greater chance of success than of failure.

Pears, because of their characteristic demands as to soil, fertilization, and culture, do not offer so many advantages as fillers as do the other larger fruits mentioned, although in some cases they may be used advantageously.

The cherry tree seems to be as well adapted for filler purposes as any tree thus far mentioned. It has not, however, been used as commonly as either the peach or the plum. The slower-growing habit of this tree and the occurrence of the harvest period at a time when the orchardist has more or less leisure are two great inducements for its utilization by the more intelligent orchardist.

2. *Small fruits.* Small fruits are well adapted for companion crops with a young orchard. Owing to their smaller structure and spread, they do not rob the trees of sunlight nor, to any great extent, of the plant food or moisture. They may also remain longer in the orchard than the larger tree fruits.

Strawberries seem to be the most desirable small fruit to use. They are planted between the rows of trees, usually in either the



FIG. 74. Intercropping the young orchard

Orchard showing strawberries between rows of trees, all under irrigation. (After *Farmers' Bulletin No. 404*)

matted row or the hedge row, with enough space near the young trees for cultivation. Some orchardists do not permit planting closer than 3 feet from the trees the first few years, perhaps increasing this distance to 4 feet the third year, to 5 feet the fourth year, and so on, until the clean-cultivated strip forces out the intercrop.

Strawberries as a companion crop are very profitable in many sections. Sometimes as much as from \$300.00 to \$500.00 per acre may be received from the sale of the fruit, but ordinarily the returns are less. The length of time that the strawberry bed is allowed to remain is but two or three years, and only two years are fruitful.

Currants offer many advantages as a filler crop—both as to growth and as to returns in money. They may be planted in the row with the trees, — a very common method in the northeastern states, — or they may be planted in rows between the rows of trees. A good way is to plant a row of currants halfway between the rows of trees, and on both sides of this, at a distance of 4 or 6 feet, another row, spaced like the first, making in all three rows, which

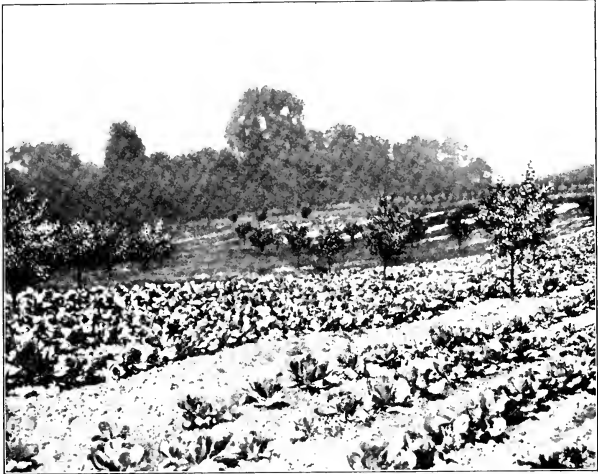


FIG. 75. Another profitable companion crop

Cabbages as an intercrop used between young trees — a practical way of obtaining revenue from an orchard before the trees begin to bear

are far enough away from the young trees so that for several years they will not interfere with the needs of the tree roots. The fruit can be harvested, sometimes the second year, but usually the third year; it may even be later in some cases, the time depending on the age of the plants, the care given them, and the resultant growth. About \$100.00 an acre would be a fair return from currants.

Gooseberries may be substituted for the currants and should be treated in the same manner as regards planting and culture.

Usually, however, the returns from this fruit are not so large as from the currant.

Blackberries and raspberries are sometimes planted in the orchard. They are not so well liked as the other small fruits, chiefly because of their thorns and new sucker growth. Both of these characteristics render cultivation and other work among them more difficult. The returns from blackberries approach those obtained from currants, but the raspberries are greatly inferior as a money producer.

3. *Vegetables.* Many kinds of vegetables may serve as an intercrop with apple trees. Some of the most commonly used are potatoes, cabbage, beans, squash, melons, turnips, beets, carrots, the selection depending on the demand of the market or the needs of the farm. It is better, however, to select several crops, if possible, and grow them in rotation. In a large orchard a third of the area may be planted to potatoes, another third to squash, and the other to beans; the next year potatoes may be succeeded by squash, squash by beans, and beans by potatoes; the third year beans may be substituted for squash, potatoes for beans, and squash for potatoes, followed the next year by the original crops. By rotating the crops or changing them each year, there is less robbery of certain elements of the soil and better returns are usually obtained.

4. *Field crops.* Some of the field crops are not suitable for use in the orchard. Corn seems to be the crop that is the least desirable; it robs the young trees of sunlight, moisture, and food, and has not met with the general approval of those who have grown it. Rye, oats, wheat, buckwheat, or barley, being robbers of soil moisture and plant food, are not to be specially recommended as companion crops. However, for late planting as cover crops, they offer some advantages. If they are to be grown early in the spring or summer, they should be spaced off from the trees as described previously (p. 160), to prevent injury to the young trees.

Cow beets, mangel-wurzels, and other large root crops that are sometimes grown as field crops may be used as an intercrop with a good deal of success and satisfaction, especially where they are planted far enough from the young trees, and good, clean cultivation is practiced. The returns from such a crop are often large and are of special value to the orchardist who keeps cows.

Rotation for young orchard. The author has practiced the following crop rotation in a young orchard of 700 trees:

The first year potatoes occupied the land, the clear space on each side of the young trees being 3 feet. The second year beans were grown, and a slightly greater distance — about $3\frac{1}{2}$ feet — was allowed on each side of the trees. The third and fourth years strawberries occupied the land, giving, even with the matted-row system, a greater cleared space near the trees. The fifth year potatoes were used again, one less row being planted between the rows of trees than was planted the first year, thus increasing the space given to the trees. The sixth year squash was planted, two rows of squash in hills being sown between each two rows of trees. The seventh year the clover from the cover crop was allowed to remain. Beginning with the eighth year, clean culture was given except every fourth or fifth year, during which the orchard was permitted to remain in sod — generally clover sod from the cover crop planted the year previous.

This rotation has proved very satisfactory, and, with minor changes to suit the preferences of the amateur orchardist, is earnestly recommended for his consideration.

CHAPTER XVII

THINNING

Among the orchardists throughout the country the practice of thinning the apple crop has not met with as universal approval as other methods of orchard culture. However, in the West, where the competition in fruit raising is very keen, the practice has been readily adopted in the belief that by this means an apple of superior value could be produced. Many progressive Eastern orchardists later followed this plan, and each year it is becoming more common.

The same principle is involved in the thinning of the apple crop as in the thinning of beets or other vegetables; that is, the removal of a large percentage of the young plants gives to the remaining plants the necessary space for their proper development.

The apple tree, in its attempt to reproduce its kind, strives for the production of the maximum amount of seed. A small apple is as efficient as a large one in this respect, for seeds are often as large and as numerous in small apples as in large ones. It so happens, however, that man covets the apple for its fleshy parts, and the fewer apples per tree the greater will be the development of the fleshy parts of the fruit. The larger the apple, within certain limits, the larger the edible portion and the more highly it is valued. Take, for instance, two perfectly sound, well-colored Jonathan apples — the one that is less than $2\frac{1}{4}$ inches in diameter would be considered a cull, worth about 5 cents a bushel by any fruit-shipping association, and would be fed to the stock or made into cider or thrown away; the apple that is about $2\frac{3}{4}$ inches in diameter would be considered a fancy apple and be highly prized by any lover of fruit, its wholesale price averaging from \$1.00 to \$1.25 a bushel. In other words, according to the market standards, by increasing the diameter of the apple $\frac{1}{2}$ inch we increase its market value from 20 to 25 times. Surely if we are engaged in commercial apple production we cannot overlook a consideration of this kind. By

the removal of part of the fruit crop at an early stage in its development this increase in size can be obtained, and it is often impossible to obtain it otherwise.

In the production of fancy boxed apples the necessity for thinning has been more apparent as competition has become keener. But while the practicability of thinning peaches and pears is no longer doubted, the majority of apple-growers have not yet realized

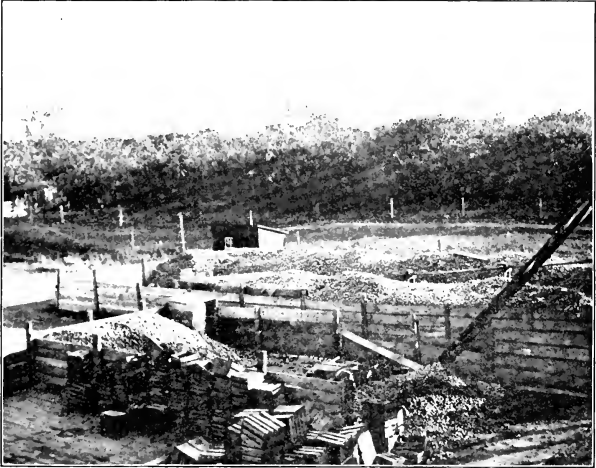


FIG. 76. Apples waiting for the press

Would you rather produce this sort at five to ten cents a bushel or thin your fruit and sell high grades?

the value of systematically thinning their apples. The time is fast approaching when the intermountain fruit-grower will be forced to the conclusion that it no longer pays to grow ordinary fruit. There are but few localities in the United States in which medium to good apples cannot be raised, and this grade of fruit must everywhere compete with the home-grown product. On the other hand, localities in which strictly fancy apples can be raised are much less numerous; therefore such grades less frequently come into

competition with a home-grown product. This means that to produce readily saleable fruit the orchardist must resort to thinning.

Benefits from thinning. Some of the benefits that may be derived from properly thinning the fruit are as follows:

1. The color of the fruit in many cases is greatly improved. It has been found that in heavily laden trees the color was somewhat increased, while in sparsely laden trees little or no appreciable difference was noticed.

2. The size of the fruit is increased. Sometimes the number of first-grade fruit on a tree that has been thinned is from 10 to 18 per cent greater than where thinning has not been practiced.

3. There is more uniformity in the fruit, the natural result of selection.

4. The vitality of the tree is conserved, which has a tendency to encourage annual bearing. Much of the so-called habit of "alternate bearing" in apple trees is directly traceable to the fact that they overbear one year, and recover from this overtax by bearing a very light crop or none at all the following year.

5. The number of broken limbs in the orchard can be lessened, thereby saving both time and money, and in some instances reducing the cost of propping.

Methods of thinning. The apples are removed by hand or by shears, the consensus of opinion being that hand picking is better or at least quicker. This is undoubtedly true when the variety to be thinned has long stems or long fruit spurs, but varieties with short fruit spurs cannot be so readily handled this way, and in such cases small shears made especially for this purpose will be useful. Whatever the method of thinning, care should be used not to break or injure the fruit spurs. Few will be broken by the careful worker if they are grasped firmly in one hand while the apples are removed with the other. An upward and backward twist of the fruit will loosen the stem from the spur without breaking the spur or disturbing the remaining fruit. One or two apples are often removed from a cluster in this way, leaving the remaining apple or apples undisturbed. Careless workers who persist in pulling off the fruit should not be tolerated. A light picking-ladder, from which the entire bearing surface may be easily reached, will hasten the work with the older trees.

Some people thin to a definite number of boxes for each tree of a certain age. This number may be determined by actually counting the apples on one or two trees. Other growers have learned by experience the proper distance between apples if they are to reach a marketable size. When eight-year-old and nine-year-old Jonathan trees were thinned to a minimum distance of 4 inches, there were still too many apples remaining for their maximum development. A minimum distance of 5 or 6 inches would no doubt have given better results. On young Gano trees good results were obtained from thinning to one fruit on a spur, with the spurs a minimum distance apart of about 6 inches. Some varieties of apples, like the Winesap, tend to set too abundantly and need heavier thinning than most other varieties. With the Newtown the Western growers thin so as to have as many 4-tier apples as possible.

It is evident that no exact rules for thinning can be formulated. The requirements will vary for different varieties, for different trees in the same year, and for the same tree in different years, according to the amount of fruit which is set.

Time to thin. For the best results the thinning operation should commence immediately after the June drop, while the apples are 1 inch or $1\frac{1}{2}$ inches in diameter. Broken limbs may be avoided if the thinning is done in August, but the other benefits will not be so pronounced as when the work is done earlier. It is only natural to expect that the sooner the remaining apples have the benefit of the entire strength and nourishment of the tree, the better will be the results. In other words, less of the tree's energy will be thrown away and more diverted to the proper channels if the thinning is done early in the season. Sometimes it pays to go over the trees more than once — even three times in special cases is not too much. Sometimes the thinnings obtained from the second and the third operation may be sold at remunerative prices.

Cost of thinning. According to Western figures the cost of thinning is slight compared with the increased returns. The actual time spent in thinning will be saved at harvest in the sorting of the crop. If, however, full time is charged to this thinning work, the cost should not exceed from $1\frac{1}{2}$ cents to 2 cents per box of harvested fruit. In the case of the Gano variety, which is more readily thinned than some other sorts, the cost will hardly exceed

1 cent per box on low-headed trees. This work can be done entirely by boys and girls, and thus the cost can be kept well within the limits just mentioned. Girls are generally quicker and often more careful than boys. From 10 cents to 15 cents per hour can be profitably paid for this work.

In the East and other sections where the trees are larger, the cost of thinning mature trees which are well loaded should not exceed 50 cents per tree and probably would average less than that. For a 10-barrel crop per tree the cost might exceed this amount by 25 cents or more per tree.

Increased value of the thinned crop. It is estimated that the thinned fruit brings from 10 to 15 per cent more per barrel than the unthinned. Some Eastern orchardists claim an increase of between 40 cents and 80 cents per barrel. In the West, experiments have shown that with the Ben Davis the net increase per tree was \$1.16. Where Jonathans were thinned to a minimum distance of 4 inches, the average increase per tree was 71 cents. Where the trees were set 16×24 ft., or 115 trees per acre, the increase per acre was decidedly good — \$81.65.

In considering net profits still other factors, such as ease of picking, expense of grading, and the general welfare of the tree, should be given attention. A good idea of the saving in these particulars is found in the statement of a practical grower, that "picking apples from thinned trees is from 10 to 20 per cent cheaper than from unthinned, and the packing is cheaper by 15 to 30 per cent."

All varieties cannot be handled in the same way. Each grower must solve his own problem, considering such factors as the age of the tree, its size, and the cultural practices. He will find that frequently certain varieties or certain trees of a variety will need little or no thinning during a particular season. Where the trees have been pruned severely, not so much thinning will be necessary. It is often suggested that pruning may be substituted for thinning; but while pruning thins out the fruit buds and affords relief for the crowded clusters, it can hardly take the place of thinning, for a pruning severe enough to reduce sufficiently the crop of a bearing apple tree would probably be too severe in other respects.

Does thinning pay? Practical growers, as well as experimenters, generally concede that when growing for the general market, if the crop set is very full, — making it probable that there will be a large and widespread crop of small-sized fruit, — it will pay to thin to such an extent as to insure good-sized fruit. For the fancy trade, thinning of fruit will undoubtedly pay well.

It is possible to apply mathematics to the solution of this question. If apples are not thinned, there would naturally be plenty of them, selling from 40 to 50 cents a bushel; whereas, if properly thinned, larger, choicer fruits would be obtained. The number of bushels would be less, but the price would be higher — \$1.00 a bushel or more — because of the greater desirability. In terms of dollars and cents, 100 bushels of unthinned fruit at 50 cents would bring \$50.00; 60 bushels of thinned fruit at \$1.00 would bring \$60.00. The thinning would generally not cost as much as the extra expense of picking, grading, packing, packages, etc. for the unthinned fruit. There seems to be, therefore, a small net balance in dollars and cents in favor of the thinned fruit. Besides the commercial money value there would be the probable keeping of customers by selling extra-fancy apples instead of average sorts.

CHAPTER XVIII

INSECTS

Insects which prey upon the apple tree or its products are very numerous. In 1894, before a Western horticultural society, a list of 281 species was discussed, to which might have been added at least 50 others, making a total of over 300. To make the list complete there must, of course, be added such others as have been reported during the twenty years since 1894. Although this list covers a large territory and includes many species not known to be seriously injurious, it is suggestive of one of the dangers to the apple crops of the country.

Besides the common harmful insects with which every orchardist is familiar, there are others, which, although less generally destructive, of less general distribution, more given to seasonal fluctuations, and usually accorded but slight attention, are nevertheless causing considerable annual losses. These are sufficiently injurious to warrant special attention outside the usual, general spraying.

Many injurious insects fluctuate in numbers through more or less definite cycles ; they gradually increase to a maximum of destructiveness, which may extend over two or three years, and then, through the increase of parasites or through weather conditions unfavorable to them, they rapidly decrease in numbers until they cease to attract notice for a time, possibly for several years. Some insects, like the codling moth, appear to be perpetually in evidence ; but even with this insect there are marked seasonal differences in numbers, which are sometimes attributed to the maximum development of parasites or to climatic extremes, but which often cannot with certainty be assigned to any definite cause.

As destructive insects fluctuate between minimum and maximum destructiveness, so their parasites fluctuate between minimum and maximum efficiency, maintaining a balance that prevents perpetual ascendancy on the part of either host or parasite. An

insect appearing as a casual invader upon fruit trees may become a serious pest by reason of scarcity of its natural food plant. During a period of minimum production of a given species, some insect which has accepted that species as its food may be driven to seek sustenance elsewhere and is likely to find its wants met by foliage or fruit of some crop plant.

The clearing away of a timber tract may result in serious deprivations upon neighboring orchards by insects whose natural food plants have thus been destroyed. When a native insect leaves a wild food plant and finds an acceptable substitute in leaves or fruit of orchard trees, it enters upon a new career and is likely to push rapidly to a maximum in numbers because of the abundance of food at hand. When the apple curculio and the dreaded railroad worm, which originally fed on the wild hawthorn, and the flat-headed borer, which lived in the oak, were forced by the decrease of their natural food plants to substitute cultivated fruits and fruit trees, they solved their own food problem, but in so doing laid a heavy burden upon the fruit-grower. They have become real pests and, while held more or less in check by natural enemies, must be seriously considered in fruit-growing operations.

From the little that has been said it should be evident that attention must be given to all insect injuries that may be discovered on tree or fruit, no matter how slight or infrequent they may be. Establish the connection between the injury observed and the insect that does it; learn the habits of the insect, its period of work, and all facts possible regarding its history; or take the safe and more expedient course of sending the insect and a specimen of its work to an entomologist for determination and information regarding its history, its standing as an injurious species, the probabilities of its becoming seriously destructive, and the most efficient remedies. File this information for easy access when the time of need comes.

The discussion of the insects affecting the apple will be subdivided according to the parts of the tree.

1. Those affecting woody parts.
2. Those affecting leaves.
3. Those affecting blossoms.
4. Those affecting fruit.

INSECTS AFFECTING THE WOODY PARTS OF THE TREE

Flat-headed borer (*Chrysobothris femorata*, Fab.). The adult flat-headed borer is smaller than the adult of the round-headed species, being only about half an inch in length. It is a beautiful,

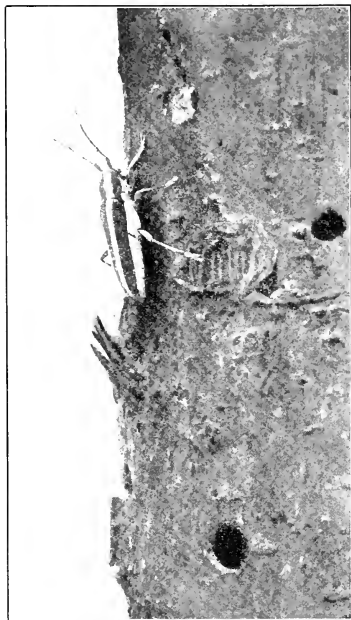


FIG. 77. Adult round-headed apple-tree borer (natural size). (Photograph by W. E. Rumsey)

burnished beetle, reflecting bright metallic colors in which green, black, and bronze predominate. The body is flattened and tapers at the posterior end. It makes an early appearance in the spring, lays its eggs, and larvæ are hatched which mature in one year and issue as adults the following spring. The larva tunnels first into the sapwood, but later bores into the heartwood, working back to the bark in the spring and pupating. Sometimes the winter is passed in the pupa state. In making its escape from the tree the borer cuts an elliptical hole, thus differentiating this species from the round-headed borer, which cuts a circular emergence hole.

Nature of the injury. The flat-headed borer is more injurious to young apple trees than to old bearing trees. The larva generally works in the trunk, and gets higher up in the young trees, often to the first lateral limbs. It is not unusual, however, to find it working in the roots of young trees some inches below the surface of the ground. Infestations are detected by the patches of

discolored, undermined bark. Generally this borer does not show a preference for trees of vigorous, unimpaired growth, but attacks weakened, devitalized trees; when these are lacking, however, it attacks sound trees.

Remedies. The control measures for the flat-headed borer and the round-headed species are the same. The trunks of trees are sometimes painted with deterrent compounds, such as whale-oil soap, carbolated soft soap, etc., to discourage egg laying. These remedies should be applied early in the spring as thick pastes, and renewed at intervals throughout the summer.

Round-headed borer (*Saperda candida*, Fab.). The adult of this species is a large beetle, nearly one inch in length, yellowish-brown above and silvery-white beneath. Two broad, white, slightly-curved stripes traverse the entire length of the back. The larva is a large, footless, light-yellowish grub, about one inch long when fully grown, tapering in a graduated scale from segment to segment through-

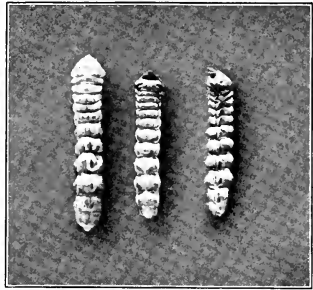


FIG. 78. Round-headed apple-tree borer (natural-size dorsal, ventral, and lateral views). (Photograph by W. E. Rumsey)

out its entire length. The head is darker than the body and slightly larger in diameter. The pupa is slightly shorter than the larva and looks something like the adult.

The beetles appear in May and June, and eggs are laid soon after. The eggs are deposited by the females in slits cut in the bark near the base of the tree, and are hatched in two or three weeks. The larva at once tunnels into the bark and feeds on the sapwood during the first year, cutting a disk-shaped burrow, at the bottom of which it passes the winter, not feeding again until the spring of the second year. The burrow is enlarged greatly the second year by the renewed feeding of the larva, and the castings are pushed out through holes cut in the bark. In small trees the trunk is often completely girdled by these holes. The larva

increases considerably in size the second year and does not feed exclusively on the sapwood, but gnaws into the heartwood. The winter of the second year is passed deep in the burrows. The third year the borer penetrates still deeper into the heart of the tree, there reaching a full larval development. It finally forces its way back to the bark and forms a pupa, from which it emerges the following spring as the adult beetle.

Appearance of infested trees. The presence of the round-headed borer is usually not detected until the second year. It may be recognized by the discolored, sunken patches of bark marking the burrows beneath. These areas sometimes show an exudation of sap from the wound, but more often are evident by the castings thrust out by the larva. The area of egg-laying is usually in the trunk, within a foot or two of the ground, but in small trees it is often found below ground, at the crown. Several larvæ may girdle and destroy a young tree. In older trees the injury is not always fatal, but the growth of both tree and fruit is heavily retarded.

Remedies. The borers are readily removed by a knife, or killed by a prodding of their channels with a sharp wire. When there are several borers in one tree the use of a knife is not altogether safe because of the danger of girdling the trunk. The safest, surest method is to tap the channels and inject into them small quantities of bisulphide of carbon, stopping up all entrances to the channels with wax, or something similar, to prevent the escape of the gas. The deadly fumes of carbon bisulphide penetrate to all parts of the tunnels and kill the larvæ within, making it unnecessary to cut into the bark or wood in search of them.

Shot-hole borer. The shot-hole borer usually works in the branches of the tree. So far as observed, it has not yet done a great deal of damage to the apple trees in the Eastern states. In any event, it is injurious only when a tree is greatly reduced in vitality from some other cause, and the remedy is to increase the vigor of the tree.

LICE, OR APHIDS

Oyster-shell scale. Three scale insects commonly occur in our apple orchards. The scurfy scale is found in almost every orchard, but seldom in very large numbers. The oyster-shell scale, or

bark louse, as it is sometimes called, is much more prevalent, and occasionally becomes so numerous as to destroy a tree. Generally, however, this and the scurfy scale are kept in check by efficient parasites. From a study of the history of these scales, we find that the females lay eggs under the scale covering in the fall of the year and subsequently die. The eggs live over winter and hatch the following season, about the last of May or the first of June. At this time the unprotected larvæ crawl about over the tree, looking for a place to settle. This is the time when they should be attacked. The young larvæ may be readily destroyed by almost any contact insecticide, such as whale-oil soap or kerosene emulsion, if it is applied before they have a chance to form their scale covering.

San José scale (*Aspidiotus perniciosus*, Comstock). The San José scale belongs to the category of sucking insects, and takes its food in a liquid form by means of a long, bristlelike proboscis inserted into leaf or limb or fruit, as the case may be.

Its habit of feeding renders it immune to treatment with arsenical poisons, which must be taken internally to be effective. As the insect is powerless of itself to extend its sphere of infestation from its own immediate habitat, and as the fruit is infested directly from the tree, it follows that the destruction of the scale on the tree removes simultaneously the danger to the tree and that to the fruit. This



FIG. 79. Oyster-shell scale. (Courtesy of Ohio Agricultural Experiment Station)

is accomplished through the agency of contact sprays applied externally. Scale-extirpative measures are most successfully applied in the winter, for the reason that the trees are then dormant. Powerful contact poisons, because of their strength and causticity, cannot be used when the trees are in foliage.

History. As the term "scale" suggests, the insects are protected by a waxy excretion under cover of which they feed and breed. Save for a few hours after birth, during which they crawl about, the females pass their entire existence under this covering.

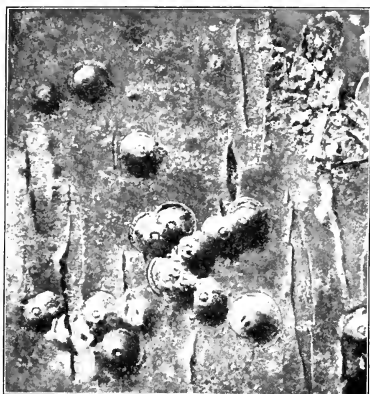


FIG. 80. San José scale (enlarged). (Courtesy of Ohio Agricultural Experiment Station)

The males, after several molts, leave the scale casings as fragile two-winged flies and enjoy an ephemeral span of liberty. In this brief season before death they unite with the scale-imprisoned females.

The San José scale passes the winter in the half-grown stage under the small, black, circular scales. Individual scales are no larger than the diameter of an ordinary pin, and in small numbers are so insignificant as to be invis-

ible to all save the eye trained to observe them. Very early in the spring the males pupate, emerging soon after to unite with the females, which by then have arrived at the proper stage for complementary reproduction. In about three weeks or a month the young of the first brood appear. These are borne alive by the mother insect without an intermediate egg stage. Parturition continues several weeks before the female dies.

The newly born young, light yellow in color, crawl about several hours before settling down in their fixed positions. The long sucking tube is inserted into the tissues of the plant, and the

formation of the scale begins. This, at first, is white, but changes in color through successive molts to gray or black.

Each circular scale is surmounted at the apex by a nipple. In the elongated males the nipple is also present, but near the anterior end. The conformation of this nipplelike marking is characteristic of the San José scale and differentiates it from other species which otherwise outwardly resemble it. The size of both sexes materially

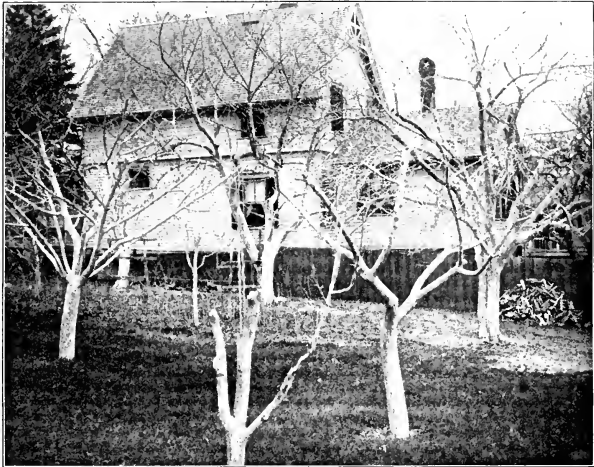


FIG. 81. Result of scale injury

Trees which had to be dehorned owing to the work of the San José scale. (Courtesy of A. E. Stene, Rhode Island)

increases with age, and the male assumes an elongated shape. Each generation requires from thirty-three to forty days from the emergence of the larvæ of one brood to the emergence of the larvæ of its progeny. The average period of oviposition of a female being about six weeks, there is consequently a well-defined overlapping of summer broods.

Since the female never leaves its scale covering, it is evident that the spread of the insects from one plant to another and from

one premise to another must be effected artificially. Scale infestations are usually set up locally by the removal of the crawling young from their birthplaces to other places on the legs and bodies of larger insects and on the persons and clothes of orchard workers, or by birds, plow animals, and possibly, for short distances, by high winds. Scale-infested nursery stock is the commonest cause of long-distance infestations. Thus it may readily be seen how important it is to protect oneself by guarding against the introduction of nursery stock from infested territory.

Allowing forty days to a generation, five full generations of this scale are easily possible in the 214 days from April 1 to October 31. In all probability there are more. Marlatt,¹ estimating 200 females as the offspring of a single mother of the first generation, shows a possible progeny of 3,216,080,400 at the fifth brood. These figures offer some explanation of the almost complete annihilation in a single season of entire orchards where conditions have been favorable for the multiplication of the scale.

Characteristic injury of the San José scale. The effect of the feeding of many scale insects is the slow sapping of the life of the tree, or, in the case of fruit, a scurfy appearance, vivid discoloration, and consequent depreciation or worthlessness as a market product. On smooth bark that is slightly infested, there is a reddish or purplish discoloration surrounding the insects, which extends through the bark to the wood proper. The sucking of the insects results in a pitted, indented twig or limb. In heavy infestations the scales overlap each other, literally incrusting the bark so that it cannot be seen at all and giving the limbs the appearance of having been dusted over with ashes. On a badly infested tree in midsummer one can see with the naked eye thousands of the yellow young crawling about.

The apples themselves offer tempting conditions to the crawling larvæ and are freely infested where scale is present on the tree. Even a few scales will discolor the skin of an apple, and a moderate infestation will stultify the growth, often leaving the apple cracked and misshapen.

Treatment. The San José scale is most successfully destroyed in the late fall or winter months. The tree is then dormant, and

¹ C. L. Marlatt, entomologist, United States Department of Agriculture.

therefore immune from spray injury. Spraying may be safely done at any time after the leaves are off until just before the blooms begin to open in the spring. Weather conditions usually are more favorable in the fall; among other things there is an absence of the high winds prevailing in February and March. For reasons concerned with fungous affections of the apple, it would seem more desirable, however, to apply a full-strength scale insecticide as late in the spring as may be done with safety to the tree and fruit. The fungicidal value of such an application would continue to be felt into the period of early development of fruit and foliage, and act as a preventive of the diseases that are prevalent both at that time and later. However, the orchardist should be governed by conditions, only being sure to give at least one thorough spraying within the time limits named above.

As exterminators of the San José scale, the standard solutions of lime and sulphur have proved without an equal and are as cheap as the other compounds sometimes used. The only other exterminators worthy of mention are the soluble-oil preparations and kerosene emulsion. Of the former a few, notably Scalecide, have done excellent work. But lime-sulphur solution possesses composite qualities which are lacking in miscible oils; it is both a powerful insecticide and a fungicide, the latter property usually being absent in the oil preparations. Lime-sulphur wash produces a sanitary condition of the bark, causes dead tissues and scales to slough off, and leaves the trees smooth and clean.

Recommendations. As a spray for San José scale when the tree is in a dormant state, lime and sulphur is recommended, the application to be made from any time after the foliage is off until just before the blooms appear. Any good prepared lime and sulphur, well applied, will give the desired results. Nothing is superior to the homemade article, though it is comparatively little used because the prepared solutions give practically the same results without the trouble and cost of cooking. The manufacturers of the commercial article generally recommend diluting it at a ratio of 1 part lime and sulphur to 10 parts water. It should not be forgotten that the more thorough the application the better the results. One infested limb or twig left unsprayed by a careless workman may easily reinfest the tree and its fruit before reproduction is suspended.

Badly infested trees should be given two applications. Pruning should always precede winter spraying.

The prepared solution, in a proportion of $1\frac{1}{2}$ gallons of lime and sulphur to 50 gallons of water, is a dependable spray to use in the summer. Although too weak to kill the protected scale insects, it is caustic enough to kill by contact all that are crawling or otherwise unprotected.

The type of nozzle best adapted for use in this spraying is one that throws a medium-fine, cone-shaped spray. High pressure should be maintained, so that the mist at close range will possess a penetrating power.

Woolly aphid (*Schizoneura lanigera*, Hauss). The woolly aphid works injury both to limbs and to trunks, and also to the roots. It is only the injury to the roots, however, that demands specially directed treatment, the limbs and trunks being readily freed from this pest by high-pressure applications of diluted lime and sulphur during the summer. The white cottony substances secreted by the insect protect it against contact sprays, unless administered forcefully.

The root form of the woolly aphid, by reason of its peculiar feeding habits, damages the roots seriously, and not infrequently causes the death of the trees.

Treatment. The most dependable remedy yet discovered for the root form of the woolly aphid is kerosene emulsion. In recommending it, however, an emphatic warning should be given: the utmost care must be taken thoroughly to emulsify the kerosene, so that it will not separate into a free state. This cannot be done by merely stirring the constituents together. They should be mixed in a vessel larger than necessary to hold them, to allow for the increase in bulk which results from the process of emulsifying, and then be forcefully and continuously beaten for at least ten minutes. A 10-per-cent solution is recommended on account of the possible injury to the trees from an emulsion carrying a greater percentage of kerosene, and it is as effective as a stronger solution, although the length of time it retains its strength is not so lasting. If the preparation is made, carefully following suggestion here given, and applied only in the growing season, no damage to the tree or its roots need be feared.

Many other remedies for the woolly aphid have been tested, but none has proved so effective as kerosene emulsion. The odor of kerosene remains in the soil several months after application and effectually prevents reinfestation.

INSECTS AFFECTING THE LEAVES

Green-apple leaf aphid (*Aphis pomi*, De Geer). The green-apple aphid is especially injurious to nursery stock and to young trees in the orchard. The sucking of the juices of the leaves, usually on the terminal growth, causes them to curl, blacken, and wither. This injury to the leaves is followed by the stunting of the wood growth, and on small trees which have been generally infested, the stunting effect is often noticeable for years afterwards. The fruit of bearing trees, when surrounded by aphid-infested foliage, practically ceases to grow, the apples remaining green, hard, and gnarled for some time and then dropping.

Since the insects cannot be successfully combated after the leaves have curled, the grower must resort to preventive measures.

Treatment. The green-apple aphid passes the winter season in the egg stage on the limbs and twigs of apple trees. It is possible to destroy the insects at this stage and thus protect trees and foliage for the first two or three months of summer by thorough sprayings with lime-sulphur solution in the late winter or the early spring.

Contact poisons must be used to destroy the fully developed aphid. Because of the curling of the leaves it is practically impossible to make applications by means of a sprayer thorough enough to reach the insects beneath. It is quite a simple matter to treat nursery stock and orchard trees in their first and second years by dipping the infested foliage in a vessel filled with an efficient contact poison and carried from tree to tree by hand. This is simple, rapid, and more thorough than any spraying could possibly be. With the disappearance of the aphids, growth is renewed and the trees thrive.

Besides kerosene emulsion, whale-oil soap, tobacco decoctions, etc., a manufactured product called "Black Leaf 40" — a concentrated solution of nicotine sulphate — has come into the market

recently and given perfect satisfaction against the aphid. When used as a dip, as described above, it is a hundred per cent efficient as an aphid destroyer, and, in addition, has a healthy, stimulating effect on leaf growth.

Leaf crumpler (*Phycis indigenella*). In the fall of the year and during the winter there may be seen hanging from the trees in many orchards small clusters of brown, dead leaves. On examination it will be found that these clusters of leaves are very firmly attached to the twigs by a cord made up of numerous silken threads. Within the clusters and attached to them in an irregular manner by silken threads is a peculiar hornlike case variously curved and tapering to an attenuated point. The case itself is formed of similar threads interwoven with bits of leaves well cemented together; it is thickly lined with silk, and contains a small brown larva about one fourth of an inch in length. This small larva, securely sealed within its case, lives over winter in its half-grown condition and is ready to complete its development in the early spring by feeding on the opening buds and young leaves. It retains its winter home as a resting place between meals and, after completing its growth, pupates within the case and finally emerges, early in June, as a small ash-gray moth with brown markings. Within a few days the moth begins laying eggs, which are hatched in about a week. The young larvæ begin to feed at once, and soon commence the construction of a protecting case, to which additions are made as they increase in size. Leaves are drawn and fastened to the case of silken threads, and the worms are thus protected while feeding. In the fall, when the larvæ are about half grown, they prepare for winter by securely attaching the cases to branches and fastening additional leaves to the outside for further protection.

Treatment. Where this insect is present on small trees or in a nursery, it is possible to destroy large numbers by hand-picking the clusters of dead leaves, but for bearing orchards this would not be practicable. If, in early spring, pushing buds are thoroughly sprayed with some arsenical, the worms may be caught when they commence feeding, but after they have tied leaves together in clusters they cannot be reached by sprays. The leaf crumpler is commonly present in our orchards, and for this reason an arsenical should be included in the early sprays.

Leaf roller (*Cacæcia rosaceana*). There are several species of insects the larvæ of which tie leaves together or fold them in various ways to form nests within which they may do their feeding undisturbed, or to which they may retreat for rest between meals when feeding on leaves outside. The clusters of partly eaten leaves turn brown and are unsightly evidences of the presence of these insects. Where they are numerous, young trees may be almost entirely defoliated and bearing trees greatly injured.

The oblique-banded leaf roller is reported as injurious in several states, not only to the apple but to pear, plum, and peach trees, and also to small fruit plants.

The leaf tier, also called the lesser apple-leaf folder (*Teras minuta*), is a widely distributed species that is often very injurious, especially to nursery stock. It produces three broods, the larvæ of the first brood folding young leaves longitudinally and tying the edges together with silken threads. Several leaves may be tied together, and if two larvæ inhabit the same cluster the whole cluster may be involved. The leaves, which are in part skeletonized and in part eaten through, soon turn brown and readily make apparent the extent of the injury. The larvæ pupate within the leaf clusters, the later broods effecting the same kind of injury, except that, where eggs are laid on fully developed leaves, usually only one edge of the leaf is turned in to form the nest. Moths which appear in the fall live over winter and deposit eggs on the opening buds in spring.

Leaf skeletonizer (*Pempelia Hammondi*). This insect is common in orchards east of the Rockies. The brown, skeletonized leaves are often very conspicuous, particularly late in summer. The injury is done by the larvæ of small moths, which appear in spring and deposit eggs on the leaves. The moth has a wing expanse of about half an inch and is of a dark-brown color relieved by two light-gray bands across each fore wing.

The larvæ spin thin silken webs, under which they work, and often draw neighboring leaves together but do not fold them down, as does the leaf crumpler. They eat the upper epidermis and the pulp, leaving the lower epidermis and the network of veins. They are transformed to pupæ on the leaves under the webs, in which stage they pass the winter. There are two broods, and in the South probably three.

As the larvæ feed quite openly, this pest should be easily kept in control in well-sprayed orchards. The fact that most of the injury is done rather late in summer, after early applications have been mostly washed off, suggests that a midsummer spray would probably be most effective.

Nursery trees and young orchards frequently suffer more from this insect than bearing orchards, for the reason that they are often less carefully sprayed. All leaf-eating insects take as kindly to young trees as to old. Young trees need all their leaves in order to make satisfactory growth, just as bearing trees need the full leaf complement in order to perfect their crops. This is sufficient reason for urging the careful spraying of all young trees before the need becomes too urgent.

Cankerworm. There are two common species of this pest attacking fruit trees—the spring and the fall cankerworm. They differ somewhat in their history, but the general treatment is the same. The larvæ when full grown drop to the ground and pupate in the soil. The female adult has no wings, and in order to reach the branches to lay its eggs it must crawl up the trunk of the tree. The fruit-grower can take advantage of this fact and place bands of sticky substances, such as Tanglefoot, around the tree trunks. An equally effective and perhaps less expensive remedy, since it can be used for a great many leaf-eating insects, is a poison spray applied early in the summer.

Fall webworm. The fall webworm is an insect somewhat similar in habits to the tent caterpillar, but appears in large numbers only late in the season. It spins its web at the tips of the branches, covering the leaves on which the young larvæ are to feed.

This insect can be destroyed in the same way as the tent caterpillar. Since the web is at the tip of the branches, it can frequently be cut off and burned. Spraying with lead arsenate or Paris green is also effective.

Palmer worm. Another fruit-eating insect, which has appeared in conspicuous numbers during June throughout the fruit belt in western New York and was quite destructive in unsprayed orchards, is the palmer worm. It was reported that in some neglected plantings in Orleans County as many as half or more of the young apples were eaten into by these active little caterpillars. It is of

interest to note that this species overran many orchards in this same region during 1900 and, because of its large numbers and destructiveness to the young fruit, created quite a little consternation among growers. This is the fourth time that this pest has attracted attention by its injurious work, the earlier outbreaks having occurred during 1791 and 1853. It is to be hoped that the short time between its last two appearances does not indicate a change in habits and that attacks are to occur at more frequent intervals. Whatever the future may have in store, it is gratifying to record that orchards thoroughly sprayed for the codling moth have suffered little or no injury from palmer worms.

Tent caterpillar. The tent caterpillar is prevalent in the apple orchard, but can be easily controlled. Everyone knows its characteristic silken nest, found usually in a fork of the tree formed by two large branches. The caterpillar retires to this when the weather is inclement, or when it is through with its feeding. This pest may be destroyed by spraying the tent with kerosene and burning it, or on its first appearance by a regular spraying of the leaves for other leaf-eating insects.

Apple-leaf trumpet-miner. The apple-leaf trumpet-miner is an insect of recent appearance which has caused considerable alarm among orchardists. As it lives most of its life between the upper and lower surfaces of the leaves, where it cannot be reached either by contact or poison sprays, it is a difficult insect to control. Fortunately, it does not occur in very large numbers until rather late in the summer, when most of the work of the leaves is over.

Brown-tail moth. Two insects that have received little notice except in eastern New England, but are likely soon to compel attention in other parts of the United States, are the brown-tail moth and the gypsy moth.

The brown-tail moth is a common European pest of fruit and shade trees, and has been an object of interest to gardeners from the earliest times. Throughout Europe it is known as the "common caterpillar," and accounts of its habits and periodical ravages

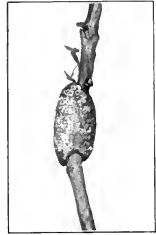


FIG. 82. Tent caterpillar

Egg mass of the tent caterpillar found on the twigs of the trees

are to be found in nearly all European works on entomology and horticulture. It made its way accidentally to Somerville, Massachusetts, in the early nineties, — probably in a shipment of roses from Holland, — multiplied, spread, and is now generally disseminated over eastern New England.

Damage by the brown-tail moth. While at first a pest only of the pear and other fruit trees, the brown-tail moth has now adapted itself to various species of forest trees, notably the oaks. In the spring, as soon as the buds unfold, the young caterpillars begin to feed and, where numerous, completely strip even large trees. When the food supply gives out they swarm forth along fences, walks, etc. in search of other foliage. As in the case of the gypsy moth, all the destructive work of the brown-tail moth is done by its caterpillar.

Whenever these insects come in contact with human flesh, they produce a severe and painful irritation, which is apparently due to some poisonous substance in the hairs, and also, perhaps, to the finely barbed and brittle hairs themselves. So severe is this affection that in many cases people have been made seriously ill by it. The best remedy for it is the liberal use of cooling lotions or the free use of common vaseline.

History of the brown-tail moth. *The moth.* The moths are pure white on the wings, but the female has a conspicuous bunch of brown hair at the tip of the abdomen, hence the name "brown-tail moth." The female has a wing expanse of about $1\frac{1}{2}$ inches, that of the male, which is slender-bodied, being slightly less. Both the male and the female fly mainly by night, and are greatly attracted to lights.

The egg. The egg mass of the brown-tail moth somewhat resembles that of the gypsy moth, but is laid on the underside of a leaf, — seldom on a tree trunk, — and is smaller, more elongated, and of a brighter reddish-brown color. From July 15 to the end of the month the white moths lay their eggs in brown, hair-covered masses on the leaves near the top of the trees. Each egg cluster contains about 300 eggs, closely packed in a mass about $\frac{2}{3}$ inch long and $\frac{1}{4}$ inch wide.

The caterpillar. The eggs hatch during August, and the young caterpillars begin to feed in clusters on the upper surface of the

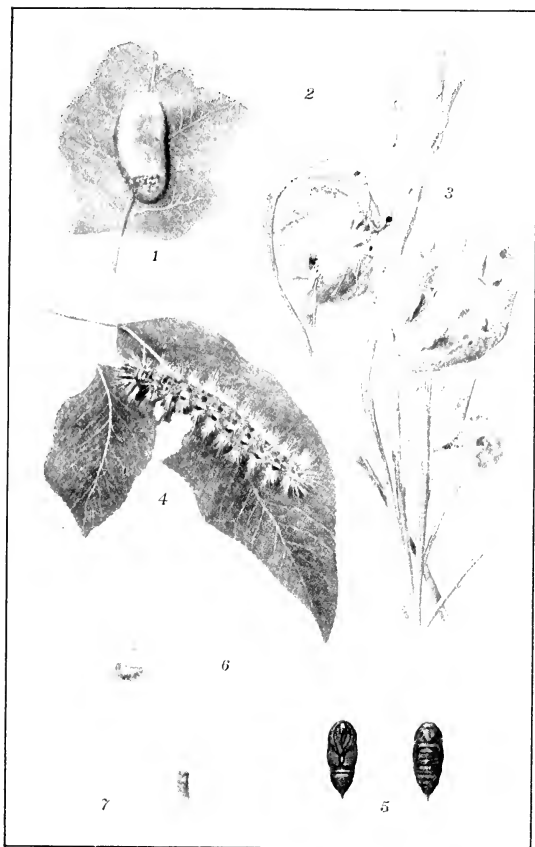


PLATE II. LIFE HISTORY OF THE BROWN-TAIL MOTH

1, egg cluster; 2, single egg (enlarged 5 diameters); 3, winter nests on tips of twigs; 4, caterpillar; 5, pupa (ventral and dorsal view); 6 and 7, female and male moths

leaves, but soon commence to spin their winter webs. A number of leaves in the vicinity of the egg clusters are drawn together and carefully spun in with a tenacious silken web, which is grayish in color, composed of dead leaves and silk, and very hard to tear apart. Each web contains about 250 caterpillars and varies in length from 4 to 6 inches. With the approach of cold weather the caterpillars enter the web and close the exit holes. We then have the strange phenomenon of a caterpillar only a quarter grown living through the winter and emerging the following spring to complete its life. The extremes of cold in Massachusetts, where they are so common, do not seem to affect these insects adversely. They emerge in the spring, usually early in April, eat first the buds and then the blossoms, and attack the foliage of fruit trees as soon as it develops. Unlike the gypsy-moth caterpillars they habitually feed by day. Stripping one tree of its foliage, they go to others and continue to eat until full grown, when they spin their cocoons within the leaves at the ends of the branches or sometimes on the tree trunks. The full-grown caterpillar is about 2 inches in length, with a broken white stripe on both sides and two conspicuous red dots on the back near the posterior end.

The pupa. The caterpillars pupate within their cocoons, most of which are formed at the tips of twigs within a spray of leaves, but at times are made on house walls, fences, tree trunks, etc. The pupa is a compact, dark-brown body, about $\frac{5}{8}$ inch long, with yellowish-brown hairs scattered over its surface. Pupation takes place the latter part of June, and the moths emerge about the middle of July.

Distribution. The brown-tail moth is known to have spread at least as far to the northeast as Eastport, Maine, and as far south as Cape Cod, Massachusetts. In western Massachusetts it has been found at Amherst, North Adams, and Clarksburg, while the eastern part of the state from north to south is now quite solidly infested. The moth doubtless also exists in many communities in Massachusetts and other states which have not yet been reported.

The female brown-tail moth, like the male, is a strong, swift flyer, and can carry her eggs long distances before depositing them. For this reason, this moth has spread much farther from its point of introduction in Massachusetts than has the gypsy

moth. In its flight it is often aided by strong winds, and is also transported by steamboats and by electric and steam cars, to which it is attracted at night by the lights.

The caterpillar of the brown-tail moth, when young, has the "spinning down" habit, and is transported by vehicles and pedestrians. It is therefore essential that the neighborhoods of traveled highways be kept free from this pest.

Where to look for the brown-tail moth. *The egg.* The gathering of leaves which bear egg masses is feasible only in the case of shrubs and young trees whose foliage may be reached from the ground. Rose bushes, dwarf fruit trees, and ornamental shrubs may often be cleared from the moth in this way.

The caterpillar. The winter webs or nests containing the hibernating caterpillars are conspicuous objects at the tips of twigs from October to April. These webs should be sought out and removed by the use of pole shears or long-handled pruners, and then carefully collected and burned. It is more satisfactory, when possible, to burn the webs in a furnace or stove, since with an open bonfire extra care must be taken to see that none of the webs escape with a mere scorching. The work of web destruction and gathering can be carried on to best advantage when a light snow is on the ground, although it is desirable that the work should be done as early as possible after the leaves fall. It should be borne in mind that webs cut off and thrown on a dump heap, as well as those that are beaten off by storms, will yield their quota of caterpillars the following spring.

Spraying is very effective in the case of brown-tail moth caterpillars, which are much less resistant to the action of poison than are the gypsy-moth caterpillars. For best results, spraying should be done as soon as the foliage develops in the spring. From 5 to 8 pounds of arsenate of lead paste to 100 gallons of water is an effective spray, or, if preferred, 1 pound of good Paris green well stirred into 150 gallons of water may be applied.

Such trees as are free from the moth may be protected from the caterpillars which crawl from neighboring estates by applying sticky bands. The banding, however, will not prevent the infestation of the trees by the winged female moths, which fly in July.

The pupa. When the caterpillars have changed to pupæ inclosed by their cocoons, — in which state they are most numerous the latter half of June, — they may be gathered and placed in a barrel covered with mosquito netting, which confines the moths but allows the escape of parasites. The work of gathering these cocoons is likely to be attended by severe inflammation of the skin from contact with the nettling hairs.

The moth. As already pointed out, the moths assemble in great numbers around electric and other lights. During the flying season lamp posts are frequently covered with hundreds, if not thousands, of them, which can be washed down and killed by the free use of the hose.

Natural enemies of the brown-tail moth. The brown-tail moth has natural enemies in the fungus *Entomophthora aulica*, in various parasites, and in the Calosoma beetles. The fungous disease has been found to occur in this country naturally, and has also been propagated and spread artificially. The parasites and beetles have been planted throughout the most thickly infested sections and are spreading naturally.

Gypsy moth. As far back as authentic records go, the gypsy moth has been a destructive insect pest in Europe — at times increasing enormously and disastrously, then for other periods decreasing, only to increase again and renew its extensive ravages. At the present time it is most numerous and destructive in southern Russia.

Up to the year 1868 a gypsy moth was not known to exist anywhere within the Western Hemisphere. In that year the insect was brought from Europe to Medford, Massachusetts. Escaping, it spread into many cities and towns of eastern Massachusetts, and increased enormously, until in 1890 it became a serious pest over a large territory.

Damage caused by the gypsy moth. The gypsy-moth caterpillar will attack all fruit, shade, and woodland trees. It shows a preference for the apple, white oak, red oak, willow, and elm. It will devour on occasion nearly every useful grass, plant, flower, shrub, vine, bush, garden or field crop that grows in Massachusetts. It kills both deciduous and coniferous trees, but in its early molts will not feed on pines. Woodlands assailed by it in formidable numbers are stripped bare and many trees are killed. Where it

abounds in residential districts, it not only eats nearly everything green, but swarms in caterpillar form on houses, walks, and verandas, and often enters dwellings.

History of the gypsy moth. *The moth.* The gypsy moth, like all insects of its class, exists in four different forms during the year. Between July 15 and August 15 the winged moths emerge from the pupæ, the date varying according to the season and time of pupation. The male moth, which has a slender body, varies



FIG. 83. The work of two new insects

What the brown-tail and gypsy moths are doing to many New England orchards—
defoliating and killing the trees

Moral: Beware of the brown-tail and gypsy moths

from a brownish yellow to a greenish brown in color and has a wing expanse of about $1\frac{1}{2}$ inches. It flies actively by day with a peculiar zigzag flight.

The female moth, which is heavy-bodied and sluggish, is nearly white with numerous small black markings and expands about 2 inches. It does not fly, otherwise the spread of this pest would be far more rapid than it is. After mating, the moths live but a short time, the female dying after depositing her egg mass. The winged moths take no food, all damage to foliage being caused by the caterpillars.

The egg. The eggs of the gypsy moth are laid in July and August in a yellowish, hair-covered mass, averaging about $1\frac{1}{2}$ inches

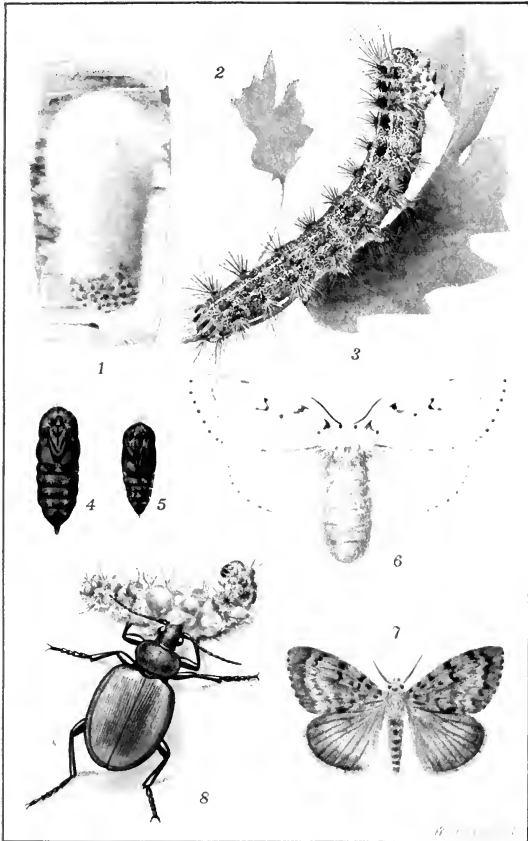


PLATE III. LIFE HISTORY OF THE GYPSY MOTH

1, egg cluster; 2, single egg (enlarged $3\frac{1}{2}$ diameters); 3, caterpillar; 4 and 5, female and male pupae; 6 and 7, female and male adults; 8, imported lion beetle (*Calosoma sycophanta*) eating a caterpillar. (Natural size, except 2)

long and about $\frac{3}{4}$ inch wide. To the eye the egg mass resembles a small, tightly stuffed, oval, buff-colored cushion. During the winter the color often fades to a dingy white. In this mass the eggs, to the average number of 500, are closely packed with yellowish hair from the body of the female. An individual egg is scarcely as large as a pinhead, salmon-colored when first laid, but turning dark in the course of a few weeks.

The caterpillar, or larva. The eggs hatch about May 1, and each mass, or cluster, yields a swarm of small caterpillars, most of which become fully grown by midsummer. The head of the caterpillar is large in proportion to its body, this being especially noticeable when it is young. Its body is decidedly hairy throughout its whole life.

The mature caterpillar has a dusky or sooty-colored body and a peculiar marking which is found on no other New England larva. Along the back, starting from the head, which is marked with yellow, is a double row of blue spots followed by a double row of red. This double row, consisting of five pairs of blue and six pairs of red spots, is usually very noticeable on caterpillars which have attained a length of $1\frac{1}{2}$ inches or more, but does not always show up on the shorter caterpillars. The mature caterpillar frequently attains a length of 3 inches.

The pupa. When fully grown, usually in July, the caterpillar spins a few threads of silk as a supporting framework, casts its skin, and changes into a pupa, or, as it is sometimes called, a chrysalis. The pupa is dark reddish or chocolate in color and very thinly sprinkled with light-reddish hairs. Unfortunately it resembles the pupæ of certain other moths found in Massachusetts, and cannot, except by experts, be identified at a glance. The thinly sprinkled, light-reddish hairs are, however, characteristic.

Distribution. The gypsy moth spreads chiefly during the caterpillar stage. While the caterpillars do not crawl very far from their cocoons, except when there is a scarcity of food, they have the habit, when small and young, of spinning down from trees and falling on vehicles, which carry them from place to place. Electric cars, pleasure and business vehicles, bicycles, and automobiles are common means of thus transporting them, and the necessity of keeping the neighborhoods of traveled highways free

from the insect is at once apparent. It has been proved conclusively that young caterpillars can also be carried a great distance by the wind, which probably accounts, in some cases, for new colonies found a long way from any known source of infestation. The egg clusters may also be transported on any of the numerous objects on which they are laid. Even freight cars that have stood near infested foliage long enough for the laying of gypsy-moth eggs may be the means of spreading the pest.

The gypsy moth now occurs in southern New Hampshire, in Massachusetts, and in the southwestern part of Maine.

Where to look for the gypsy moth. *The egg.* From August to May the egg masses of the gypsy moth may be found in places near which the moth emerged from the pupa case. The female moth deposits its eggs on tree trunks, the undersides of limbs, sheltered crotches and holes in trees, hollow trees, crevices in or under rough bark, etc. The egg clusters are also found on shrubbery, buildings, scattered and heaped rubbish, barrels, boxes, and similar objects standing out of doors, woodpiles, stone piles, fences, walls, bowlders, and the like. The tendency is to deposit the eggs on the lower or the inner surface of an object. When the moths exist in large numbers they disregard all rules, and their egg clusters may then be found in sight as well as hidden, and in all sorts of places, even within buildings.

The caterpillar. From May to August the caterpillars may be found in various stages of growth, their numbers rapidly diminishing after July 15. In the spring the small caterpillars should be looked for on the foliage, chiefly on the underside. As the caterpillars grow, they commence to feed at night. During the day they seek shelter, generally in clusters, on the shady side of tree trunks, beneath large limbs, under rough or loose bark, in holes in trees, under fence rails, in walls, stone heaps, rubbish piles — in short, in any accessible place offering shelter from the sun and the birds. The caterpillars cast their skin several times, the molted skins being a characteristic sign of the presence of the moth.

The pupa. Gypsy-moth pupæ are most abundant during the latter half of July. They are to be found in the same places chosen for the egg clusters and not infrequently, also, in the foliage of trees and shrubs.

The moth. The peculiar zigzag flight of the male moth has already been noted. The large, white, conspicuous female moths sit or crawl on tree trunks, etc., near their pupa cases. It is usually the latter half of July and through August that the females lay their eggs.

Gypsy-moth remedies. *Egg killing.* With the gypsy moth no single method of destruction is more effective than killing the eggs. The egg masses wherever accessible can be killed from August to May by soaking them thoroughly with creosote mixture, which may be applied with a small swab or paintbrush.

Caterpillar destruction. Spraying infested foliage with arsenate of lead at the rate of 10 pounds to 100 gallons of water, thoroughly mixed, is very effective when the caterpillars are small. For use on trees, a pump mounted on a barrel tank or hogshead is desirable. The mixture should be applied, if possible, on a clear, dry day, beginning at the top of the trees, and in such a manner as to cover the leaves, rather slowly, with a fine mist. The foliage should never be drenched with a stream; when the leaves begin to drip, spraying should at once cease. The work is most effective when done during May and early June.

If a strip of burlap or other coarse cheap cloth is tied about the middle of an infested tree trunk so that the flaps hang down, the caterpillars, as soon as they have acquired the night-feeding habit, will gather under the cloth and may then be destroyed by crushing or by cutting with a sheath knife. The burlaps should be examined daily, or, if the caterpillars are in great numbers, several times a day. Burlap can be successfully employed from the latter half of May to the first or middle of August, for the caterpillars will ordinarily pupate under burlap, and the winged moths lay many eggs under it. It should be borne in mind that the cloth band is in no sense a tree protector. Serving as a hiding place for various insects, it is better off the tree than on unless it can be attended to and kept clean. At the end of the caterpillar season all burlaps should be removed and burned.

Banding a noninfested tree with insect lime or other sticky substance to keep off the caterpillars can be made an effective means of protection if the branches of the tree do not interlock with those of an infested tree, and if the two do not stand so near together

that the small caterpillars can pass from one to the other by means of their fine threads. A band, to be effective, must remain sticky. When caterpillars are numerous, in their attempt to cross the band they often bridge it with their threads and dead bodies, so that other caterpillars coming later are able to ascend the tree. For this reason, and in order that the caterpillars which collect beneath may be killed, the sticky band should be inspected frequently. If the many caterpillars which often herd below the sticky bands are not killed, they will in time leave the trees for shrubbery, where they are less easily destroyed, and there will complete their feeding period and be transformed into moths. Insect lime, Raupenleim, Tanglefoot, birdlime, printer's ink, or even axle grease are among the materials most used for banding. All may be dangerous to the tree and should be removed after the caterpillar season has passed.

Destroying pupæ and moths. Pupæ are commonly found under the burlap and in other places frequented by the caterpillars. They are often massed under large branches or in other sheltered places. In similar locations the female moths may be found in numbers. Both forms of the insect may be crushed by hand during July and August.

Natural enemies of the gypsy moth. The gypsy moth has some natural enemies that seem at the present time to promise help in the warfare of destruction. The most important is the wilt disease, or "flacherie." The disease occurs naturally when the caterpillars are in great numbers and find feeding scarce. It is a bacterial disease which affects the intestinal canal of the caterpillar and soon causes death. There are other diseases which afford help at times, but none of any considerable importance.

The large carnivorous ground beetles, such as *Calosoma* sp., and other parasites of the gypsy moth have now been planted over all the worst-infested sections, and it is believed that they are increasing in numbers and actually becoming acclimated. Since all these parasites are helps to the suppression of the gypsy moth, their appearance should be studied so that they may not be destroyed by mistake.

INSECTS AFFECTING THE BLOSSOMS

Bud moth (*Tmetocera ocellana*). The eye-spotted bud moth is recorded as injurious in most of the Eastern states, in Michigan, and in Missouri. The moths of this species appear in June and deposit eggs singly on the undersurfaces of leaves. The larvæ eat the lower epidermis and the pulp, thus skeletonizing the leaves. They spin thin webs under which they work until early fall, when they move to twigs, where, in any rough or angular place in the bark or about a bud, they spin a silken case to which they retire for the winter. In the spring the half-grown larvæ emerge and eat into the buds or tie together the young leaves or flowers, forming nests within which they work. Late in May they pupate within these clusters, and soon the moths appear. There is thus but one brood.

Where numerous, these insects do very serious damage. The destruction of flower buds cuts short the fruit crop, and the destruction of leaf buds induces irregular growth and interferes with the symmetry of the trees.

The apple-bud moth (*Eccopsis malana*). Saunders,¹ in his work on injurious insects, describes another species, which he says has seriously injured the apple trees in the orchards of northern Illinois by devouring the terminal buds on the branches.

Pear thrips. In its appearance and habits the thrips is quite different from the other insects which our growers have to combat. The adult is a small, dark, flylike creature, which seeks the buds as they are opening and attacks the tenderest of the flower parts. The destructive work of the insect is largely done before the appearance of the flowers, and trees that are severely injured have at the time of blossoming the appearance of suffering from blossom blight. Affected orchards sustain losses in yields according to the severity of the attacks. In the worst-infested areas one may frequently observe plantings which show total losses in fruit yields.

Spraying experiments indicate that this pest may be effectively combated. Growers interested in the work of this new pest are referred to *Bulletin No. 343* of the Geneva (New York) Experiment Station.

¹ William Saunders, F. R. S. C., *Insects Injurious to Fruits.*

INSECTS AFFECTING THE FRUIT

Codling moth (*Cydia pomonella*, L.). Of the insects preying directly upon the fruit of the apple the codling moth, or apple worm, is the most important economically. Because of its universal distribution it is well known both to producer and to consumer. To the latter, only the result of the insect's injury is familiar, the worm itself usually having long since forsaken the apple. When one encounters an apple tunneled by cavities with blackened and bitter walls, and partially filled with the blackish frass, or castings, of the worm, he may know that the agent of these hidden and distasteful mining operations is the larva of the codling moth.

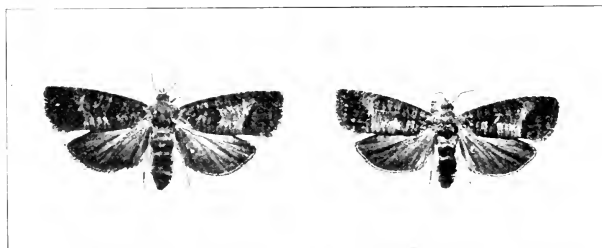


FIG. 84. Codling-moth adults. (Department of Entomology, Cornell University)

But it is to the grower that the insect is best known and most unwelcome. To him the moth represents steadily cumulative losses throughout the whole growing season. A large percentage of the apples which fall prematurely from May until harvest time are victims of the voracity of the codling-moth larva. One has but to keep a record of the windfalls from a single unsprayed tree for a season, classifying them according to the initial cause of their fall, to realize that the apple worm is a guest with an appetite that is costly to satisfy. Nor does its havoc stop here. Not only does it cut off many apples from all possibility of maturity but it so affects others that cling to the tree that they are, at best, unfit for sale except as culls.

History of the codling moth. In order successfully to combat an insect, it is necessary to know its history, for most insects are



PLATE IV. THE CODLING MOTH AND ITS WORK *

(After a drawing by L. H. Joutel. Courtesy of the New York State Museum)

more vulnerable at one stage of their development than at others. The history of the codling moth from egg to adult is in four stages — the egg, the larva (or worm), the pupa, and the moth. Normally there are from one to three broods.

The adult. The adult insect is a moth having a wing spread of from $\frac{1}{2}$ to $\frac{3}{4}$ inch. The fore wings are striped transversely with alternate dark gray and brown. The hind wings have the same general grayish-brown, nearly saffron coloring of the body. The moth is seminocturnal in its habits, confining its activities to dusk and early dawn. For this reason, and because of the manner in which its color blends with its natural surroundings, it is nearly invisible and is seldom detected.

The egg. The egg-laying season begins in the early spring several days after the moth emerges from hibernation. It is renewed at intervals, coincident with the maturing of successive broods, until well into September, reaching its zenith with the third brood. There is a partial overlapping of generations, which renders egg-laying more or less continuous. Approximately 85 per cent of the eggs are laid on the upper surface of the leaves. There is much variation in the number of eggs deposited, the average being about 50, and also in the length of life of the moths.

The eggs are laid singly, and when first deposited are of a milky-white color, circular in outline, of about the diameter of a pinhead,

* *A*, two small apples, the end of one and the side of the other wormy. The former is the most common method of injury by apple worms or larvæ of the first brood, while the other is very characteristic of larvæ of the second brood, and is usually confined to points where fruits touch or where a leaf and apple adhere. *B*, group of blossoms ready to spray and showing conditions just after the petals drop. Note that the green sepal lobes are widely expanded or drooping, and that conditions are therefore favorable for filling the calyx cup with poison. *C*, three mature apples showing the work of the apple-worm (or codling-moth) larva about the core, at the blossom end, and an irregular cavity at the side, a point where the full-grown larvæ frequently escape. *D*, a piece of bark removed from the tree and showing on the undersurface the numerous cocoons in which the insects hibernate and undergo their transformations from the caterpillar to the pupa and moth. *1*, moth with wings expanded, natural size. *2*, moth resting on young apple, side view. *3*, moth resting on leaf, seen from above. *4*, a portion of a pinkish apple worm or larva in a wormy apple. *5*, cocoon, seen from the underside and showing the hole made by a woodpecker in search of the apple worm or larva. *6*, cell on the underside of the bark containing a codling-moth worm or larva. Note its nearly doubled position. *7*, upper surface of bark showing hole made by a woodpecker. The same condition seen from the inner surface is represented at *5*. *8*, empty cocoon. *9*, group of old cocoons. *10*, two cocoons in which apple worms or larvæ have been destroyed by fungus. *11*, oval excavation in the bark made by the apple worm or larva prior to spinning its cocoon. *12*, newly made cocoon, the silken case being nearly obscured by particles of bark.

and with a slightly convex upper surface. When the eggs have attained a certain stage of incubation (variable according to season and temperature) a reddish ring appears around the center, which later changes to a black spot. The egg is then almost ready to hatch. Early in the season eggs require eight or ten days for hatching, but as the season advances fewer days are required, the average being about five days in June, July, and August.

The larva. From the egg emerges the larva, the length of which is then only about a sixteenth of an inch. It proceeds almost at once to crawl to the nearest apple, sometimes selecting as a site for its entrance an abrasion or break in the skin, but usually the blossom end. It is not uncommon to find the larva first feeding on the leaf, especially when it was hatched some distance from an apple. Most of the invasions of the fruit are effected through the calyces, as these afford the least natural resistance, but the larvæ also often penetrate the unbroken skin of the fruit. They usually protect themselves by a network of silken threads spun at the place of entrance.

The color of the young larva is white at first, but becomes pinkish as it increases in size. There are three pairs of true legs on the anterior part of the body and five pairs of prolegs on the abdominal segments.

As the larva feeds, it increases rapidly in size. The castings produced along the journey into the fruit are at first thrust backwards and out of the opening made by entering. This mass is held together by silken threads. Later, as the larva advances into the apple, generally toward the core, the castings are pushed into the channels which it has traced. Full growth is attained in approximately three weeks (a variable item), and the larva is ready to leave the fruit. When full grown, it measures from $\frac{5}{8}$ to $\frac{3}{4}$ inch in length.

When ready to make its exit from the fruit, it either makes use of the entrance channels or eats its way to liberty at another point.

When apples are infested before they are half grown or soon after, they generally fall from the tree. Usually, however, the fruit does not fall until after the emergence of the larva. In the latter part of the season most of the infested fruit holds to the tree, but is of greatly lessened value, if not entirely worthless.

The pupa. After leaving the apple the larva seeks a favorable place in which to spin its cocoon for pupation. Sometimes it lowers itself directly to the ground by means of the silken thread it can so prodigally spin, pupating in litter or some other protection found on the ground. Usually, however, it crawls down the limbs of the tree to the trunk, hiding itself under partially loosened bark or in crevices and cracks in the wood, and spinning about itself an elongated, tightly woven cocoon. In this silken sleeping shroud are undergone the subtle, invisible transformations from larva to pupa and from pupa to imago.

The pupa itself is a contracted embodiment of the larva. The average length is about half an inch, and the color ranges from light to dark brown.

The length of pupation varies greatly. The average time is from two weeks to sixteen or eighteen days. Eventually the pupa works its way from the cocoon as an adult moth,

and after a brief interval the female begins to deposit eggs for another brood. The larvæ entering cocoons in the fall do not at once pupate, but hibernate as larvæ, pupating at the approach of warm weather the following spring.

Treatment. It is evident that control of the codling moth must be effected chiefly by measures prohibitive of the entrance of the larvæ into the fruit. The best means of securing this end is the use of poison sprays. There are several arsenicals which have been and are still being used, but from the point of view of efficiency, economy, and harmlessness to foliage and fruit, arsenate of lead is doubtless superior to all. Clean, smooth-barked trees and ground free of rubbish also unquestionably help the orchardist by depriving the worms of their pupating quarters, but these conditions are not essential — only desirable.

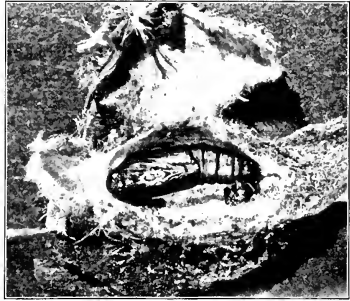


FIG. 85. Pupæ of the codling moth.. (Department of Entomology, Cornell University)

When to spray. The first spraying is all-important, and upon its timeliness and thoroughness depend the grower's chances of success. When the calyx cups have been filled with poison and the calyx lobes have closed upon it, the fortification of the apple against infestation in that direction is complete, for the first food taken by the young larva as it seeks to enter will result in death.

First spraying. Following the shedding of the bloom, the young apple soon reaches the proper condition for the first spraying. The outer cup is so shaped as to catch and retain the liquid poison, but the entrance to the inner cup is obstructed by the pistils and their encircling stamen bars. It is plain that it is not enough merely to fill the outer calyx cup. The spray must be applied with sufficient pressure and volume to force itself past the obstructing stamen bars, otherwise maximum good results will not be effected.

The experimental work of the past two years has demonstrated that the best results are obtained by applying the spray to the fruit with a nozzle throwing a heavy, coarse spray under high pressure — from 200 to 300 pounds. Only in this way can the inner calyx container be impregnated with poison. The fruit clusters at this stage point up and down and to all parts of the compass, and to drive the spray directly and forcibly into them the nozzle must be carried to all parts of the tree and be used at all angles. On tall trees the bloom ends of the highest fruit clusters which point upward cannot be reached by a spray from the ground; they must be drenched from a tower mounted on the spray wagon.

The imperative necessity of filling the cluster cups at this time demands thorough, conscientious work. Too much stress cannot be placed upon making the spraying liberal and painstaking. The material used in this spraying should be from half to twice as much as in any subsequent treatment. All expenditures of time and care and money will yield rich returns in the cleanliness and value of the mature fruit.

It is recommended that 3 pounds of arsenate of lead to 50 gallons of water be used, to which should be added a milk-of-lime solution made from 3 pounds of slaked stone lime. All constituents — lead, lime, and water — should be carefully strained into the spray tank or barrel.

Second spraying. The difference in the time of blooming of different varieties of apples, and even of fruit clusters on individual trees, makes it certain that when the calyx end of a certain percentage of the fruit has advanced to the proper conditions for the first spraying, the remainder — perhaps the greater part — is yet in bloom. A second spraying, a week or ten days later than the first, is necessary in order to reach these belated blooms before their calyxes close. It is also desirable to apply to the fruit a heavy coating of arsenical spray material as quickly as possible on account of the early and great activities of curculio. The second application is more valuable if applied with a view to treating belated blooms than if applied arbitrarily three weeks after the first spraying.

As it is not practicable to consider a schedule of spraying for the codling moth independent of apple diseases, it is recommended that where diseases are prevalent the arsenate of lead of the second spraying — whether applied one week or three weeks after the first — be incorporated into a fungicide.

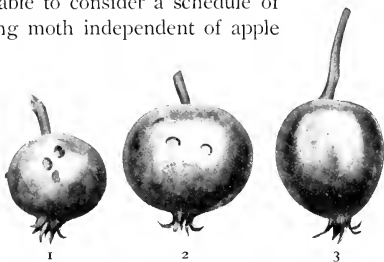


FIG. 86. Work of curculio (1 and 2) and apple weevil (3)
(Photograph by F. E. Brooks)

Third spraying. The third spraying of lead should be applied, in combination with Bordeaux mixture, six weeks after the first. To 50 gallons of Bordeaux mixture should be added $1\frac{1}{2}$ pounds of lead.

Plum curculio (*Conotrachelus nenuphar*, Herbst). As a perennial problem of apple-growing, the plum curculio takes the second place in point of economic significance. In spite of its name its dietary range includes other fruits than the plum. In addition to apples, peaches, and plums, it feeds upon and breeds in cherries, pears, and other cultivated fruits. It is recognized as the principal insect enemy of the peach, and was not successfully combated until the introduction of arsenate of lead as a means of control. In peaches, when unchecked, it finds a most congenial environment for breeding, and there reproduces itself with amazing multiplicity.

Investigations of the character and extent of this beetle's injury to fruits show that it is almost, and in some instances quite, as inimical to apple-growing as to peach-growing. The form of the injury is radically different, however. Except in extremely rare cases, curculio larvæ do not mature in the apple. The female deposits eggs freely in them, and the majority of them hatch, but unlike those hatched in peaches a very small percentage survive the larval state. They succumb to the forces exerted upon them

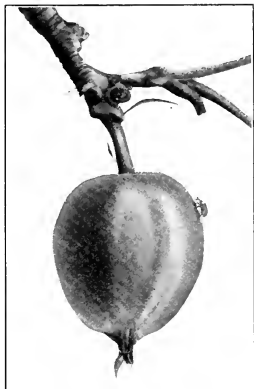


FIG. 87. Apple weevil. (Photograph by F. E. Brooks)

by the natural enlargement and cell formation of the apple, and work no injury except that of giving to the fruit a distorted shape and surface imperfections, arising from the egg and feeding punctures. This injury, however, is costly to the apple-grower. As a medium for the perpetuation of its species, the apple is fatal to the curculio.

Description and history of the plum curculio. The beetle is a member of a family of weevils conspicuous for the taxation they impose on cultivated and stored crops. The adult curculio is a beetle about a fifth of an inch in length, and is armed with a proboscis, or snout, a third as long as itself. The color is

black or dark gray, marked with ochre yellow and white. The back is ridged, bearing two well-developed humps, besides several minor prominences.

Because of its natural secretiveness and its relative inactivity in exposed places during daylight hours, the beetle is seldom seen on the trees by even the most careful observer. A peculiarity of the species is that it resorts to alleged "possum" tactics to escape observation, and will simulate death by curling up and dropping to the ground when disturbed. The beetles could be easily caught by jarring them from the trees onto sheets spread beneath, and picking them up while they are motionless and apparently dead.

This treatment by jarring has been found to be impracticable, however, and inordinately expensive.

The egg. A large number of the eggs never hatch. One reason is improper fertilization ; another is the condition produced in the egg cavity by the drying out of the tissues immediately surrounding the egg, and the heat to which it is subjected when exposed to sunlight in this relatively moistureless environment. Under such unfavorable conditions the egg collapses and the contents become thin and watery.

The greater part of curculio injury is found not in the actual destruction of the apple, but in the misshapen and blemished fruit caused by early-season egg punctures. Most of the eggs are deposited within the first six or eight weeks of the apple's life. These eggs are usually accompanied by the characteristic crescent mark of the female curculio's puncture, and with the growth of the apple the crescent cuts produce an atrophied growth at the point of incision, resulting in a malformation of the apple at that point. Later the wound heals over, but the skin forming the cicatrix is thickened and russeted. By the time the fruit is ripe for picking, this russeted skin has enlarged until it is the size of a dime, with an irregular outline. Very often there are several of these scars on a single apple.

The larva. Four or five days after it is laid, the egg is hatched into a minute, footless grub nearly white in color and with a distinct, brown head. At first very small, it grows rapidly with feeding until ready to emerge, attaining a length of about a third of an inch. The larva rarely goes to the core, as does the codling-moth larva, but eats its way into the flesh of the apple, leaving a brown, grainy ordure in its wake. Small apples often are completely emptied of their contents, save for the castings of the departed worm. In about three weeks from hatching, the larva emerges and goes into pupation in the earth.

Larval mortality. Very few larvæ ever succeed in attaining full growth in the apple. They perish before half grown, leaving as the only evidence of their occupancy a hairlike line, dark green against the white flesh of the fruit. The tissues along this line harden, becoming bitter to the taste and impairing the flavor of the apple to that extent.

The pupa. On the emergence of the larva, it digs its way into the earth, where it is transformed after a few days into the pupa. The depth to which it tunnels the soil varies, but rarely exceeds three inches. A pupating cell is prepared by the twisting and turning of the worm. In this the pupa remains dormant and inactive until it has reached the final (or beetle) stage, when, conditions being favorable, it at once forces its way to the surface. The subterranean life of the curculio is extremely variable and is largely governed by the condition of the soil. A moist soil hastens the emergence of the beetle, while a hard, baked condition greatly retards it. The average subterranean life of the beetle in loose, moist earth is about three weeks.

Soon after emergence the beetle renews its feeding upon fruit, this time by gouging out holes with its long snout, thereby making the circular punctures so commonly found in fruit in the fall. It sustains life by these depredations until the approach of winter, when it goes into hibernation in such protected places as are most readily found. In the early days of the following spring the beetles reappear, mate, and soon begin egg-laying in the fruit left exposed by the falling of the blossoms.

Treatment. By means of thorough spraying with arsenate of lead just after the blooms are off, the apples may be rendered relatively immune from the curculio egg-laying and feeding. The first application of arsenate of lead for the codling moth is rightly timed to give a protective coating of poison against the earlier activities of the curculio. Apples at that time have a pubescent growth which is retentive of liquid spray. A second spraying a week or ten days later (as recommended for the codling moth) is of more value against curculio than if applied several weeks later. The spray material adheres much better to the surfaces of apples and foliage after one or two applications. The solids deposited hold subsequent sprayings, and aid in securing a thicker and more uniformly distributed investment of poison. For this reason two sprayings should be administered in quick succession.

The habit of the plum curculio in pupating at a shallow depth in the soil renders it peculiarly liable to destruction by the clean cultivation of the orchard. Light surface harrowing either destroys the beetles or so exposes them that they ultimately perish.

Green-fruit worm (*Xylyna*). Early in the season when apples are quite small, it is not uncommon to find fruits that have been



FIG. 88. Apple maggot, male (adult stage)
(Department of Entomology, Cornell University)

eaten on one side. Sometimes the injury appears as a round or irregular cavity, and again half the fruit is eaten. Apples growing near together, as in clusters, may all show injuries of the same character. The cavities are clean and not spun over with web, indicating that the work is done by large rather than small worms. The worms responsible for these injuries are usually more than one inch

long when full grown, and are of light-green color, marked by longitudinal stripes and more or less distinct cream-colored spots.

These insects have been found in orchards for many years. As far back as 1870 they were reported as destructive, not only to apples but to pears and peaches. They have a wide distribution, being found in Canada and in most of the states east of the Rocky Mountains. In 1877 they did serious damage to fruit in the orchards about Lockport, New York, and in 1896 they were again numerous enough to attract general attention, specimens being received from twelve counties.



FIG. 89. Apple maggot, female (adult stage)
(Department of Entomology, Cornell University)

The green-fruit worm belongs to the genus *Aylina*. Slingerland¹ describes three species — *Aylina antennata*, *Aylina laticenerca*, and *Aylina grotci*. Dr. Riley² regarded the last two as varietal forms of the first. The specific differences are slight, and as the feeding habits are the same they may be considered as one species. Their history is about as follows: The eggs are laid in the spring by moths that have wintered in the adult stage or have just emerged from the pupa state. The early feeding habits of the larvæ seem not to have been observed, but probably buds and leaves form their



FIG. 90. Larvæ of the apple maggot (enlarged)
(Department of Entomology, Cornell University)

food. When discovered eating the fruits, they are about half grown. During the early part of June they complete their feeding, drop to the ground, burrow down 2 or 3 inches, and are transformed to pupæ in earthen cells. About the middle of September the moths begin to come out; some, however (possibly those that pupated late) remain as pupæ all winter,

the moths emerging in the spring. There is but one brood.

Since these worms are voracious feeders, it would seem that the arsenical sprays applied for codling moth would control them, but apparently they do not. Possibly applications of arsenical poisons made just as the buds begin to open, followed by further applications as the leaves unfold, would be effective. The presence of the worms is usually not discovered until the fruit is attacked, and then it is too late for preventive measures. By the next season the injury is forgotten, or is not remembered as serious enough to

¹ M. V. Slingerland, entomologist, Cornell University.

² W. A. Riley, entomologist, Cornell University.

warrant measures to prevent its recurrence. The worms have some parasites that help to reduce their numbers. They also have the habit of dropping to the ground when subjected to a sudden jar, just as does the plum curculio; thence, if the worms become numerous, jarring upon sheets could be profitably practiced except for very large trees.

Apple maggot (*Rhagoletis pomonella*). This insect has come under my notice only in apples from the Eastern states. In 1867 B. D. Walsh¹ described the insect from flies bred from Eastern

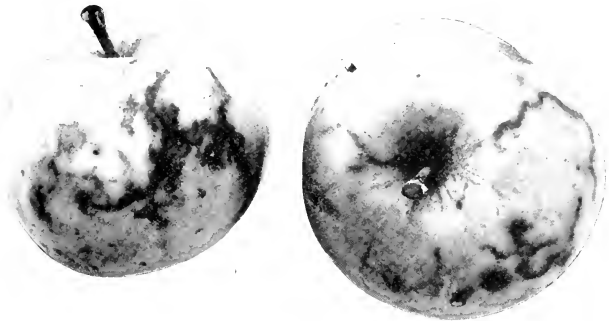


FIG. 91. The work of the apple maggot

Early harvest apples badly affected with maggots. (Department of Entomology, Cornell University)

apples and from native haws, and since that time it has been frequently reported as a serious pest in New York and in most of the New England States. In 1884 it was reported to be doing great damage in Michigan.

For some reason not readily explained the insect has failed to become generally disseminated in the Middle Western states. Most reports of serious injury come from New York and other more eastern states. These reports agree (1) that the insect spreads slowly and may infest a few trees in an orchard for several years without spreading to neighboring trees; (2) that summer and fall apples suffer much more than do winter varieties; (3) that there

¹ B. D. Walsh, Illinois state horticulturist.

are marked differences in infestation in different seasons; and (4) that it is difficult to control.

The maggot that does the injury is the larvæ of a two-winged fly, a little smaller than the house fly. At the North the flies appear early in July; in more southern regions somewhat earlier. The eggs are deposited singly beneath the skin of the apple. An individual female is capable of producing from 300 to 400 eggs, the period of egg-laying continuing throughout its life. The larvæ bore irregular channels through the fruit, feeding as they go. The feeding period continues until the fruit drops and becomes mellow. Then the larvæ bore out, go below the ground surface to pupate, and there remain as pupæ until time for the flies to emerge in early summer. There is thus but one brood a year.

As the eggs are deposited under the skin of the fruit and the larvæ feed entirely within, applications of poison are ineffective. There are two remedial measures that are successful in proportion to the thoroughness with which they are performed; namely, destruction of the fallen fruit and frequent tillage of the surface soil. The first aims at the destruction of the larvæ, the second is more or less destructive to the pupæ.

CHAPTER XIX

DISEASES

It is difficult for the amateur to realize the many ills to which apple trees are subject, but as the apple industry becomes older and more specialized, the more apparent is the necessity of a thorough investigation of the diseases of this fruit.

Careful observation of all the characters of any disease, with a full description of them on the part of the investigator, will aid in determining just what particular trouble besets any tree. This is especially true when the orchardist has a good, reliable guide to compare with the written description of the disease. Often a treatise may be most helpful if it is arranged in some logical order, especially with reference to the parts of the tree affected.

It is the purpose of this chapter to set forth in a practical manner the diseases of the apple tree with special reference to the parts affected.

DISEASES AFFECTING THE WOODY PARTS OF THE TREE BELOW GROUND

Root gall (*Pseudomonas tumefaciens*). Many times when young apple trees are removed from the nursery rows a bacterial growth in the form of a brown swelling or knot may be noticed on one or more of the roots. Generally these knots are located near the collar or crown of the roots, and therefore near the surface of the soil; but sometimes they are found to a considerable depth beneath the soil, and occasionally aboveground on the trunk.

When these knots, or galls, first develop, they may be whitish in appearance; or, if aboveground, greenish, owing to chlorophyll formation. This color, however, is soon lost and the knot becomes brown and warty. In the north these galls generally decay at the end of the season, but in the south and southwest they sometimes may continue to grow for a much longer period.

Unscrupulous nurserymen may cut away these galls if they appear on the roots, and sell the trees. But since the cutting away of the affected roots does not always eradicate the disease, the best practice is to discard all affected trees.

Root rot (*Clitocybe parasitica*). Where stumps and roots of trees have been left in the soil previous to the planting of apple trees, it has been noticed that the roots of the latter have been attacked by a mushroomlike growth. The mycelium, or root system, of this mushroom penetrates the root system of the apple tree and causes the death of both roots and tree. This disease often occurs, however, without the presence of old stumps and roots. It has been particularly troublesome in Oklahoma, Missouri, and other Middle Western and Southern states.

The means of controlling this disease seem to be simple. Digging up and burning the trees is the most practical, although trenching the affected trees is sometimes practiced.

DISEASES AFFECTING THE WOODY PARTS OF THE TREE ABOVEGROUND

Pear blight (*Bacillus amylovorus*). This is a serious disease of the apple, as well as of the pear. All varieties of the apple seem less resistant to this disease than the pears, nearly all being affected somewhat.

This disease is more commonly noticed just after pollination. Generally, during the four weeks after the fruit has "set," the tips of the branches, and often the blossoms, become wilted, turn black, and subsequently die. The bacillus as a rule does not penetrate far into the older wood of the apple tree; it injures chiefly the tips of the branches, producing the so-called "tip blight."

When first attacked, the soft bark appears water-soaked, then slowly changes in color until it is shriveled and black. Sometimes there is apparent a sharp line of demarcation between the diseased part of the twig and the healthy part, denoting that the organism has ceased to spread. Often the affected bark tissue is ruptured and a gelatinous substance, the result of the work of the bacillus, is exuded. This gelatinous matter is not always of the same color, but varies from milky white to black.

Countless numbers of bacilli are contained in the beads of the gelatinous substance, and are readily spread to the blossoms and branches by bees and other insects. They multiply rapidly in the nectar of flowers, from which they spread into the softer tissues of the young twigs. Injuries to the young growth and biting insects may assist the organism in gaining entrance to the growing tissue.

Brief exposure to direct sunlight or a period of dry weather often results in destroying the bacillus.

Where conditions are favorable the disease may winter over; but since considerable moisture and protection from drying out are necessary for successful wintering, and since relatively few twigs offer these winter conditions, it is evident that the disease does not extensively winter over.

The control methods consist in thoroughly pruning all diseased tissue and cutting each twig an inch or more below the visibly affected part. It is possible practically to control this disease if the pruning is carried on with great care and thoroughness.

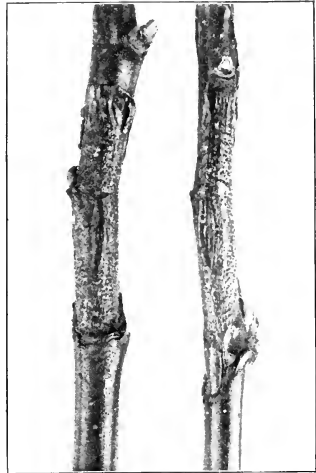


FIG. 92. Bitter rot

Stem of young tree one month after inoculating with fungus. (University of Maine)

Bitter rot (*Glomorella rufomaculans*). This disease appears as cankers or sunken areas on the bark and may be found on the limbs of the trees, where it generally passes the winter. Beneath the bark the wood growth dies and cracks open. It seems highly probable that there is a relation between the canker on the limbs and the summer form of the disease on the fruit. Duggar¹ likens the relation to a pyramidal area at the apex of which is found the cankered limb and below it the ever-increasing area of the

¹ B. M. Duggar, Professor of Plant Physiology in Cornell University.

summer rot of the fruit. Infections of the tree doubtless have their origin in the spores given off by the fruit, while, on the other hand, it is equally reasonable to assume that the canker is the means of infecting subsequent crops.

Control measures are to prune out all limbs showing canker, and spray the tree with Bordeaux mixture or lime-sulphur from two to four times during the season.

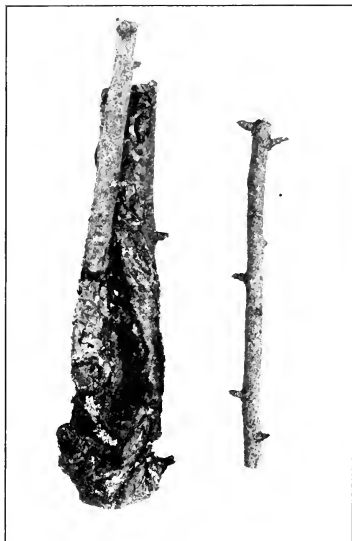


FIG. 93. Stages in the formation of *Sphaeropsis* limb cankers. (University of Maine)

Black rot and canker (*Sphaeropsis malorum*). Of late much damage has been done by this canker. It was first studied in New York State, and has since been known as "the New York apple canker." However, it has been found in other sections of the country, notably in the northeastern and north-central states, as well as in Canada, and probably in all apple-growing regions.

Its presence is indicated by a swollen appearance of the limb and a very rough and depressed bark, with sometimes an exposure of the wood in the center of the affected part. Often the affected area

extends several feet along the bark, while in its mild form the canker may be merely a spot. Small twigs and the trunks are sometimes affected, but the disease most often occurs on the larger limbs of the older trees. Young trees are occasionally infected, the result often being a complete girdling of the tree, and death.

From the available data it is evident that the most serious damage by this rot is only on limbs which have received wounds

through which the fungus can gain entrance. Sun scald injures the trees in such a way as to give an entrance to this fungus. Varieties most susceptible to this canker are the Spitzenburg, Twenty Ounce, Baldwin, Wagener, Greening, and King. Some reports speak of the Tolman Sweet as practically resistant.

Pruning, scraping, and spraying are the remedies mentioned for the control of this fungus. Good, thrifty trees, well taken care of, are a good insurance against its attacks.

European apple canker (*Nectria ditissima*). The European apple canker is a common fungus throughout Europe and to a large extent in the eastern and northeastern states. It resembles somewhat the other cankers, but is a perennial and therefore extends its growth each season, while most of the others are probably annuals. Besides this, the injured bark often peels off. The fungus first gains entrance through wounds caused by hailstones, poor pruning, carelessness in cultivating, etc. The remedy, then, would be to prevent these injuries, or to protect the wound by applications of good paint or spray mixture, such as Bordeaux or lime-sulphur.

Blister canker (*Nummularia discreta*). Although this fungus has not been a serious pest in any particular place, still it has such a wide distribution throughout the United States and Europe that it seems worthy of some consideration. It has sometimes been



FIG. 94. Limb canker on young twigs
(University of Maine)

called the Illinois canker because of its destructive work in that state. Being perennial in habit, it will in time result in the girdling and death of the limb or tree.

In appearance the blister canker differs greatly from the other cankers described. The area infested by it is only slightly sunken, brownish in color, turning black as if charred, with a mottled arrangement of healthy bark and diseased tissue. Later on the seemingly healthy bark dies, and the whole infested area has a highly uneven surface, often cracking and becoming very dry. There is a sharp line of demarcation between the infested area and the healthy bark surrounding it.

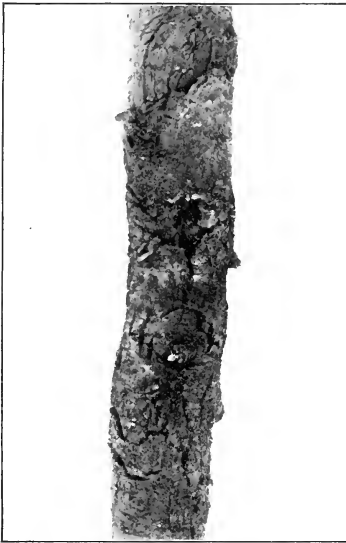


FIG. 95. Limb canker on older limbs
(University of Maine)

Pruning out the diseased areas will aid in controlling this fungus, and since it gains entrance to the tree through wounds, these must be treated as recommended in the case of the other cankers.

Decay or rot (*Polyporus sulphureus*). This fungus establishes itself in the decaying wood of the tree, especially about knot holes,

from there gaining entrance to the heartwood and killing the fibers as it progresses. The affected wood at first turns brown, then decays rapidly. In the autumn yellowish or sulphur-colored shelving clusters of the fungus are developed on trunks and limbs of trees.

Control measures are to protect all wounds with paint or some other material, in order to leave no openings for this pest. Scars

of broken limbs, pruning scars, and bruises of all kinds on roots or wood should be covered promptly and thoroughly.

Scab (*Venturia pomii*). Scab is sometimes found on the twigs of trees, especially where it is prevalent on fruit and leaves. It will be discussed in connection with diseases affecting the leaves.

DISEASES AFFECTING THE LEAVES

Pear blight. The leaves of the apple are affected by this fungus in the same manner as the twigs; in fact, the whole tip of the limb — leaves, twigs, blossoms, and fruit — has the appearance of being scorched by fire. The means of detecting this fungus and its remedy are the same as given for the woody parts of the tree aboveground (see p. 210).

Mildew (*Podosphaera Leucotricha*). A mildew covering both surfaces of the leaves is often found on nursery stock and sometimes on older apple trees. The tender twigs are also sometimes affected. The fungus can be quite easily controlled by spraying with any fungicide, such as Bordeaux, lime-sulphur, or potassium sulphide.

Cedar rust (*Gymnosporangium juniperi-virginianæ*, Schw.). As the name implies, cedar rust has for its native host plant the cedar, upon which one stage of its life cycle is spent. Infections of apple fruit and foliage are made directly from cedars and not from other sources. It follows, then, that orchards in sections free from these trees are not subject to cedar rust. There is wide variation in the effects of this disease on apple trees. Some varieties are practically immune from it, while others are ruinously susceptible to it.

Both the foliage and the fruit of the apple are attacked. The rust appears on the upper surface of the leaf as light-yellow spots, and on the fruit as brighter yellow spots which frequently have a greenish cast. As these spots enlarge, finally reaching a diameter of from $\frac{1}{8}$ to $\frac{1}{4}$ inch, they change gradually to an orange-yellow color, and numbers of minute black dots become visible in the center. After a few weeks there develops on the opposite side of the leaf a thickened cushion, which forms spore-bearing tubes, the ends of which split and curl backward, producing a fringed effect. Spores are produced in great quantities, and are carried far and wide by

winds, but have not the power to reinfect apples. Finding the original host plant, the cedar, the spores lodge there and start a new growth, producing ultimately cedar balls or cedar apples — round, reddish, gall-like swellings, usually less than an inch in diameter.

The galls begin their growth on cedar twigs during the early summer months, pass the winter there, and renew growth the

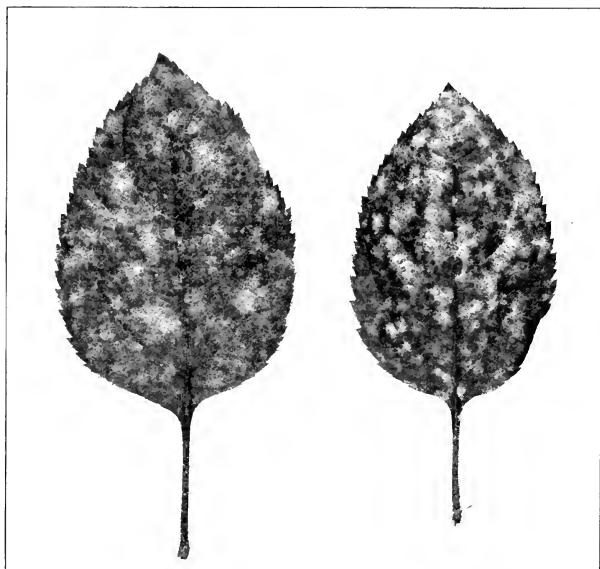


FIG. 96. Powdery mildew on leaves. (University of Maine)

following spring. Full growth is reached the second fall after the start of the infection. The second spring, in wet weather, yellow jelly-like growths protrude all over the balls. From this gelatinous mass is produced a second and smaller crop of spores, which, when dry, are like dust and may be carried by winds to apple trees, where they infect the foliage and the fruit, causing the abnormalities described above.

Cedar rust on the fruit appears as bright-yellow spots. It occurs in the majority of cases in and around the blossom-end depression. Spores are produced from the diseased areas in projections like those occurring on the leaf. The fungus penetrates into the flesh of the apple, producing a yellowish, atrophied condition of the cells.

It is well known that certain varieties of apples are more resistant to the disease than others. In some varieties it is the foliage that is most affected, while in others it is the fruit. The foliage of the Ben Davis and the Shockley is extremely susceptible to this rust, while the fruit of the latter suffers almost as much as the foliage. The principal injury wrought by the disease is to the foliage, for this naturally reacts on the whole tree. The diseased leaves fall; in some instances nearly complete defoliation takes place, with the result that the feeding functions of the whole organism are impaired, to the detriment of the crop on the trees and of the fruit buds of the succeeding crop.

Treatment. The surest method of preventing the establishment of cedar-rust infections in orchards is to remove all cedar trees and shrubs within a radius of at least a mile. The source of infection is always the cedar, since the fungus cannot exist without reproducing itself in this tree at one time in its history.

W. W. Chase¹ says that he has had only indifferent success in spraying against the disease. The sprayings were beneficial, but far from satisfactory. A fourteen-year-old Shockley orchard was used in the experiments, portions being sprayed with atomic sulphur and others with prepared lime-sulphur. The disease gets its start in early spring, at a time when wet weather favors the production of the spores on the cedar balls and their germination on apple trees. To be most beneficial the treatment should begin with the appearance of the foliage and continue at intervals of from ten days to two weeks, until the leaves and fruit are well covered by a protective fungicide.

Apple scab (*Venturia pomii* [Fr.] Wint.). With the single exception of abnormally virulent outbreaks of bitter rot, no disease of the apple is of more economic significance than apple scab. In orchards where no measures are taken to prevent or control it, the scab-diseased fruit may easily outnumber the scab-free fruit two to

¹ Assistant state entomologist, Georgia.

one. Sometimes the proportion is even greater. The badly diseased apples are small, unshapely, and often cracked and worthless. Light attacks of this scab, while not always stunting or splitting the fruit, lower its market value.

Apple scab is caused by a fungus which lives in summer on the leaves and fruit and, to some extent, on the twigs, and in winter on fallen leaves. The character and extent of its work are well known to all apple-growers. Scab appears on the fruit as roughly circular, dark-gray or olive-brown spots. The size of individual spots varies from tiny specks to blotches half an inch in diameter.



FIG. 97. Scab

Malformation and cracking resulting from a bad attack of scab. The surface of the fruit is nearly covered with scab spots. (University of Maine)

Frequently two or more scab spots join, and together extend their development so that almost the entire epidermis of the apple is scabbed. In such attacks the apple usually cracks deeply, and even if it does not drop prematurely, it has no market value.

The fungus also attacks the leaves, causing the same olive-brown discoloration common to its early stages on the apple. Most of the infections of the leaf are confined to the downy underside, the fungus rooting and growing there more readily than on the glaze-like upper surface.

The development of apple scab is coincident with the appearance of the foliage and fruit in early spring. The fruit buds are often destroyed in large numbers at this season, and when the leaves are

severely attacked, the trees are almost denuded of foliage by May. Cool, wet weather is favorable to the development and spread of scab infections, and for this reason it is most active in early spring and the rainy periods of summer.

Treatment. Destructive as the disease may be, it yields readily to control measures. Preventive measures are the surest, but they

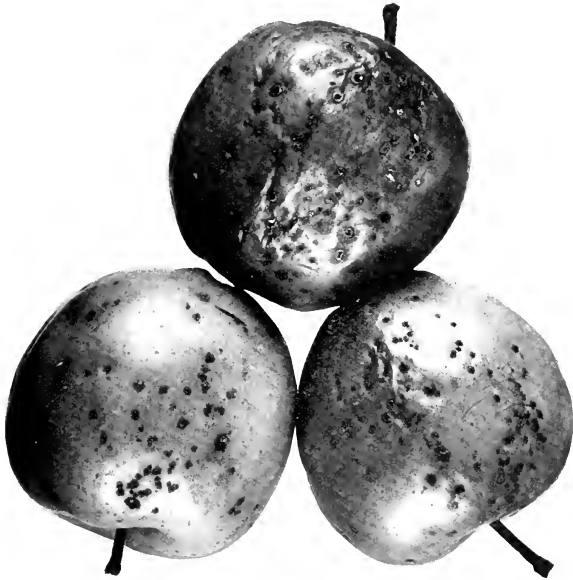


FIG. 98. Scab developed in storage. (University of Maine)

must be applied at precisely the right time to be of maximum value. It is next to impossible to check the defoliation of the tree and the scabbing of the fruit when it has gained a good start and the weather conditions are propitious for its continuance. Safety lies in being forearmed against the enemy.

The commercial lime-sulphur, diluted in the proportion of 2 gallons to 50 gallons of water, gives best results. Atomic sulphur

fails satisfactorily to qualify as a control, and has manifested decided defoliating tendencies, causing the leaves to assume a light yellowish appearance and finally to drop. The action of atomic sulphur is apparently toxic, so that the leaf is gradually discolored, its functions are impaired and finally cease, and the leaf falls. This defoliation stops after a time, but is renewed with each spraying. However, Mr. Chase¹ says that he has not observed it completely to denude a tree, the defoliation never going beyond a very appreciable thinning out. The whole process, as to coloring and dropping, is similar to that which accompanies the natural shedding of the leaves at the approach of winter.

The first spraying with 2 gallons of prepared lime-sulphur to 50 gallons of water just before the cluster buds open should be followed in two or three weeks by a second spraying with the same material, in the proportion of 1½ to 50, and by a third of the same strength three weeks later. This schedule reduced the scab to an insignificant consideration.

Apple-leaf spot (*Sphaeropsis malorum*, Peck). One of the most destructive diseases of apple foliage is known as leaf spot or frog eye. It is more or less prevalent every year, and in favorable seasons the defoliation produced by it is very serious. Like most fungous diseases, it flourishes best where there is an abundance of moisture. On apple trees located on low, poorly drained land, where there was little air drainage and the moisture on the leaves and in the soil remained longest, Mr. Chase repeatedly found that the young leaves were heavily smitten by the disease. With the coming of dry weather the defoliation ceased and the trees leafed out anew. The loss of foliage in these instances had a markedly depressive effect on the growth of the fruit.

Leaf spot is another of the apple diseases appearing soon after the leaves are out in spring. Its period of greatest activity is confined to spring and early summer. The first indication of it on the leaf is a small, grayish, circular spot. When the diameter of this spot has reached about $\frac{1}{8}$ inch a well-defined, dark-brown raised margin is developed. Numbers of spots appear on the leaf simultaneously. A single mature spot has a diameter varying from $\frac{1}{8}$ to $\frac{3}{4}$ inch, or more. At the center of each diseased area there is

¹ See p. 217.

a grayish-white spot about $\frac{1}{8}$ inch in diameter. Several raised, concentric grayish or brown rings may form at irregular intervals in the muddy-brown diseased tissue beyond the frog-eye center. The circular growth of the center spot is often modified in the extended growth, becoming lopsided. None of the above characteristic markings, with the exception of the frog-eye nucleus, is clearly defined on the undersurface. The coloring of the latter is a uniform dark-brown, punctuated by the round and lighter-colored frog-eye spots.

Leaf spot is caused by a fungus which lives over winter on fallen leaves and in cankers on the limbs and trunks of trees. In the spring are produced spores, which germinate when they fall on the young apple leaves, if moisture is present, then penetrate and grow in the leaf tissue, causing the spotted appearance described above.

Treatment. The treatment prescribed for apple scab will be found effective against leaf spot. To insure best results, apply the first spraying of lime-sulphur just before the cluster buds open; do not wait until the full leaf crop unfolds. Fertilization and clean cultivation render trees more resistant to the disease. Trees growing on well-limed soils have been observed by Mr. Chase to be less seriously attacked than trees on soil deficient in lime.

DISEASES AFFECTING THE BLOSSOMS

Blight. The blossoms are affected by a fungus which is locally called blossom blight. This is, so far as known, the same fungus that is named pear blight, a description of which is given on page 210. The effect of this fungus on the blossoms is to blast them so that their normal functions cannot take place. Careful cutting away of diseased portions and conscientious spraying will tend to wipe out this blight.

Scab. Sometimes scab affects the blossoms of the apple and destroys great numbers of them. Careful attention to spraying will tend to subdue the scab fungus in time.

DISEASES AFFECTING THE FRUIT ON THE TREE

Black rot (*Sphaeropsis malorum*). This disease, commonly known as the New York apple canker, attacks the fruit as well as the bark. It may attack the fruit while growing on the tree, but is more

common on the neglected, fallen fruit, which is a source of infection to the tree. It may first appear as a very small spot, generally near the bud end or calyx of the fruit, then spreading rapidly over the entire fruit. It may be brown in color at first, but it later changes to black, hence its name. It differs from bitter rot in not having the characteristic fungous tissue. It may be readily interchanged between bark and fruit, and therefore is a very dangerous disease. The remedies given are thorough spraying with Bordeaux

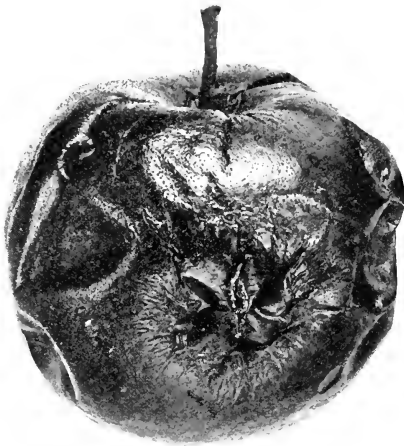


FIG. 90. Black rot. (University of Maine)

mixture and attention to the bark, as described in a previous part of this chapter (p. 212).

Blotch (*Phyllosticta solitaria*). The first evidence of the disease on the fruit is a very small, inconspicuous, light-brown blotch, which, under a hand lens, has the appearance of a stellate collection of brown fibers just beneath the epidermis. The blotch, spreading radially, increases in size until it attains

a diameter of from $\frac{1}{8}$ to $\frac{3}{8}$ and sometimes $\frac{1}{2}$ inch, and becomes darker in color. The advancing margin is irregular and jagged and has a fringed appearance. On very young apples the points of infection occasionally show as small water-soaked areas, and in wet weather there may be a yellowish, gummy exudation from the spots. Where the spots are numerous, they often coalesce and form large blotches, which may cover half or more of the apple. The fungus kills only the superficial cells (the epidermis and outer parenchyma), so that the continued growth of the uninvaded tissues beneath results in a cracking of the diseased areas. The cracks

thus formed, though usually about $\frac{1}{2}$ inch long, may girdle the fruit and extend to the core. The cracks often intersect, forming a cross. The character of the spots is not always the same on the different varieties. There are all variations, from the quite large, much fringed, and smooth spots on the Missouri variety to the small, compact, and often umbonate spots on the Limbertwig. An occasional spot somewhat rectangular in shape may be decidedly sunken and quite black, with a definite margin.

Within a few days after the spots become visible, black pycnidia begin to develop on the diseased areas. Three, four, or many more occur on each spot, and are scattered promiscuously or grouped on a small blister cracked around the margin.

The general effect of the blotches on the fruit is to mar its appearance and render it unfit for packing. Moderately affected fruit, especially if not badly cracked, may be evaporated, but much of it cannot be used even for this purpose because of the difficulty of paring, and is a total loss except where it can be used for vinegar. A large percentage of the affected fruit drops prematurely and unless utilized immediately is a total loss.

Bitter rot (*Glomerella rufomaculans*, Berk. and Sp. & Von Sch.). Of all diseases of the apple, bitter rot is one of those most to be feared and fought. It is the most insidious because of its erratic behavior. It appears with great suddenness, laying waste in a few days or weeks all the careful work of the orchardist. Few, if any, advance notices of its appearances are served, and the only effective campaign that can be waged against it is that of prevention. Once well started, an outbreak can at best only be checked. The fact that the disease does not appear to a destructive extent in successive years and that the outbreaks come without warning makes the grower feel inclined to take a chance at its nonappearance and to dispense with preventive sprayings. This "gambling," however, often results in a loss of all or a large part of the apple crop. It is always the part of economy to prepare each year for the possible appearance of the rot. It should be mentioned, however, that some varieties are much more susceptible to this disease than others, two of those which show little resistance being the Ben Davis and the Shockley. Many other varieties can be easily determined by investigating in the orchard.

Bitter rot is caused by a fungus, and not by wet weather as many growers believe. Hot, muggy, or showery weather in summer is the most important factor in the development and spread of the disease. Where such weather conditions obtain for any length of time after apples are half grown, bitter rot is almost certain to develop. Rains spread the disease by washing the spores from affected fruits to healthy fruits. The rot usually does not appear on the fruit until the early part of July. It makes its first appearance on

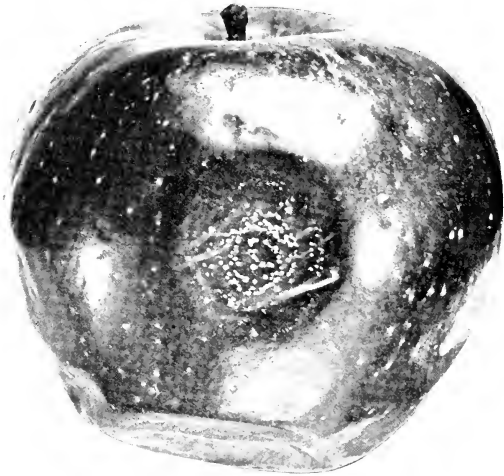


FIG. 100. Bitter rot. (University of Maine)

the apple as very small, brownish-colored specks beneath the skin, which grow quickly, assuming a circular outline. The diseased area becomes sunken and increases rapidly, the infection radiating by concentric rings with clear-cut margins. The mycelium of the fungus penetrates the flesh of the fruit, involving the tissues in a soft, brownish, cone-shaped decomposition. The small black spots which appear beneath the skin of the diseased circles finally break through and give off the spores or seeds of the disease. The spore masses are pinkish in color, and are readily washed about by rain and

infect the sound fruit, as already stated. Infections are most readily made through breaks or abrasions in the skin of the fruit, quick and complete decay following the entrance of the spores. Insect punctures, therefore, have a direct relation to bitter-rot outbreaks.

Treatment. The best results in fighting the bitter rot have been obtained from sprayings made with the prepared lime-sulphur solution in the early summer (until the middle or last of June), and with Bordeaux mixture in the latter part of the season, from about July 1 to the time of the last spraying.

In 1911-1912, at Cornelia, Georgia, such a spraying schedule, the work of W. W. Chase, assistant state entomologist, resulted in practical freedom from bitter rot, while unsprayed plats were freely infected.

The removal of all mummied fruits from the trees and ground and of the cankered limbs, or the cutting out of cankered areas and a subsequent disinfection and filling-in of these with cement, are valuable aids in the work.

Fruit spot (*Cylindrosporium pomi*). This disease is especially common in New England, but is becoming known in other north-eastern states and Canada. It is so frequently found on the Baldwin that it has received the name Baldwin fruit spot.

During August minute spots or specks appear on the surface of the fruit. They are at first very small, with a reddish color if upon the red cheek of the apple, and of a deeper green color if found



FIG. 101. Brown rot (*Sclerotinia fructigena*)
Similar to brown-rot disease affecting peaches and plums
(University of Maine)

on the yellow or green surface of the fruit, but as they increase in size they become sunken and brown.

Control measures consist in spraying with a fungicide like Bordeaux mixture or lime-sulphur, generally a weak solution, any time before the last of June.

Cedar rust and scab. For a discussion of these diseases the reader is referred to diseases affecting leaves, pages 215–217.

Sooty blotch and fly-speck fungus (*Leptothyrium pomi* [Mont. & Fr.] Sacc.). In ordinary seasons the sooty blotch appears chiefly on apples grown in low, moist situations. The Peck, Rhode Island Greening, and Rome Beauty are conspicuously affected by it. This

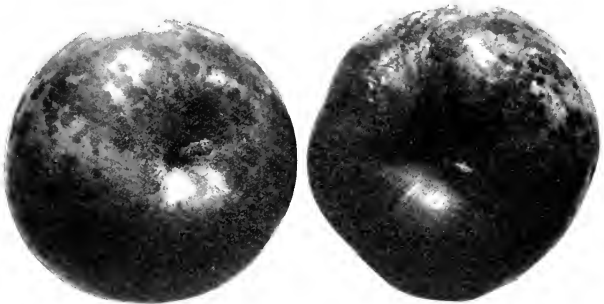


FIG. 102. Sooty blotch. (Courtesy of Michigan Farmer)

disease causes two kinds of spots — a large *sooty* spot, apparently made by a fungous mycelium, which spreads over the whole of the discolored area, and a small *fly-speck* spot, also of fungous origin. Both kinds of spots may occur on the same specimen; in fact, it is rare to find an apple affected with one that does not show the other also. The fungus of both spots is evidently parasitic in character, but appears to be quite superficial, occasioning no hardening of the skin or cracking of the apple, as in the case of apple scab, but diminishing the brightness of the skin and the market value of the fruit. From some reports it would seem that the fungus may develop after the apples have been packed in barrels and stored.

A single spraying with Bordeaux mixture, applied at the time the apples are the size of hickory nuts or larger, would prevent most, if not all, of this spotting. For the Maiden's Blush, Grimes, and Belmont, and fair-skinned varieties generally, the spraying should be done earlier to avoid russetting the fruit.

Spongy dry rot (*Volutella fructi*). This disease shows itself as a rotten black spot which increases in size until it eventually encompasses the whole fruit. The central and older portions of the decayed region are of an intense coal-black color, while the younger region — the outer border, which is about five eighths of an inch wide — is brownish.

Close inspection reveals the presence of slightly elevated pimple-like places in the cuticle. These are found to within about one fourth of an inch of the edge of the spot, and become larger and more pronounced as the center of the spot is approached; indeed, the black color of the spot seems to be due to the large number of these pimples crowding its surface. In many instances there is no other peculiar development and the disease might readily pass for the ordinary black rot, caused by *Sphærospis*, and doubtless is often taken for it. In the older spots, however, the pimples break through the cuticle of the apple, each appearing as a small wartlike excrescence, which a good lens shows to be thickly covered with stiff black hairs. These hairs are the chief characteristic of this disease, and when present serve to distinguish it from *Sphærospis* rot. An open apple shows a brownish zone, the latest-affected part, around a black area. Although the decayed portions are softer than the healthy ones, this is in no sense a wet rot, the softness being a spongy dryness rather than any watery breaking down of tissue.

DISEASES AFFECTING THE FRUIT IN STORAGE

Pink rot (*Cephalothecium roseum*). This fungus, which has been so destructive to apples in many parts of the country, is very characteristic in appearance and is frequently called the "pink fungus" by fruit-growers. The examination of an apple affected by this disease in its more advanced stage will disclose one or more pink spots somewhat circular and sunken. Around the fungus and in the edge of the depressed portion the skin is brown.

The apple-scab fungus usually precedes the pink rot, growing beneath the skin, and as it matures, rupturing the skin and leaving the edges somewhat upturned. It is near the upturned edge that the pink fungus so often makes its beginning, forming a ring of mold. The entire scab spot, however, is usually covered with a white mold, which gradually changes to a pink or a rose color as it is dusted over with the pale rose-colored spores.

The first change in the appearance of the apples is that the skin around the spots turns brown. This brown area gradually extends in all directions, the various spots merging with one another until a large part or the entire surface of the apple is covered. As the spots increase in size they also sink. The sinking may be due not only to the dissolving of the solid parts of the apple by the fungus but also to evaporation of water through the spots. The flesh beneath the sunken spots is brown like the skin above it and is bitter to the taste.



FIG. 103. Pink rot following scab. (University of Maine)

Is the pink fungus a parasite? In order to determine the method of attack of this fungus, apples were inoculated with a pure culture of the spores. These spores were placed on the scab spots of apples which were free from the pink fungus, and also on sound apples. Other fruits free from the fungus spores were kept as checks. The apples having scab wounds were easily inoculated, but the sound fruit was not affected. Apples which were suspected as being already affected by the fungus were thoroughly disinfected and subjected to the same tests with the same results. The fungus developed in the tissues of the apple only where a wound had previously been made.

As with most fungi, considerable moisture is necessary to its vigorous growth. This it finds among apples which have been piled in heaps or put into tight barrels, or in various places of ordinary storage where moisture is easily conserved.

Greenings and Baldwins are both very susceptible to the fungus, especially the former. In searching the markets of Ithaca, New York, for Greenings affected by the scab, for experimental purposes, none were found that were not also victims of the pink fungus.

This disease is supposed to attack only apples already parasitized by apple scab. If this is the case, the first and obvious thing to do is to prevent apple scab. Fruit-growers are familiar with the treatment of this disease, which is pre-

ventive. The tree is covered with a protective coating of Bordeaux mixture, which prevents the germination of the spores from which the parasitic plant is developed. When the parasite becomes established, remedies are relatively ineffective. While a scab spot will cease to enlarge if thoroughly covered with Bordeaux mixture, no amount of doctoring will fully repair the injury.

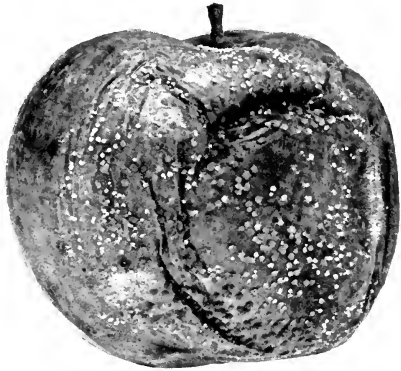


FIG. 104. Blue-mold decay (*Penicillium*)

A rot of ripe apples—often seen where apples have been bruised by careless handling. (University of Maine)

CHAPTER XX

SPRAYING

Older orchardists often tell us that successful fruit-growing is impossible at the present time because of the great increase in the number of diseases and insect enemies with which the fruit-grower must contend. It is undoubtedly true that the difficulties of the fruit-grower have greatly increased, for not only have many new fruit pests been brought from foreign countries, but the standard of marketable fruit has been constantly raised until, at the present time, first-class fruit must be practically free from all blemishes. But to offset these discouragements is the fact that at no time in the past have we had such a thorough knowledge of the means of combating these pests or such efficient apparatus. The up-to-date fruit-grower therefore fears his insect and plant-disease enemies less to-day than he did half a century ago.

A man who thoroughly understands spraying as related to successful fruit-growing has little to fear from the enemies of the orchard. While simple in itself, spraying is somewhat complex from the standpoint of efficiency in checking fungi and insects. To obtain the best results the grower must have a working knowledge of the habits and methods of feeding of the insects which prey upon the orchard, so as to be able to attack each at the most vulnerable point in its development and in the most economical manner; he must know how to prevent the introduction of fungus and bacterial disease, and how to combat them once they have gained entrance; he must understand the value of different fungicides and insecticides, the manner and the time of application, and the proper amounts to use; he must secure efficient, up-to-date apparatus; and since thoroughness is the secret of successful spraying, he must see that the work is thoroughly done.

It will be a help to the orchardist also to keep these suggestions in mind: (1) buy good stock and make sure that it is free from plant pests by personally inspecting it and having it inspected by

official inspectors ; (2) give the pests as little chance as possible, by destroying all breeding places, such as volunteer, neglected trees, rubbish which may harbor insects over winter, and secondary hosts which may help to propagate injurious insects and plant diseases ; (3) keep trees healthy and vigorous ; (4) prevent decay or the entrance of disease into the trunk or branches of the tree by intelligent pruning and by protecting the exposed surfaces ; (5) clean out, disinfect, and fill the holes if decay does start ; (6) gather from the tree and the ground all injured or diseased fruit and destroy it.



FIG. 105. A power sprayer

A large type of practical orchard sprayer out in the orchard ready for work

The good effects of cultivation in the orchard are by no means confined to making available the food supplies contained in the soil and to the conservation of moisture. Cultivation also assists materially in controlling the fungous and insect pests of the orchard, particularly the latter.

It is an old story that orchards should not be sprayed with any arsenical spray during their bloom, both for fear of killing the bees that pollinate them and for fear the spray will itself injure the stigmas or pollen. Recent investigation, however, seems to show that spraying an apple tree in bloom does not do so much damage to bees visiting the tree as has been supposed ; though there is still room for further test experiments. But, on the other

hand, it is now thoroughly established by experience (and it conforms to common sense too) that there is a great and ruinous danger to bees from spraying an apple orchard at a time when a cover crop of clover under the trees is in bloom, whether the trees are in bloom or not. Of course the spray falls down into the clover, and clover blossoms have just the right funnel arrangement to concentrate the poison. In considerable parts of Colorado the



FIG. 106. Bees and the orchard

An orchard in full bloom, predicting, if nature wills, a full crop of the choicest of fruits.
At this period spraying may do injury to bees and other insects

beekeepers have had to move their bees away from the neighborhood of orchards, far enough to be beyond a bee's ordinary flight; those who stayed by the orchards have lost almost all their stock of bees; and this was not on account of spraying while in bloom (which is now prohibited by law in Colorado) but on account of spraying when the clover under the trees was in bloom.

The spraying appears to kill not only the bees that visit the flowers but also the larval bees in the hive, to which the poisoned honey is carried back. One might easily stir up a scare about

danger to human beings who might eventually eat honey from that hive, but doubtless the bees die off too fast to lay up a store that would hurt human beings much. Wasps would not be in the same danger in this respect, because they feed their young not on honey but on caterpillars, etc.; but wasps are much less valuable than bees in securing a good set of apples on the tree.

It may be noted that the *Long Island Agronomist*, which had for some years been urging the farmers and gardeners of Long Island not only to spray diligently, but to prefer Pyrox (a preparation containing both arsenic and copper) to any other spray for most purposes both as insecticide and as fungicide, complained in the fall of 1914 that the Long Island cucumber crop of that year was 40 per cent below normal because there were not bees enough to pollinize the blossoms.

The precaution generally approved is to plow or mow. If a cover crop is to be plowed under, it should on all accounts be plowed as soon as it begins to bloom; and plowing at any date before you spray saves the bees. If plowing is not in your plan, mow the clover (if in bloom at all) just before spraying; it thus ceases to rob the ground of valuable moisture, and the stalks can profitably be disked into the soil as soon as they wilt.

Dr. A. J. Cook, Horticultural Commissioner of California, suggests that the cover crop be not clover but vetches, which help the soil as clover does, and bloom after spraying is over. Yellow annual sweet clover is also thought well of in California. Any plant whose blossom droops so that a shower from above runs down outside the petals, and cannot get inside, ought to be safe.

Another suggestion that has been made is that whenever the spray is poisonous to bees it should be mixed with enough tobacco tea so that the odor will keep bees away from the sprayed area till the poisoned blossoms have had time to wilt. This suggestion has not been tested in practice to determine the amount of tobacco that would have to be used to make it effective.

The need of spraying. During the year 1910 the fruit crop was almost a total failure in some of the states. Nearly everyone assumed that in 1911 there would be no worms because of the lack of fruit to furnish food and breeding ground for the pests. The fallacy of this reasoning was proved, however, by the great

increase in the number of the insects and by the worm infestation of a very large proportion of the fruit the following season.

The lesson taught by this costly experience is that if we would produce fruit sound and free from blemish, which will keep long enough to be in good market condition when demands are greatest and will be attractive enough to draw the best prices and to net returns sufficient to make fruit-growing profitable, then we must spray thoroughly and with judgment every year — not spasmodically or carelessly as our fancy may dictate.

What to spray for. The protection of apples against insects and diseases by spraying is really a simple matter. It may be divided into four common forms of treatment:

1. The use of fungicide to prevent the germination of the spores of fungous diseases, such as apple scab. Bordeaux mixture and lime-sulphur are the leading fungicides.

2. The use of an arsenical poison (a poison with arsenic as its base) in controlling biting insects. The codling moth and all the leaf-eating insects come under this head. Lead arsenate, arsenate of lime, Paris green, etc. are the best arsenical insecticides.

3. The use of a contact poison like kerosene emulsion, whale-oil soap, or tobacco solution to destroy sucking insects. Plant lice and many of the true bugs are controlled in this way.

4. The use of a lime-sulphur wash as a winter or early spring spray against scale insects such as the San José scale or the oyster-shell bark louse.

The first two of these forms of treatment are those most commonly employed, and may be successfully combined.

MATERIALS TO USE

Lime-sulphur, self-boiled. Formula: 8 pounds stone lime, 8 pounds sulphur, and water enough to make 50 gallons.

It is often convenient to prepare the self-boiled mixture in a barrel, using quantities about three times that of the regular formula — that is, 24 pounds of lime, 24 pounds of sulphur, and about 150 gallons of water. The larger quantity of lime slaked at one time results in a greater amount of heat than is obtained by preparing it in three 8-pound lots, as suggested by the standard

formula. It is also much more economical from the standpoint of time and labor to prepare it in quantity. The mixture can be prepared in quantities four to five times that of the standard formula if one has a vessel large enough, but such quantities cannot be prepared in an ordinary barrel, for in this case they cannot be kept properly stirred while the lime is slaking.

First moisten the sulphur with water, breaking up all lumps and stirring thoroughly to form a thick paste. Place the lime in



FIG. 107. Spraying trees in Colorado

A two-and-one-half horse-power engine, a 150-gallon tank, three men, and a pair of horses will cover a large number of trees with spray material in a day

a barrel and add just enough water to start vigorous slaking. As soon as the slaking is well started, add the moistened sulphur. Stir the mixture continually, adding sufficient water to maintain a thin paste to keep the lime actively slaking and yet prevent burning.

Quick, active-slaking lime should be used in preparing this mixture, because lime which is sluggish does not produce sufficient heat. If the lime does not slake readily, warm water should be used; otherwise cold water will be found satisfactory. The lime should supply heat enough to boil the mixture violently for several

minutes. The time at which the cold water should be added to cool the mixture and prevent further action varies according to the activeness of the lime. If the mixture remains hot too long, an excess of soluble sulphur will be formed, which is injurious to peach foliage. It is therefore very important that all action should be stopped at the proper time, which, generally speaking, is just as soon as the apparent action of the lime has ceased.

The final mixture should consist of finely divided lime and sulphur with only a slight amount of soluble sulphur. This finely divided lime and sulphur will settle very quickly, leaving a clear solution above. The clear solution should be orange yellow in color, due to the soluble sulphur it contains. If the clear solution presents a distinctly red appearance, similar to that of concentrated lime-sulphur, it indicates an excessive amount of soluble sulphur, which may injure the tender foliage. A few practical tests will enable anyone to prepare this spray and to recognize mixtures having a dangerous amount of soluble sulphur.

It is best to apply the self-boiled lime-sulphur as soon as possible after it has been prepared, although it may be kept for a time without loss. The mixture should be thoroughly stirred, and well strained when transferred from the barrel to the spray tank. It is very important that the outfit used to apply this spray be provided with an agitator that will stir the mixture thoroughly, because of the large amount of heavy sediment contained. Thorough agitation is especially important when the self-boiled formula is used in combination with arsenate of lead.

Concentrated lime-sulphur, commercial. The commercial lime-sulphur can be had from practically all the insecticide companies, and varies in price according to the amount purchased. In barrel lots (50 gallons) it costs about \$9.00 delivered; in half barrels, 20 cents per gallon; in ten-gallon lots, 25 cents; in five-gallon lots, between 30 and 40 cents; and by the gallon, from 50 to 75 cents. In ten-barrel lots it will cost about \$8.25 per barrel. This material tests from 32 to 35 degrees Baumé, and should be clean and bright, without any sediment. Because of the variation the hydrometer should always be used so that the exact strength may be known. When properly diluted, there is little or no danger of burning apple-tree foliage.

Concentrated lime-sulphur, homemade. The same material can be made at home much more cheaply if the number of trees warrants purchasing the material in quantity. For small orchards — up to 200 trees — it is probably better to buy it, as the making is somewhat disagreeable and requires some experience.

A formula giving good results is 40 pounds lime, 80 pounds sulphur, and 50 gallons water. Other formulas that can be used are 50 pounds lime, 100 pounds sulphur, and 50 gallons water, or 55 pounds lime, 110 pounds sulphur, and 60 gallons water.

If live steam is available, it is possible to make the lime-sulphur in a wooden tank at a very small cost. Where steam is not available a kettle with a capacity of from 25 to 50 gallons is generally used.

Put about 10 gallons in the kettle and heat; add the lime, and after it has started to slake in good shape, add the dry sulphur and mix thoroughly. When the mixture is through slaking, add water enough to make 50 gallons and boil for about an hour. More water will have to be added from time to time as it boils away, so as to keep the mixture at the 50-gallon mark, and more or less stirring will be necessary while the cooking is going on. After it is cooked, the mixture should stand long enough to allow the sediment to settle to the bottom; then the clear solution should be dipped out and strained into a tight barrel. When it is cool the Baumé reading should be taken and marked on the barrel. If the reading is taken while the solution is warm, it may not register the actual strength. The barrel should be closed tightly as soon as possible, and should be stored in a place not subject to very low temperature. It is not advisable to keep it in storage a long time, for it is better when used immediately.

The principal difficulty is to obtain a mixture of high density having a small amount of sediment. The sediment may vary from 2 to 30 pounds, the density from 31 to 24 degrees Baumé. Clean lime freshly burned and guaranteed at least 90 per cent calcium oxide aids greatly in reducing the amount of sediment, and this the grower should always demand. The cost of the homemade mixture will vary from \$3.00 to \$5.00 per barrel according to the cost of the materials, the manner of making, and the density obtained. The cost of the sulphur will be from 2 to 4 cents per

pound; of the lime, from $\frac{3}{4}$ to 1 cent per pound; and of labor, from 30 to 60 cents per barrel.

The solution obtained by following the above directions should never be used at full strength, but should be diluted with water, the amount depending on its density and the condition of the trees to which it is to be applied. If directions are carefully followed, a solution should be obtained having a specific gravity between 1.24 and 1.27. Mixtures prepared with exactly the same grade of materials may vary somewhat in density, and it is necessary to have a means of testing them. Accurate tests may be made with a hydrometer having a specific-gravity scale, it being essential of course to use an instrument made for testing liquids heavier than water. A hydrometer for testing lime-sulphur should have a scale ranging from 1.00 to 1.32 or 1.35 specific gravity.

A lime-sulphur mixture having a specific gravity of 1.03 will control the San José scale, and therefore is efficient for all applications made when the trees are dormant. For spraying apple and pear trees in foliage, it is not safe to use this mixture at a strength greater than 1.01 specific gravity.

To determine the proper amount of water to use with each gallon of a home-boiled or commercial concentrated lime-sulphur mixture, divide the decimal of the specific gravity of the concentrate by the decimal of the desired spray. For example, if the specific gravity reading of the concentrate is 1.24, divide .24 by .03 to get a spray of 1.03 specific gravity. The result is 8, which is the number of dilutions required. In other words, in every 8 gallons of spray mixture there should be 1 gallon of concentrate and 7 gallons of water. This means that in 50 gallons of spray solution there should be $6\frac{1}{4}$ gallons of concentrate and $43\frac{3}{4}$ gallons of water.

Bordeaux mixture. This material is being used less and less each year in orchard spraying. So much fruit has been russeted and so much foliage burned by it that growers have generally taken lime-sulphur as a substitute. It is still used to a certain extent, however, and gives good results in some cases.

The formula 3-3-50 is used more than any other in orchard work. An excess of lime is not recommended, as it causes a slower action, clogs the machinery to some extent, causes an uneven application, and is more readily washed from the trees. In wet seasons

it may cause the mixture to be efficient for a longer period and thus lessen the danger of injury.

Suspend 3 pounds of copper sulphate, or bluestone, in 25 gallons of water until it is dissolved. Slake 3 pounds of the best quicklime that can be obtained, taking care not to use an excess of water; then add enough water to make a whitewash. Strain to remove lumps, and add sufficient water to make 25 gallons. Pour the two



FIG. 108. Spraying equipment

Elevated platform, at the right, for preparing Bordeaux mixture. The larger tank on the higher platform is for water storage. Types of spray rigs. (University of Maine)

solutions into a barrel, and test to find out if any free copper is present. To make the test, proceed as follows:

1. Take a portion of the clear fluid that is left on top after the sediment settles and put in a saucer. Blow gently over the surface. If a thin white pellicle forms over the top, there is lime enough.

2. Immerse a newly filed piece of steel for a minute or so. If it becomes coated with copper, more lime is required.

Whale-oil soap. Whale-oil soap, which has the peculiar characteristic of remaining liquid when cold, has greater penetrating powers than other soaps and is more fatal to insect life. The formula is 1 pound of soap to 2 gallons of water, the soap being

cut in fine pieces and dissolved in warm water. The cost of the soap varies from 5 to 20 cents per pound.

Kerosene emulsion. When properly made and diluted, this material proves very satisfactory in checking the work of the aphid. It must be carefully prepared, however, else it will burn the foliage severely. The formula is kerosene, 2 gallons; water, 1 gallon; soap, $\frac{1}{2}$ pound.

Heat the water and dissolve the soap in it. Add the kerosene and churn or mix forcibly with a force pump for ten minutes. The mixture should be smooth and creamy, and will adhere to a glass surface. Dilute in the proportion of 1 part emulsion to 10 parts water before applying to foliage.

Black Leaf 40. Black Leaf 40 is a tobacco extract and may be purchased from dealers in spraying supplies or from seed houses. Directions for diluting are given on each bottle. It is easily and quickly applied, and seems bound to become the popular aphid spray for summer use.

Paris green. Paris green is fast going out of use in orchard work because of the free arsenious oxide which it contains. The danger of burning the foliage is too great to justify its use.

Commercial arsenate of lead. At present arsenate of lead is used more than any other poison for leaf-feeding and fruit-infesting insects. It can be bought from any of the insecticide companies and from local dealers at prices varying from 7 to 20 cents per pound. It should not cost over 8 cents in 100-pound lots, and small growers will do well to combine their orders in buying.

The commercial paste varies in water content from 25 to 50 per cent. It is guaranteed 12 per cent arsenic acid (As_2O_5), and may run as high as 20 or 25 per cent. It should not contain more than .75 per cent soluble arsenic.

It can be had in the powdered form, about 1 per cent water and 25 per cent arsenic acid, but is usually preferred as a paste, as it stays in suspension better and is more adhesive. Care should be taken when it is purchased in quantity to keep up the water content. It does not burn the foliage, and its only disadvantage is that it is relatively slow-acting.

Homemade arsenate of lead. Arsenate of lead can be made at home by using acetate lead, 11 ounces; arsenate soda, 4 ounces;

water, 1 gallon. Dissolve the soda in $\frac{1}{2}$ gallon of water, and in a separate pail dissolve the lead, also in $\frac{1}{2}$ gallon of water. When dissolved, pour the two together. This is equivalent to 1 pound of the paste, provided the chemicals used are of good quality.

The homemade arsenate of lead gives as good satisfaction, when properly made, as the commercial brands, and in some cases it has the added advantage of being somewhat cheaper.



FIG. 109. Compressed-air sprayer

Spraying apple trees on the farm of M. G. Keenan near Oneonta, New York. Second spraying, lime-sulphur and arsenate of lead, three hundred pounds' pressure used. (Photograph by F. O. Sibley, Milford, New York)

Miscible oils. Formulas for the home preparation of miscible oils have been published by the Delaware Experiment Station and by the Storrs Experiment Station of Connecticut. The following suggestions are taken from a recent bulletin of the latter station. Note that there are three parts to the process of preparing the oil according to the formulas given, and also that the author uses the term "soluble oil" instead of miscible oil.

1. The making of the emulsifier is the most complicated part of the formula, although little difficulty will be experienced if the proper materials are used.

EMULSIFIER

Carbolic acid (crude liquid 100 per cent)	2 quarts
Fish oil	2½ quarts
Caustic potash (granulated)	1 pound

Heat to 300 degrees F., remove from the fire, and immediately add:

Kerosene	3½ quarts
Water	5½ quarts

These quantities will make 13 gallons of the complete soluble oil or 416 gallons of the spray mixture. It may be made up in any quantity and kept indefinitely. The cooking is best done in an iron kettle—the ordinary kettle or caldron such as is commonly used on the farm for making soft soap will answer the purpose. It should have a cover and be so arranged that it can be readily removed from the fire. Since the mixture is inflammable when hot, the kettle should not be more than half filled, to allow for foaming, and the fire must be kept from blazing up around the top. The cooking should not be done inside or near a building, unless a steam-coil or jacketed kettle is used. A good thermometer graduated to about 320 degrees F. will be necessary.

The various materials should be added separately in the order named and while the whole is being stirred. The resultant mixture will thicken up and present, except for its darker color, the appearance of soft soap.

2. Although the soluble oil will remain in good condition for a long time, the second part of the formula should be prepared just before using.

THE COMPLETE SOLUBLE OIL

Emulsifier	8 parts
Crude petroleum	18 parts
Rosin oil	4 parts
Water	1 part

By securing the materials in large quantities the soluble oil may be made for 16 cents or 18 cents per gallon. If diluted with 15 parts water, as recommended, the spray mixture costs slightly over 1 cent per gallon. In view of the fact that its tendency is to spread when applied to the tree, and that it can be

sprayed with a fine nozzle, a gallon will go much farther than the same quantity of lime-sulphur.

3. To use the soluble oil, stir thoroughly, and to 1 part oil add 15 parts water. When about to mix large quantities, it is well to test the miscibility of the oil by pouring a few drops in a glass of water and stirring it. If a good milky emulsion without free oil on the surface is formed, the solution is all right to use. The spraying utensils should be absolutely clean.

It should also be noted that Bordeaux mixture, Paris green, or lime-sulphur are liable to spoil the emulsion.

Other materials. Pyrox, Bordo Lead, Kil-o-scale, Target Brand, Antiscale, Scalecide, and a number of other commercial brands can be obtained from local dealers, and in general do very good work. They are usually more expensive than the regular materials, and are not superior. However, for those who cannot prepare their own solutions or who have only a small amount of spraying to do, stock-prepared solutions will answer the purpose.

When to apply the spray. The first spraying is done when the leaves have dropped in the fall, and before foliage appears in the spring. The material used may be homemade lime-sulphur wash, commercial lime-sulphur solution, miscible oils, whale-oil soap, or nicotine solution, properly diluted to winter strength. This dormant



FIG. 110. First application

When the buds are developed like these it is time for the first spraying, to prevent scab. (Cornell University)

spraying is intended to destroy scale, insects, and the winter spores of fungus and lichens. Trunks of trees should be sprayed as well as branches.



FIG. 111. Second application

The right time for the second spraying, in order to control the scab. (Cornell University)

calyxes have closed, the third spraying should be given. The commercial lime-sulphur solution, properly diluted to summer strength with $2\frac{1}{2}$ pounds of arsenate of lead added to every 50 gallons of the spray, is recommended. This early summer spraying is very important, because if the codling moth is to be destroyed, the poison must be forced into the calyx cups before they close. This spraying will also destroy scab, blight, etc.

The fourth spraying should be like the second,

The time for the second spraying is when buds show pink. For this, full-strength Bordeaux mixture with 2 pounds of arsenate of lead added to each 50 gallons of the spray material should be used. This spraying will destroy apple scale, fungus, bud moth, cankerworms, and case-bearers.

Just as soon as the blossoms have disappeared and before the



FIG. 112. Third application

Ready for the third spraying for scab. (Cornell University)

only the quantity of arsenate of lead should be reduced to 2 pounds for every 50 gallons of spray.

The fifth spraying, which is like the third, is a preventive against the various fungous encroachments, and also destroys the larvæ of the San José scale and other scale insects.

The sixth spraying should be made between the first and the fifteenth of August with the full-strength Bordeaux mixture and 2 pounds of arsenate of lead added to every 50 gallons of the spray material. This application will control bitter rot, apple blotch, and also the lesser apple worms, or side worms, as they are commonly called.

Spraying schedule for apples recommended by the College of Agriculture, Cornell University. *Dormant spray.* Lime-sulphur (32 degrees Baumé) diluted 1 to 8 for the San José scale, oyster-shell scale, and blister mite; for bud moth add 2 pounds arsenate of lead to 50 gallons of mixture. Apply when the leaf buds begin to show green.

Summer sprays. 1. Lime-sulphur (32 degrees Baumé) diluted 1 to 40 for apple scab; add arsenate of lead, 2 pounds to 50 gallons, for bud moth and case-bearers. Apply when the blossom buds begin to show pink.

2. Lime-sulphur (32 degrees Baumé) diluted 1 to 40 for apple scab; add arsenate of lead, 2 pounds to 50 gallons, for the codling moth. Apply when the last of the petals are falling. This is the most important spray for the control of the codling moth and should be thoroughly applied.

3. Lime-sulphur (32 degrees Baumé) diluted 1 to 40 for apple scab; add arsenate of lead, 2 pounds to 50 gallons, for the codling moth. Apply three weeks after the petals fall.

NOTE. Aphis, which may be detected by the curling of the leaves, should be sprayed as soon they appear with a nicotine solution properly diluted for foliage spraying. For woolly aphis, besides spraying the entire tree with a nicotine solution, remove the soil for a depth of 3 inches and a radius of 3 feet around the base of the tree. Saturate well with the nicotine solution twice as strong as used for summer spraying, and then replace the soil.

Winter strength of commercial lime-sulphur is a dilution of 1 part solution to 10 parts water.

Full-strength Bordeaux is the 3-3-50 formula. The arsenate of lead recommended should contain 15 per cent arsenious oxide.

4. Lime-sulphur (32 degrees Baumé) diluted 1 to 40 for apple scab; add arsenate of lead, 2 pounds to 50 gallons, for the second brood of the codling moth. Apply the last week in July.

How to apply the spray. To do effective work in orchard spraying requires constant care and watchfulness on the part of the operator and also a certain amount of practice to secure the best results. Thoroughness is essential, but by thoroughness is not meant drenching the tree. The spray should be delivered with a constant, strong pressure, issuing from the nozzle in a fine mist, the finer the better. After a little experience the operator will find that if the right type of nozzle is used, and if the extension rod carrying the nozzle is properly adjusted and kept at the right distance from the leaves, he can cover the tree thoroughly with a fine, mistlike coating, and there will be no tendency for the mixture to form large drops on the leaves or to drip from the edges. While care must be taken to avoid dripping, the foliage and limbs on all parts of the tree must be reached. It is impossible to do thorough spraying on trees which have not been properly pruned or on trees whose tops are filled with water sprouts and interlocking branches.

Successful spraying depends on many factors, but chiefly on care and thoroughness. Of the many precautions which might be given the orchardist we shall mention only a few of the most essential.

1. It is vitally essential to success that every detail of the work be carefully and thoroughly done. The spray must be directed into each tree until every twig and leaf is covered with the glistening fluid, and every bud and crevice filled to overflowing.

2. To be successful, spraying *must* be done in season. It is easy to neglect this work, especially if the weather is rainy or windy, until the sepals are closed and the little worms are safely established within the apple. It is impossible to overestimate the importance of this point. During the critical period following the fall of the petals spraying must not wait for high winds to subside nor for rains to cease.

3. A sufficient number of sprayings must be given. It is not safe to risk less than three applications, and four or five are better. To control the second brood of the codling moth, which is particularly destructive, sometimes two sprayings are necessary.

4. Do not try to save expense by scanty spraying. This may prove to be very shortsighted economy.

5. A high pressure maintained constantly is essential to the best results. It must be sufficient to drive the spray well into the interior of the trees. In the application just after the blossoms fall — the most important in controlling the codling moth — it is necessary that the pressure be sufficient to drive the spray through the interfering stamens and down into the calyx cup.

6. The poison must not be adulterated, and must be used in sufficient quantity. Paris green is often adulterated with some other material, and should be tested by dissolving a small quantity in ammonia, in which it is entirely soluble. The failure of any part of the solid to dissolve within a few minutes indicates adulteration.

7. The lime should not be air-slaked. Fresh stone lime that has not been exposed to air or moisture should be used. The work of the lime is to take up the free copper in Bordeaux mixture and the free arsenic in the arsenious poisons. If the lime is weak it fails to perform this function, and the caustic copper or other poison will seriously injure the leaves and fruit.

8. The spray material should be stirred well while being applied. It is of the utmost importance that a good agitator be kept going constantly. This will make the mixture of the same strength throughout, avoiding the danger of a weak solution in the upper part of the tank and a strong one, dangerous to foliage, in the bottom.

9. The solids must be dissolved separately. This is especially true in the case of Bordeaux mixture. When the copper sulphate



FIG. 113. A small compressed-air sprayer
Practical for the home gardener or for very
young trees

and the stone lime are dissolved in separate vessels and then mixed, they will remain in suspension much longer than when dissolved together.

10. The thorough straining of the material as it is poured into the spray tank is essential. This will prevent much trouble with clogged nozzles.

11. Care must be taken in the selection of a nozzle. Defective nozzles throw too coarse a spray. A fine spray is best, but it must be ejected with force.

Careful spraying is necessary when the winds are high. Work must often be done while a strong wind is blowing, in which case the trees should be sprayed entirely from the windward side. The wind will assist in driving the liquid through the trees.

The advice usually given is to spray against the wind. However, it is much easier to say this than actually to perform the work. No available figures on this point were at hand until R. W. Westlake, New York, made some careful experiments along this line. The results are shown in the following table :

TREE	AGE OR SIZE	TIME IN MINUTES AND SECONDS	
		<i>With Wind</i>	<i>Against Wind</i>
Apple	40 to 50 years	1.40	Impossible, no time
		2.25	
		2.00	
		1.50	
		Av. 1.58	
Apple	14 years	.56	1.00
		.43	1.10
		.45	.58
		.40	1.30
		1.08	
Av. .53	1.10		
Apple	11 years	1.20	1.20
		.50	.47
		1.06	1.05
		1.43	1.42
		Av. 1.14	1.13
Peach	2 years	.11	.10
		.15	.15
		.16	.12
		.13	.16
		Av. .13 $\frac{1}{4}$	.13 $\frac{1}{4}$

In the first two cases two men were required to spray each tree, in the last three only one man was needed. A constant pressure of 175 pounds was used in each case.

Since the amount of spray material that passes through a nozzle under a certain pressure is almost constant, the shorter the time taken to spray a tree thoroughly, the less will be the material used and consequently the less will be the expense of spraying. Therefore, I think these figures will prove to others what they proved



FIG. 114. At work in the orchard

Spraying apple trees with Bowker's insecticide and fungicides

to me — that to save time and material it is best to spray all small trees against the wind, but large or tall trees with the wind.

Spraying machinery, tools, etc. When there are 500 or more trees a power outfit is much better than a barrel pump, and will be a paying proposition. The spraying can be done in this way more cheaply, easily, and thoroughly, as the pressure is higher and more even, the agitation better, and less time and fewer men are required for the same amount of work.

On smaller orchards the barrel pump is perhaps more suitable, because less expensive. In many sections small growers can

combine to their advantage in purchasing a power sprayer and the other necessary spraying materials.

Important points about spray pumps. The size and type of spray pump selected will depend on the kind of work to be done. There are so many special styles of pumps on the market that it is an easy matter to find one well adapted to almost every type of spray work.

Construction. The construction of the pump is important. The most satisfactory styles of bucket, knapsack, and barrel outfits have the pumping cylinder submerged in the spray liquid. This renders close packing unnecessary, which lessens the friction on the pumping cylinder and makes the work much lighter. This style of pump usually has a large air chamber, which is also set within the spray vessel. The air chambers which are mounted on top of the spray barrels are usually made of iron, and are therefore heavy and in the way, thus making the outfit much more cumbersome than those in which the air chamber is submerged.

To be most durable the working parts of a pump and all parts that are submerged or come in contact with the liquid should be made of brass or bronze. The nozzles, including caps, should also be made of brass, and the extension rods should be lined with either copper or brass pipe. Clear water should be run through the pump after each day's spraying, especially if lime-sulphur is used.

The pump should have sufficient capacity to do the required amount of work with ease. To produce a good spray, it is necessary to have high pressure, and here lies the secret of the value of the modern power sprayers.

Agitation. One of the most important points in a spray outfit is the means used for agitating the liquid. Good agitation may increase the effectiveness of the spray from 20 to 50 per cent. The best barrel and power outfits secure this by a direct attachment to the pump. A stream of spray liquid returning into the tank does not usually give good agitation. Some form of paddle agitation, either whirling or dashing, is preferable.

Straining. The spray machine should be equipped with a good strainer, such as the Stewart strainer, in which the liquid passes upward through the screen. Other types of sloping screen are good. The screen, no matter how made, should be of heavy brass cloth and have at least 14 wires to the inch. Wire cloth having

more than 24 meshes to the inch is not strong enough to withstand rough usage, and the fine mesh fills up with sediment and is hard to clean. A strainer of some kind is usually placed on the suction pipe, or suction hose, but some machines are equipped with a metal box or well, attached permanently to the bottom of the supply tank, in which a simple, easily cleaned strainer may be inclosed, thus permitting the tank to be drained completely. These wells are furnished with only a few makes of machines.

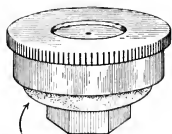


FIG. 115. A good type of nozzle

Hose. Suction hose that is at least 1 inch in diameter should be used with large spray outfits. Plenty of good hose, piping, cut-offs, hose connections and bands, rod cut-offs, and other necessary accessories should be at hand. The high pressures used in spraying with modern power spraying-machines make the use of strong, heavy-walled hose imperative. Half-inch high-pressure hose of 5-, 6-, or 7-ply construction is generally bought for this purpose. Except where oil sprays are used, the heavier grades usually last enough longer to warrant their purchase. The $\frac{3}{4}$ -inch hose, having sufficient strength to withstand 200 pounds' pressure, is not practical, because it is cumbersome and too heavy for the operator to drag around. The $\frac{3}{8}$ -inch high-pressure hose costs almost as much as the $\frac{1}{2}$ -inch hose of similar quality, yet does not have sufficient capacity to supply a cluster of large nozzles without greatly reducing the pressure of each. The hose connections for this size of hose have much smaller openings than the $\frac{1}{2}$ -inch size, which partially accounts for the reduction of pressure at the nozzle cap. The lead of hose to the operator on the ground should be at least 35 feet, but the lead to the tower can be as short as 12 feet without hampering the operator in handling the spray rod. Barrel pumps and large hand pumps will seldom supply more than one lead of hose at a satisfactory working pressure, but two nozzles can be used on the spray rod when one nozzle does not utilize more than half the capacity of the pump.

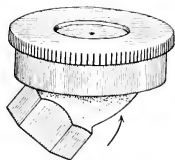


FIG. 116. Angle nozzle, a convenient necessity

Nozzles. The pump should be fitted with the kind of nozzle best adapted to the work to be done. Generally speaking, the disk

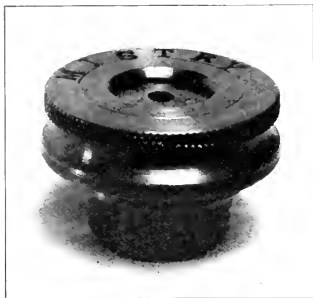


FIG. 117. Type of Mistry nozzle (straight)

type, which breaks the liquid into a very fine mist and produces a short-distance, cone-shaped spray, gives the best results.

Spray nozzles may be divided, according to the shape of the spray, into hollow-cone, solid-cone, solid-stream, and flat or fan-shaped nozzles; but for practical purposes it is better to classify them according to their construction as disk, Vermorel, modified Vermorel,

self-cleaner, cap, Bordeaux, cyclone, and solid-stream nozzles.

Different types of nozzles are suited to different kinds of work, and as their efficiency sometimes depends upon the pressure, care

must be taken not to select a nozzle which will be unsuited to the machine with which it is to be used. Some nozzles are of very large capacity and should not be used with pumps whose capacity per minute is less than that of the nozzle. The disk nozzles, as compared with most of the Vermorel or self-cleaner types, have a greater capacity, are more compact, lighter in weight, less liable to clog, and do not have any projecting parts to catch onto limbs and make trouble. Although disk nozzles have been on the market for only a few years, they are rapidly superseding the older and more common types.



FIG. 118. Type of Mistry nozzle (angle)

have been on the market for only a few years, they are rapidly superseding the older and more common types.

Most of the Vermorel and self-cleaner nozzles are of small capacity, largely because the small orifices through which the liquid must pass, and the abrupt changes of direction which it must make, reduce its speed and nullify the effects which would otherwise be obtained. The Bordeaux type of nozzles — strongly advocated by many Western orchardists — usually make a flat, fan-shaped spray that is coarse and much heavier in the center of the fan than at the edges. These are also of large capacity, and can be adjusted to throw a solid stream of liquid.



FIG. 119. Type of nozzle

Cap nozzles of small capacity, which are often miniature types of disk nozzles, are suitable for bucket pumps and small hand sprayers. Those of large capacity are preferable to the Vermorels. Solid-stream nozzles are best suited for spraying tall trees, and because of their extremely large capacity cannot be used with any of the smaller power machines. This observation applies especially to the Worthley nozzle, which has been developed for use in spraying the gypsy and brown-tail moths in Massachusetts.

Spray rods. Extension rods are necessary for spraying large trees, since most of the modern nozzles produce a fine-mist spray, which has very little carrying power. For small orchards a section of $\frac{1}{4}$ -inch iron pipe serves the purpose very

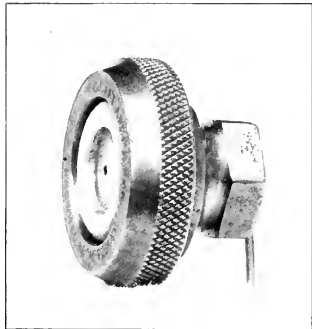


FIG. 120. Type of nozzle

well if the rods needed are not over 6 or 8 feet in length. Longer lengths of $\frac{1}{4}$ -inch iron pipe are hard to handle on account of their weight, and often break off in the threads. Rods of brass pipe are too flexible when made of light tubing, and too heavy when made of strong tubing large enough in diameter to obviate flexibility.

Extension rods made of bamboo and lined with brass or aluminum pipe are light, strong, and large enough in diameter to be handled conveniently without unduly tiring the operator. The base and top should be constructed like rod ends, for these thimbles prevent the accidental breaking of the rod at the juncture of the fitting and the lining pipe. Aluminum-lined rods of this type are practically as strong as the brass-lined ones, and are much lighter in weight. Bamboo rods 10 feet long are usually the most practical, although the 12-foot size is not too heavy nor too long for tall trees. The plain thimble bamboo rods with wired ends are seldom as durable as the other kinds mentioned, for the bamboo is liable to split, and the rod ends are more readily broken off; the lining pipe and thimbles get loose and turn around in the bamboo support, and there is no satisfactory way to remedy the defect.

Types of sprayers. *Bucket pumps.* Pumps of this class are of small capacity, but give a good pressure when properly controlled, and are very useful in greenhouses, conservatories, and small gardens. They cost from \$1.75 to \$5.00.

Knapsack pumps. These pumps, which have about the same capacity as the bucket type, are mounted in galvanized-iron or copper tanks. One of the best of these has a compressed-air equipment. They are useful in small vegetable and fruit gardens. The chief objections to them are the cost, — from \$5.00 to \$12.00, — which is relatively great when the capacity is considered, and the tendency of the tanks to give way, most of the material used in their construction being too thin to stand rough usage.

Neither the bucket nor the knapsack pumps are adapted for commercial operations.

Hand, or barrel, pumps. This designation includes all pumps of moderate capacity that are mounted on tanks having a capacity of from 50 to 300 gallons and operated by hand power. The most common is the brass pump mounted on the 50-gallon spray barrel, which has a sufficient capacity to carry two lines of hose.

Barrel pumps are made in various sizes, and will carry from one to four lines of hose. For small and moderate-sized orchards, not over 10 acres, and for general spray work on the farm the barrel outfit is satisfactory. It is also very satisfactory for spraying potatoes, if mounted on a two-wheel cart and an attachment added behind so that four rows at a time may be sprayed by one man, who both drives and pumps. A good barrel outfit, including pump, barrel, hose, rod, and nozzles, can be bought for from \$15.00 to \$25.00.

One of the most desirable spray outfits for moderate commercial operations — for instance, an orchard of from 10 to 20 acres — is the large-sized hand pump. Most of these are horizontal, two-cylinder and double acting, giving nearly twice as much pressure from the labor of one man as a small hand pump. They should be fitted with a pressure gauge and mounted on a tank having a capacity of from 150 to 250 gallons which is supplied with an agitator. Either one or two men can pump, and the pressure may be easily kept at 150 pounds. This style of outfit can be bought for from \$40.00 to \$64.00, exclusive of the running gear, and is recommended for those who have not sufficient spraying to justify the purchase of a power outfit.

Geared sprayers. There are a large number of special outfits, the power for which is supplied by a geared drivewheel. These outfits are especially useful in spraying vineyards and low-growing crops like potatoes, bush fruits, strawberries, and even small trees. They usually carry a set of nozzles so arranged as to dispense with the use of a man at the spray lance. It is not wise to attempt to spray trees over four or five years old with this type of sprayer, since the pressure will not be maintained long enough to spray thoroughly. The grower should exercise caution in the selection of a pump of this type, since some of these outfits are of too flimsy construction to be durable. The usual cost of a geared sprayer is from \$150.00 to \$250.00.

Gasoline sprayers. The most satisfactory outfit for extensive spraying is the modern gasoline-power sprayer. The high and uniform pressure at which these pumps may be held (150 pounds or more to the square inch) gives a uniformly strong delivery and enables the workmen to spray rapidly and effectively. One of the

best features of these pumps is that they can be worked continuously ten hours a day and thus cause little waste of time.

Many of the older types of gasoline outfits were clumsy and easily put out of order. The more recent types are much lighter, simpler, and more reliable, no expert mechanical skill being required to run them — only care. They are, however, more reliable on fairly level ground than on steep or rough land. Two or three leads of hose are needed with a gasoline outfit, and if the trees are old, one man should stand in a tower built over the tank. Both



FIG. 121. Putting on the finishing touches
— spraying begins to-morrow

A modern, up-to-date, practical equipment for spraying in a commercial apple orchard

air-cooled and water-cooled engines are satisfactory.

The compressed-air sprayer.

For some of the roughest orchard lands compressed-air outfits are preferable. These pumps and others of similar type have all the advantages of the gasoline sprayer and are free from some of the most annoying disadvantages. Some orchardists now have outfits for filling compressed-air tanks at home.

One air compressor, costing from \$75.00 to \$150.00, will fill a number of sets of tanks,

so that although the first cost is large, the subsequent expense for increasing the outfits is small. The compressor may be driven by water power, but if this is not available, then by a gasoline engine of from 6- to 12-horse power. As the engine is stationary, it is not so likely to get out of order as one mounted on a spray wagon. A storage tank for compressed air is used by some. The spray wagon or cart contains two galvanized-iron tanks, tested to 200 pounds' pressure and holding from 50 to 100 gallons, one for the liquid and the other for compressed air. From this, spraying pressure of from 80 to 140 pounds can be secured. As already pointed out, compressed-air outfits are especially adapted for very steep and rough land.

Results of spraying. The following tables are based on figures obtained by Cornell University, New York, as to the yield and income of both sprayed and unsprayed apple orchards. These figures are the result of apple-orchard surveys in the state.

Two computations were made on how spraying affects yields and incomes. One included all orchards within the survey, and the other only well-cared-for orchards. By studying the first table, it is evident that the greatest yield follows from the three sprayings, although there is a small gain in the average income in favor of four sprayings. It is very instructive to note the rising scale of average incomes, beginning at the unsprayed group and passing from that up to the group sprayed four times. In both tables this scale holds good.

SPRAYED AND UNSPRAYED ORCHARDS

HOW SPRAYED	NUMBER OF ORCHARDS	NUMBER OF ACRES	AVERAGE YIELD	AVERAGE INCOME
Unsprayed	99	1071	261	\$45
Sprayed once	74	737	364	93
Sprayed twice	162	1778	509	101
Sprayed three times	63	526	577	171
Sprayed four times	5	76	390	183

SPRAYING, YIELD, AND INCOME PER ACRE (ORCHARDS ALL WELL CARED FOR)

HOW SPRAYED	YIELDS			INCOMES		
	Number of Orchards	Number of Acres	Average Yield	Number of Orchards	Number of Acres	Average Income
Unsprayed	57	720	266	63	810	\$95
Sprayed once	40	368	353	48	488	146
Sprayed twice	81	753	422	82	758	147
Sprayed three times	40	425	440	40	425	201
Sprayed four times	3	43	285	3	43	226

It is interesting as well as instructive to compare the average income from the unsprayed crop with that from crops sprayed four times.

Two additional tables are given on page 258 showing that the orchards that were sprayed gave a much larger income and yield per acre than those not sprayed; these tables are worthy of consideration.

SPRAYING, YIELD, AND INCOME PER ACRE, ORLEANS
COUNTY, NEW YORK, 1904

HOW SPRAYED	YIELDS			CROP BARRELED	INCOMES		
	Number of Orchards	Number of Acres	Average Yield		Number of Orchards	Number of Acres	Average Income
Unsprayed	100	917½	245	71	94	861½	\$92
Sprayed once . . .	49	504	307	71	46	468	116
Sprayed twice . . .	90	921½	343	75	84	864½	127
Sprayed three times	40	426	322	83	37	406	139
Sprayed four times .	6	43	569	77	5	43	211

SPRAYING, YIELD, AND INCOME PER ACRE, ORLEANS
COUNTY, 1904 (ORCHARDS ALL WELL CARED FOR)

HOW SPRAYED	YIELDS			CROP BARRELED	INCOMES		
	Number of Orchards	Number of Acres	Average Yield		Number of Orchards	Number of Acres	Average Income
Unsprayed	43	381	328	66	54	449½	\$103
Sprayed once . . .	33	352	346	74	30	316	139
Sprayed twice . . .	70	701	374	78	64	644	143
Sprayed three times	27	247½	414	87	25	236½	184
Sprayed four times .	6	43	569	77	6	43	211

The difference in income is due to larger yields and to a larger proportion of fruit suitable to barrel, which result in higher prices. These conditions in turn depend on better orchard management and careful attention to spraying. Allowing for the additional expenditure involved in the purchase of a spraying outfit, — barrels, spray materials, labor, etc., — there is still a good profit in the returns from sprayed trees as compared with those from unsprayed trees. It is therefore clear that the extra expense and work are justified on economic grounds as well as from the standpoint of satisfaction in producing a large percentage of high-grade fruit.

Cost of spraying. It will cost from 10 to 30 cents per tree to spray, varying with the number of applications, the size of the tree, the kind of machine used, the area of the orchard, the price and character of the materials used, and the efficiency of the labor. In

Nebraska, after a long series of careful tests of prices and effectiveness of the various methods and materials, it was found that trees could be thoroughly sprayed for from 18 to 25 cents each during the season. The cost of 1000 gallons of arsenate of lead and Bordeaux mixture, which is sufficient to spray 500 trees quite thoroughly once, will approximate \$6.60. One can spray a tree four times quite satisfactorily with 8 or 10 gallons of spray material.

The cost of labor will vary from 3 to 5 cents per tree when a large power outfit is used, and from 15 to 25 cents per tree when a small barrel pump throws the liquid.

The following is a reasonable estimate of the cost of spraying 100 trees :

Cost of material	\$6.60
Cost of labor	6.60
Interest and wear on machinery	5.20
	<u>\$18.40</u>

This means a trifle over 18 cents per tree. The returns are practically certain to justify this expenditure many times over.

CHAPTER XXI

MISCELLANEOUS INJURIES

Apple orchards are subject to many injuries which are often more fatal to the trees than are years of depredations by insects and diseases. Most of these injuries could be prevented, but there are some of them which seem to be beyond the help of man.

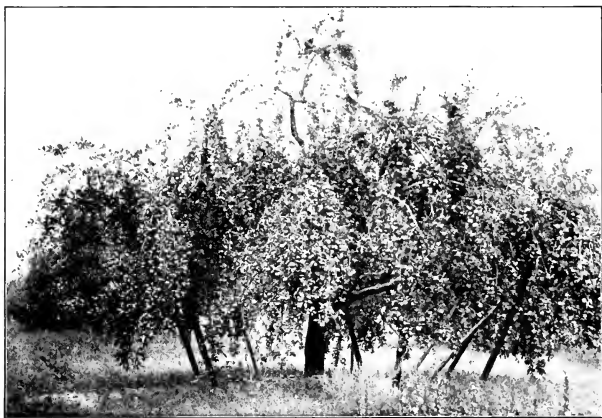


FIG. 122. A well-propped tree

A heavy load of apples, causing the owner to prop the limbs in order to prevent breaking

Injury by wind. One of the greatest losses to both trees and fruits is caused by excessive winds. Let a wild wind sweep through an orchard loaded with large apples nearly ready to pick, and perhaps in ten minutes' time most of this fruit will be strewn on the ground and so injured that it cannot be marketed as a first-grade product. Even if the wind is only strong enough to cause the limbs

to blow or bend, this may be the last straw needed to break a limb, and thus waste years of growth.

Windbreaks, if properly constructed, will help in such cases. So far as the load of fruit is concerned, it may be lightened considerably by judicious thinning, and may be further protected by proper supports under each heavily laden limb. Common bean poles or ordinary poles or boards will answer. One very good support is made with a smooth base upon which $5\frac{1}{2}$ inches of the limb rest. It is made on a swivel and will adjust itself to any angle, thereby equalizing its weight, without either rubbing or breaking the bark. The hanger, or socket, allows for a wood stake to be inserted. Growers who have used this prop have been well satisfied with it. Its cost is \$10.00 per hundred.

Injury by carelessness. Each orchardist can undoubtedly call to mind cases where by a little more care, injury to the trees could have been prevented. Perhaps the injury was made at the time of plowing the orchard, or when harrowing by "barking" the tree with the end of the whiffletree, thereby inviting further injury by disease. Perhaps it was in driv-

ing too close to the tree that the old high hames barked a limb or broke it. In any such case the injury could have been prevented.

Injury by animals. Cows, sheep, pigs, and other animals may cause considerable injury to trees, either by consuming the young growth or by destroying the bark and girdling the tree. Sheep are particularly fond of chewing the tops of young branches, and pigs are sometimes very destructive in girdling trees, especially when there is a lack of ordinary food.

Some owners advocate the pasturing of orchards by these animals, and certain particular orchard conditions may warrant such a procedure, but unless the trees can be protected from injury, this would seem to be more devastating than beneficial.



FIG. 123. A metal head for props

Oftentimes overloaded branches are broken when ordinary tree props are used. By placing a metal head on each prop, similar to that above, the difficulty will be obviated.

Injury by mice. The injury by mice to all crops during a year reaches enormous proportions. At certain times between fall and spring they seem to have a decided liking for young apple trees, completely girdling many and partially girdling others, thereby causing unsatisfactory growth. Young trees that have grass or rubbish quite close to their trunks are liable to be attacked. Under ordinary conditions an apple tree 4 or 5 inches in diameter is safe from attack, but when food is very scarce, even these may suffer.



FIG. 124. An orchard heavily laden

Trees loaded with fruit, causing the branches to touch the ground and in many cases necessitating props

Several ways have been found to protect trees against mice. One is to use thin strips of wood called "wood veneers," which may be easily wrapped around the tree and tied with string or wire. The lower ends may be creosoted to prevent rot if the veneers get pushed into the ground. An important point to remember is that the wood should be wet, preferably soaked in water, before being tied in place. The cost of these veneers is about a cent each, often less. They should not be placed about the tree until early autumn, probably the last of August or during September in the Northern states, nor should they be allowed to remain around the trees later

than early summer, probably May or the first of June. If they are left on the trees too long, such insects as the woolly aphis may take advantage of their shade by making it a breeding place, or borer beetles may lay their eggs under them. Some injury also seems to be done if the trunk is deprived too long of sunlight.

Tar paper, sheet iron, laths nailed close together, and many other devices have been brought forward as satisfactory protectors against mice, each probably being the most satisfactory for a special condition. Where sheet iron, veneer, and other forms of cylinder protectors that do not permit of easy entrance of sunlight are used, some device should be arranged to keep out the snow and sleet. A collar or cap of red building paper could be easily made. A piece of paper the shape of the collars worn by boys a few years ago is just right. This paper should be wrapped around the top of the cylinder and slightly slit at the top, so that it can be easily and securely tied to the tree. It will form a slanting roof over the cylinder, keeping out snow and sleet, and at the same time prevent chafing by keeping the top of the cylinder away from the tree.

Ordinary wire screening is a form of protector that has met with universal approval. The galvanized $\frac{1}{4}$ -inch mesh screen is generally preferred. A piece 18 inches long and 12 inches wide is required for very young trees. It may be wrapped around the base of the trunk, or may be bent into a cylindrical form first and then be slipped quickly into place. Care should be taken to have it at least 2 inches below the soil to prevent underground girdling. This may be easily accomplished by excavating slightly about the base of the tree, or if the soil is soft, by pushing the screening into it. The screen may be held together at its edge by two pieces of copper wire or hay wire, or two wire nails thrust through the layers. At the top a piece of binder twine tied from one side of the screen around the tree to the other side, from east to west and also from north to south, will hold the screen away from the tree. Otherwise, it will be necessary to watch the trees so that they will not be girdled by the rubbing of the screening against the trunks. If the screening is put on in this way, it can remain during the summer; and if the galvanized screening is used, it will last for several years and is therefore cheaper in the end.

Injury from rabbits. The injury to the bark of the trees by rabbits differs from that done by the mice. Rabbits work higher up on the tree, commonly starting about 12 or 18 inches from the ground, tearing off the bark in strips and chewing larger bits, while mice start at or below the surface of the soil and chew out small bits.

In the West the jackrabbit is the pest, while in northern United States and Canada the hare is the destroyer. The familiar cottontail rabbit is common to the eastern regions.

The protection against rabbits may be taller wire screens or a spray or a paint. Lime-sulphur wash may be used as the spray, and may be applied in November at the time the orchardist is spraying for the San José scale. If the trees are not being sprayed, the solution may be applied with a brush or small hand sprayer. The home grower with a few trees should purchase a can of some one of the commercial brands of prepared lime-sulphur rather than go to the trouble of mixing a small amount.

White-lead paint promises to become the most satisfactory treatment, owing to its cheapness, permanency, and ease of application, as well as its power to prevent the entrance of borers into the tree. In painting, it may be necessary to remove some loose soil at the base of the tree. Allow time for the bark to dry out where the soil lay against it. Give the bark when dry a thorough coating with the paint, from the lowest exposed point to about 3 feet or more from the ground level. After the paint has dried, replace the soil about the trunk of the tree.

Both the lime-sulphur and the white lead have been found to be satisfactory in fighting mice also.

Many other substances have been recommended and in certain cases may be effective.

Injury from deer. In some states injury from deer is common. The deer trim the tops of newly set trees or the sides of older trees, especially young branches. It seems that the does are the chief offenders. Certain states reimburse owners for loss by deer, but the return of money for several years' growth or the constant annual deer pruning will never pay the orchardist. In some states the law permits the owner of an orchard to shoot the deer if damage is being done, reporting the case at once to the

game wardens. If the orchardist dresses the deer, the state will take it and pay him for the trouble of dressing.

Longer open seasons offer some relief, and possibly a very short doe season would drive these animals away. Fencing—if the fence is 8 or 10 feet high and of tight-woven wire — may keep them out, although in most cases where fences have been used, it has been found that the deer get in easily but cannot get out. Deterrent licks have also been tried. After the deer begin to come daily to these licks, either kerosene is poured over the salt, or sulphur is mixed with a small amount of salt. Both these substances are very distasteful to deer and will serve to drive them away from the territory.

Perhaps we shall find that applications of lime-sulphur will keep the deer from eating the foliage, but the value of this preventive has not yet been demonstrated.

Orchards may be injured in other ways than those mentioned here, but these will serve to suggest to the orchardist the difficulties against which he must guard.

CHAPTER XXII

PICKING

The picking of the fruit is one of the most important operations in profitable apple production. Most orchardists pick the fruit either too soon or too late, chiefly too early. Fruit that is not

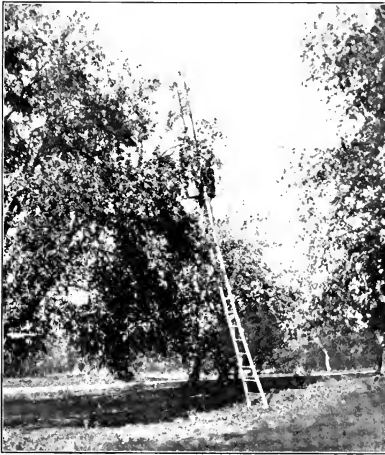


FIG. 125. Expensive work

Where trees are too high the expense of picking is materially increased. It costs money to move a heavy long ladder and also to climb up and down on it

Moral: Keep the trees low

picked soon enough rots quickly and loses its marketable qualities. However, if the market is a local one, or if the apples are to be sold immediately for consumption, they may be allowed to remain on the trees longer than would in other cases be safe. By allowing apples to remain on the trees till after the best time for picking, one great advantage is gained, and that is an increase in the color of the fruit — provided, of course, the apple has a color that can increase and deepen. Often this

heightened color materially increases the immediate returns for the fruit. Some varieties lose their crisp quality if allowed to remain too long on the tree and become soft and mushy, in which stage many people do not like them.

If apples are picked too soon, they not only lack the color that in many varieties is essential to their ready sale but, since the change from a sour to a sweeter stage has not taken place to any marked degree, they are less edible than those which are allowed to remain longer on the tree. There may also be some decrease in the size of apples picked too soon.

If apples suffer by being picked too soon or too late, just when ought they to be picked? The author wishes that he could give a helpful answer to this question, but he feels, as many other orchardists have felt, that a definite statement on this point cannot easily be made. In general, it may be said that at the time of picking, the apple should have a large degree of the characteristic color of its variety and should be of the average size of the variety. It should be firm of flesh, but should not have the firmness of immaturity. It should not be mushy or mellow, nor have a dull, over-ripe, stale appearance.

How to pick. Nature has supplied a small joint at which the stem of the apple may be easily severed from the twig. This is marked by a collection of wrinkles on the twig. If the apple is grasped and pulled away from the tree, the joint may break correctly, but the chances are that the stem will be torn out of the apple. This is not the way to pick apples from the trees. The proper method is to place the hand carefully around the apple to



FIG. 126. At work harvesting

A good stepladder, a cloth bag, and an energetic man complete the outfit. Harvesting is then done quickly and cheaply

check its falling to the ground, and with the free fingers or, better still, with the other hand, sever the stem from the twig by a side pressure at the joint. *Do not press the apple with the hand.* Apples are delicate and are often bruised by what would seem to be a slight pressure. With practice the operator can learn to



FIG. 127. Harvesting

Harvesting from a modern stepladder. Using a cloth bag for the picking-receptacle

remove the apple with one hand without pressing or bruising it. As each apple is picked it should be carefully placed in a receptacle. The exact time of picking will depend on the variety and perhaps on the tree or on the part of the tree.

Equipment for picking.

In order to carry on the operation of harvesting a crop of apples successfully, it is important that an adequate equipment be supplied. Every picker should be given a receptacle to hold the apples. Some growers prefer a peck basket, others a half-bushel basket. Split wood is used in the construction of the baskets, which generally have round sides, a small, flat bottom, and

a substantial handle. Some orchardists prefer canvas baskets, canvas bags, and the like, each operator being advised to select the picking-receptacle that he can use best.

When the trees are young and small, most of the fruit can be easily reached from the ground, but as they increase in age and size it is necessary to have some aid in reaching the fruit. Short stepladders with four legs, common in many households, are used,

A three-legged stepladder with or without a pointed top is favored by some growers. Common ladders of various lengths are also used.

A practical ladder similar to the common ladder, but having a flaring base and coming to a point at the top, is thought by many orchardists to be the best picking-ladder. A single pole with rounds and a flaring base has also been recommended. Apparatus to help the operator reach the fruit more easily are increasing every year, but many individuals are not using any of the newer devices. Most fruit-growers still cling to ordinary stepladders or the larger painters' ladders, with an occasional modification.

Picking-poles are sometimes used, but are far from common among the commercial growers. One such pole has a wire basket mounted on one end; the top of the basket is open to permit the entrance of the apple, the stem and twig working down between the wire fingers on the side, and the operator twisting the pole to the left or the right to sever the stem from the twig. The apple must then be removed from the wire basket. Another pole which operates in the same way has a wire basket with half the top open at one side. Still another pole picker severs the stem, and permits the fruit to drop down through a cloth tube to the operator or into a basket on the ground or attached to the handle. The chief objections to this kind of picker are that it is liable to bruise the apples and is slow to work with, thus increasing the cost of picking.

Organization of the picking force. Organization of the picking force in any orchard is of vital importance. For greatest efficiency, there should be but one head, or boss, who has full command of the pickers.

The picking force should not be allowed to stray away from their particular gang of which the boss is the center. The work of the crew should start at one side of the orchard, taking a certain number of rows of trees, and proceed steadily through these rows to the other side of the orchard. Then another definite set of rows should be picked. If more than one picking is to be given, or if the varieties are mixed in the orchard, slight modifications of this method may be necessary. However, the general scheme of organization is to work systematically by having the pickers grouped together under one boss, and equipped with ladders, baskets, and the other apparatus necessary for quick and efficient picking.

CHAPTER XXIII

GRADING

Reasons for better grading. Several years ago the grading of fruit was not considered necessary, but as fruit-growing has developed from a side issue on the farm to an important business, a change in the methods of handling the crop has been imperative. Competition has become so keen and the consumer has become so well educated, that in order to sell apples at remunerative prices the conscientious grading of fruit must be practiced.

Sometimes, even in recent years, buyers have been greatly deceived by unfair, dishonest methods of grading. Often barrels of apples which show good-sized specimens as "facers" grade down to small fruits in the middle or at the bottom of the barrel. In time sharp competition will eliminate such swindles, for the dishonest grower is sure to suffer in the long run if such practices are continued.

At the present time our markets are flooded with apples of poor quality that should never have been packed. As a result, not only are very low prices obtained for such stock, but the demand for the better class of apples is hurt and prices are lowered. We are rapidly reaching a period in the apple industry when there will be an overproduction of apples if the present methods of packing continue. In fact, that period of overproduction seems to have been already reached—prices are becoming lower and lower because the quality packed is inferior. There is one way in which we can prevent and remedy this overproduction, and that is to raise the standards of packing by permitting no second-grade apples to be packed. If the growers will coöperate to ship only first-grade apples to the market, and to pack those in a more attractive manner, they will stimulate a demand that will equal any production of apples that may take place.

But what shall we do with our seconds and our cider apples if we cannot pack them and ship them to our markets? The evaporators

as a rule offer a larger price for second-grade apples than they can net when packed in barrels and sent to the market. If there is not already an evaporator in your section, then there is need of coöperation among the growers to erect evaporators which shall take care of the second-grade stock. Cider apples will never be anything but cider apples, and the cider mill is the only place for them. It is absolute fraud to pack in with other apples any wormy, gnarled, diseased apples that are no larger than walnuts. But even if you had to throw away and lose absolutely all second-grade and cider apples, you would be wise in so doing, for if they are mixed in with first-grade fruit, or even if packed separately, they command only very low prices and lessen the demand for, and the price of, the best-grade apples. It would be much better to cull from the tree all small, diseased fruit while the crop is still growing, so that whatever remained would be of first quality. Any person experienced in the growing of apples knows that the fruit which remains would increase in size and make up all the loss.

Grading rules and laws. In the better grading of fruit the West has far outstripped the East. Undoubtedly the reason for this is that the Westerners early realized that they must sell their apples at a good price in order to cover the expenses of growing and shipping. It was then necessary to outdo the other competitors



FIG. 128. Harvest time

Picking, sorting, and packing, out in the orchard

in the fineness of the grade shipped. One glance at a Western box of fruit by any person would readily convince him that the apples were of uniform size, shape, and color. The East is slowly adopting the Western methods of close grading, and competition between the various apple-producing sections is becoming keener each year.

Some of the rules followed by various sections of the West are given below.

HOOD RIVER OREGON GRADING RULES

The three grades, Extra Fancy, Fancy, and Choice, heretofore in common use, will be recognized. Special and Orchard Run grades are also established. Rules governing the disposal of cooking and cider apples are appended, also the specifications and explanations defining the condition of the fruit to be placed in the respective packs and grades.

Extra Fancy. This grade includes mature, normal-shaped apples free from imperfection. Spitzenburgs 175's and larger must be three fourths (75 per cent) normal red color; sizes 185's to 200's, inclusive, must be 90 per cent red. All red varieties must show at least three fourths red color; striped or partially red one half (50 per cent) red color. Red Cheek Pippin and Winter Bananas must show a blushed cheek. The Ortley must show white, yellow, or waxy. Sizes smaller than 200's will be excluded from this grade, except Jonathan, Newtown, Winesap, Arkansas Black, and Missouri Pippin, which must not be smaller than 225's.

Fancy. All apples placed in this grade must be mature and of a normal shape. All red apples must be at least one fourth (25 per cent) normal red color; striped or partially red varieties must show 10 per cent red color. Specimens with leaf and limb rubs, spray russet, and similar defects which have not distorted the fruit, when not over $\frac{1}{2}$ inch in the aggregate, will be allowed. No fungus-infested or stung apples will be allowed in this grade. No size smaller than 200's allowed.

Special. This grade includes varieties equal to Fancy in grade, but with one sting of the codling moth or one fungous spot not larger than $\frac{1}{4}$ inch in diameter or smaller ones aggregating the same area or less. Sizes smaller than 175's must be free from stings and fungus.

Choice. In this grade may be placed all merchantable apples not included in the Extra Fancy and Fancy grades. All apples must be sound, free from bruises, with skin unbroken, and of good shape. Specimens with a fungous spot not larger than a ten-cent piece, — one to an apple, — or three spots aggregating a similar area, will be allowed. Sizes smaller than 175's not allowed.

Orchard Run. Only such apples as may be classed as Choice, or better, may be placed in this grade. No full-green specimens of a red variety will be allowed. Sizes limited to 185's for this grade.

Cooking or cider apples. The following apples cannot be placed in any of the grades, but may be disposed of for cooking purposes: those too poorly colored to meet the color requirements of the grades, windfalls, sunburned, bruised, infested with fungus, water core, Baldwin spot or other physiological defects, any of which do not render the apple undesirable for culinary purposes. No sizes smaller than 150's allowed.

Apples infested with San José scale, oyster-shell bark louse, and codling moth must be disposed of according to the Oregon horticultural law.

Sizes. Three-tier: 36, 45, 54, 63, 64; three-and-one-half-tier: 72, 80, 84, 88; four-tier: 96, 104, 112, 120, 125, 128; four-and-one-half-tier: 138, 140, 144, 150, 165, 175; five-tier: 185, 188, 190, 200, 215, 225.

RULES OF THE WENATCHEE VALLEY WASHINGTON FRUIT GROWERS' ASSOCIATION

Proper marking. In marking all fruit packages, care should be taken that all marks are made in a neat manner and in the proper place. The grower's name, and the grade, variety, and number of apples in the box should appear on the labeled end of the box above the label. We suggest that the following rule be adopted:

Summer apples. Pack only one grade of summer apples — Orchard Run; but in making this pack, keep out all small and imperfect fruit, or, in other words, pack only sound apples free from worms, scale, and other defects, and pack none smaller than 200 apples to the box. All boxes shall be stamped with the grower's name, the variety, and the number of apples which they contain.

Fall and winter apples. All fall and winter apples shall be packed in standard-size boxes, which must be new and clean. The sidepieces shall be nailed with four nails in the end of each piece. Both the top and the bottom shall be cleated, and four nails shall be used in each cleat. No smaller than fivepenny cement nails are to be used throughout. Do the nailing properly. All boxes shall be lined with paper on the inside, and all apples shall be wrapped, unless otherwise specified. The apples shall be firmly packed in boxes in tiers, and each box shall contain a uniform size of apples. The boxes after being packed shall show not more than $1\frac{1}{2}$ inches nor less than 1 inch bulge on top and bottom, inclusive. While the apples must be firmly packed, so that the boxes will be full and the apples secure in their places, the pack must not be so tight as to bruise the fruit. Apples range from 36 to 200 to the box. This year [1914] the number of apples the box contains should be stamped on the outside instead of tiers. This is done so that the retailer will know how many apples are in the box and the cost per apple or dozen. All apples must be packed diagonally, with solid sides. All fall and winter apples shall be graded in three grades, namely, Extra Fancy, Fancy, and Grade C.

Extra Fancy. In this grade all apples shall be sound, smooth, free from worms, worm stings, scale, water core, sun damage, or diseases of any kind, and of proper shape according to the variety. No apples smaller than 175's

shall be allowed in this grade, nor any apples of a red variety that are not at least three fourths red, except Rome Beauty, Ben Davis, Snow, and Apple of Commerce, that are one half red. Yellow Newtowns, White Winter Pear-mains, Grimes Golden, Bellflowers, Winter Bananas, and Red Cheek Pippins will be allowed in this grade, but no other variety of yellow apples. Winter Bananas and Red Cheek Pippins must show a red cheek.

Fancy. In this grade, also, all apples must be smooth, sound, free from bruises, blemishes, worms, worm stings, water core, sun damages, and diseases of every kind, and of proper shape according to the variety. No apples smaller than 175's shall be allowed in this grade, except apples of the following varieties, which will be accepted when packed as small as 200 apples to the box: Winesaps, Jonathans, and Missouri Pippins, when red all over. All apples of red varieties ranging in color from three fourths red down to one third red will be included in this grade. All varieties of yellow apples will be allowed in this grade.

Labels. All boxes containing apples graded Extra Fancy or Fancy must bear the association label on the end of the box.

Grade C. This grade shall be made up of all merchantable apples not included in the Extra Fancy and Fancy grades. These apples must be sound, and free from bruises, worm stings, and other diseases. The skin must be unbroken, but misshapen apples, or apples having a limb mark or other like defect, will be allowed. This grade will include apples of all colors, and as small as 200's, but no smaller. It is optional with the buyer whether or not this grade is wrapped.

RULES OF THE NORTHWESTERN FRUIT EXCHANGE

Extra Fancy. This grade shall consist of sound, smooth, well-formed apples only, free from all insect pests, disease, blemishes, and physical injuries, worms, wormholes, stings, scale, scab, sunscald, fungus, dry rot, decay, water core, spray burns, limb rub, russeting, skin puncture, skin broken at stem. All apples must be of the natural color and shape characteristic of the variety. Apples heavily coated with dirt or spray must be cleaned. Color requirements for this grade are as follows: Solid red varieties, like Arkansas Black, Gano, Jonathan, Missouri Pippin, Spitzenburg, Winesap, etc. must have at least 75 per cent of good natural color. McIntosh Red must have not less than $66\frac{2}{3}$ per cent of good natural color. Striped or partially red varieties, like Ben Davis, Delicious, Rome Beauty, Stayman Winesap, etc., must have at least 50 per cent of good red color. Red cheek or blush varieties, like Red Cheek Pippin, Winter Banana, etc., must have a distinctly colored cheek or blush. Sizes in this grade shall not be smaller than 175's, but Jonathans, Missouri Pippins, and Winesaps may be packed as small as 200's.

Fancy. Apples in this grade must possess the same physical requirements as to soundness and freedom from insect pests, disease, blemishes, and physical injuries or defects as the Extra Fancy, with the exception that minimum

defects, such as slight limb rub and russeting, may be accepted. Broken or punctured skin will not be permitted. Slight deviations from proper form may be included, but not clearly misshapen fruit. Fancy grade must be considered as representing strictly first-class commercial fruit, fit for any market. Apples heavily coated with dirt or spray must be cleaned. Color requirements for this grade are as follows: Solid red varieties, including McIntosh Red, must have at least 33 $\frac{1}{3}$ per cent of good natural color. Striped or partially red varieties must have at least 20 per cent of good red color. Red cheek or blush varieties must have correct physical qualities, without requirement as to color. Sizes in this grade shall not be smaller than 175's, except as follows. Newtown Pippins and other yellow or green pippin varieties may be packed up to 225's, inclusive. Solid red varieties may be packed up to 200's, inclusive, when containing not less than 50 per cent of good red color. Winesaps and Missouri Pippins may be packed as small as 225's when not less than 75 per cent of good natural color.

C grade. This grade shall be made up of all merchantable apples not included in the Extra Fancy or Fancy grades. Apples must be free from all insect pests, worms, wormholes, disease or physical injuries, including skin puncture and broken skin. No requirements as to color, except that the fruit must clearly be not immature. Sizes may be as small as 200's except under unusual circumstances.

NO. 1 GRADE	MINIMUM SIZE	COLOR REQUIREMENT	GENERAL CONDITION	PHYSICAL PERFECTION	PACKING STANDARD
Solid red varieties			Must be of natural color, shape, and condition characteristic of variety. Apples heavily coated with dirt must be cleaned	Must be sound, smooth, well-formed, free from all insect pests, disease, blemishes, injuries, worms, wormholes, stings, scale, scab, sunscald, dry rot, decay, fungus, water core, spray burns, limb rub, skin punctures, skin broken at stem	Each apple must be wrapped. Boxes must be lined with paper. Pack must be standard count as per list at bottom
Arkansas Black	150	75 per cent			
McIntosh Red	150	good natural color			
Spitzenburg	150				
Winesap	163				
Partially red varieties			Must be of natural color, shape, and condition characteristic of variety. Apples heavily coated with dirt must be cleaned	Must be sound, smooth, well-formed, free from all insect pests, disease, blemishes, injuries, worms, wormholes, stings, scale, scab, sunscald, dry rot, decay, fungus, water core, spray burns, limb rub, skin punctures, skin broken at stem	Each apple must be wrapped. Boxes must be lined with paper. Pack must be standard count as per list at bottom
Delicious	138	50 per cent			
Gravenstein	150	good red color			
Jonathan	150				
Rome Beauty	138				
Stayman Winesap	138				
Blushed red varieties			Must be of natural color, shape, and condition characteristic of variety. Apples heavily coated with dirt must be cleaned	Must be sound, smooth, well-formed, free from all insect pests, disease, blemishes, injuries, worms, wormholes, stings, scale, scab, sunscald, dry rot, decay, fungus, water core, spray burns, limb rub, skin punctures, skin broken at stem	Each apple must be wrapped. Boxes must be lined with paper. Pack must be standard count as per list at bottom
Red Cheek Pippin	150	Cheek distinctly colored			
Winter Banana	138				
Yellow varieties			Must be of natural color, shape, and condition characteristic of variety. Apples heavily coated with dirt must be cleaned	Must be sound, smooth, well-formed, free from all insect pests, disease, blemishes, injuries, worms, wormholes, stings, scale, scab, sunscald, dry rot, decay, fungus, water core, spray burns, limb rub, skin punctures, skin broken at stem	Each apple must be wrapped. Boxes must be lined with paper. Pack must be standard count as per list at bottom
Grimes Golden	150	Good natural color			
Ortley	150				
White Winter Pearmain	150				
Yellow Newtown	163				

LIMITED TO VARIETIES LISTED

No. 2 GRADE	MINIMUM SIZE	COLOR REQUIREMENT	GENERAL CONDITION	PHYSICAL PERFECTION	PACKING STANDARD
INCLUDES ALL VARIETIES Solid red varieties Partially red varieties Blushed varieties Yellow varieties	None smaller than size 175, except as below	33 $\frac{1}{3}$ per cent good natural color	Apples with slight deviation from proper form may be included, but not when clearly misshapen. Apples heavily coated with dirt must be cleaned	Same as for No. 1 Grade, except that apples with slight limb rub, slight russetting, or small healed sting will be admitted, but no apple shall show more than <i>one</i> of these defects	Same as for No. 1 Grade
		20 per cent good red color			
		None			
		None			

EXCEPTIONS. Yellow Newtowns may be as small as size 200. Jonathan, Spitzenburg, and Winesap will be admitted in sizes 188 and 200, if up to color requirements for No. 1 Grade. Rome Beauty, if 125 or larger, will be admitted when 10 per cent red.

No. 3 GRADE	MINIMUM SIZE	COLOR REQUIREMENT	GENERAL CONDITION	PHYSICAL PERFECTION	PACKING STANDARD
May include all merchantable apples not admitted to Grades No. 1 or No. 2	None smaller than size 150. No exceptions	No requirements in regard to color	No requirements except that fruit must not be clearly immature	Must be free from all insect pests, disease, worms, or serious injuries. Skin puncture or broken skin <i>not</i> permitted	Pack according to trade requirements, without wrapping

All grades must be rigidly observed. Apples not admissible to grades specified must be withheld from market.

Designate sizes by *count*; do not show tiers. The only recognized counts for Northwest standard apple packs are as follows: 41, 45, 48, 56, 64, 72, 80, 88, 96, 100, 104, 113, 125, 138, 150, 163, 175, 188, 200.

A national law — the Sulzer Bill. It was with the appreciation that a certain crisis had arrived in the apple industry, and that standards must be created and maintained in order that the

demand for apples might increase with the production, that the Apple Shippers' Association a few years ago drafted the first standardization measure regarding the packing and grading of apples. Gradually, various horticultural societies gave their support, and to-day the national law establishing standards for the marketing of apples, known as the Sulzer Bill, is proof that growers everywhere appreciated the need of such fixed standards.

This law is not mandatory ; it does not compel any grower to pack his apples in a different way from that in which he is accustomed to pack them ; it does not compel honesty, nor can it compel intelligence. The Sulzer law is educational in its nature, and holds out rewards for better packing and grading. It establishes a definition of standard apples. It provides that such standard apples may be packed in three grades, differing from each other only as to size. It provides and defines the capacity of a standard barrel, and states that when the standard grade defined by the law shall be packed in the standard barrel defined by the law, the grower may then use certain United States brands to designate the three grades of his apples. The law also provides that, in case any grower shall use these United States brands on barrels not packed in accordance with the law, certain penalties shall attach, and may be collected from the one responsible for the deception.

The law secures to the honest packer the results of his packing. It enables him to use certain brands to designate his methods of packing which the fraudulent grower may not use except by making himself liable to the penalty laid down by the Federal government. The standard quality of apples as provided by this law is as follows :

Apples of one variety, well-grown specimens, hand-picked, of good color for the variety, normal shape, practically free from insect or fungus injury, bruises, and other defects, shall be the standard quality. An allowance of 10 per cent leeway is made to any grower in the packing of this quality. This quality may be packed into three grades, as follows :

From $2\frac{1}{2}$ inches up, first grade.

From $2\frac{1}{4}$ inches up, second grade.

From 2 inches up, third grade.

The brands shall be as follows :

When the apples are practically perfect in quality and packed from $2\frac{1}{2}$ inches up, the barrel may be branded Standard Grade, minimum size $2\frac{1}{2}$ inches.

When the barrels are packed with apples of practically perfect quality from $2\frac{1}{4}$ inches up, the barrel may be branded Standard Grade, minimum size $2\frac{1}{4}$ inches.

In a similar manner the third grade may be branded Standard Grade, minimum size 2 inches, when it contains apples of practically perfect quality from 2 inches up.

The effect of this bill will be to give confidence to the purchaser; to increase the demand for apples; to raise the price because of the increased demand; and to stimulate the exporting of apples to Europe and South America, which is a pressing need in view of the fact that the export trade in American apples has been steadily falling off for the last five years. Canada has a standardization act regarding apples which has been in existence five years, and the Canadian exports have grown steadily and have given increasing satisfaction, while the American apples have become a source of general complaint to all European consumers.

As already explained, the Sulzer Bill permits the use of United States brands for apples that are packed in accordance with its provisions. It will not be long, however, before the retailers throughout the country will understand the distinction between the standard United States pack of apples and the ordinary pack, known as the "farmer's" pack, and will pay a premium of from 25 cents to \$2.25 for the assurance that the apples they are about to buy have the government guaranty behind them, and are packed true to the promise of the face that is opened before them. There is a general opinion that apples are worth about one price. We speak of the "going price" of apples, or what apples are worth, but, as a matter of fact, every grade of every variety in almost every orchard has a different value and sells for a different price on the market. Northern Spies of first quality from Vermont have sold all the way from \$2.50 to \$14.00 per barrel, and there is one Vermont orchard that for years has maintained, regardless of market conditions, a selling value of \$12.00 per barrel for its highest grade, which are really all facers; \$8.00 per barrel for the No. 1's, which are packed in accordance with the first provision of the Sulzer bill; and from \$3.50 to \$4.00 for the No. 2 apples.

The Sulzer Bill is, after all, very elementary and not compulsory. It only establishes by law what was supposed already to be the custom in the packing and grading of apples throughout the country.

NEW YORK STATE APPLE GRADING LAW

CHAPTER 418

AN ACT to regulate the grading, packing, marking, shipping, and sale of apples

That the standard grades or classes for apples grown in this state when packed in closed packages shall be as follows:

First: New York standard fancy grade shall consist of apples of one variety, which are well-grown specimens, hand-picked, properly packed, of good color for the variety, normal shape, free from dirt, diseases, insect and fungus injury, bruises and other defects except such as are necessarily caused in the operation of packing; or apples of one variety which are not more than five per centum below the foregoing specifications on a combination of all defects or two per centum on any single defect.

Second: New York standard "A" grade shall consist of apples of one variety which are well-grown specimens, hand-picked, properly packed, normal shape, practically free from dirt, diseases, insect and fungus injury, bruises and other defects except such as are necessarily caused in the operation of packing; or apples of one variety which are not more than ten per centum below the foregoing specifications on a combination of all defects or five per centum on any single defect. No apples in this grade shall show less than thirty-three and one-third per centum of good color for the variety.

Third: New York standard "B" grade shall consist of apples of one variety which are well-matured, hand-picked, properly packed, practically normal shape, practically free from dirt, diseases, insect and fungus injury; or apples of one variety which are not more than fifteen per centum below the foregoing specifications on a combination of all defects or five per centum on any single defect.

Fourth: Ungraded. Apples not conforming to the foregoing specifications of grade, or, if conforming, are not branded in accordance therewith, shall be classed as ungraded and so branded. The minimum size of the fruit in the package shall also be branded upon it as hereinafter specified and in addition to the other marks hereinafter required.

The marks indicating grade as above prescribed may be accompanied by any other designation of grade or brand if that designation or brand is not inconsistent with or marked more conspicuously than the one of the said four marks which is used on the said package. Apples packed and branded in accordance with the United States law approved August third, nineteen hundred and twelve, shall be exempt from the provisions of this act.

The minimum size of the fruit in all classes or grades, including the ungraded, shall be determined by taking the transverse diameter of the smallest fruit in the package at right angles to the stem and blossom end. Minimum sizes shall be stated in variations of one-quarter of an inch, like two inches,

two and one-quarter inches, two and one-half inches, two and three-quarter inches, three inches, three and one-quarter inches, and so on, in accordance with the facts.

Minimum sizes may be designated by figures instead of words. The word "minimum" may be designated by using the abbreviation "min."

A tolerance or variation of five per centum on size shall be allowed in all classes, but such five per centum shall not be in addition to the variations or tolerances for defects provided in grades "Fancy," "A," and "B."

(A) Every closed package containing apples grown in the state of New York which is sold, offered, or exposed for sale, or packed for sale, or transported for sale by any person shall bear upon the outside of one end in plain letters and figures the name and address of the packer or the person by whose authority the apples were packed and the package marked, the true name of the variety, the grade or class of the apples therein contained, and the minimum size of the fruit in the packages. If the true name of the variety shall not be known to the packer or the person by whose authority the package is packed or branded, then such variety shall be designated as "unknown." Every package of apples which is repacked shall bear the name and address of the repacker or the name of the person by whose authority it is repacked in place of that of the original packer.

(B) The marks or brands as prescribed by this act shall be in block letters and figures of size of not less than thirty-six points Gothic.

(C) It shall be unlawful for any person within the state to sell, offer or expose for sale, or pack for sale, or transport for sale apples which are adulterated or misbranded within the meaning of this act.

(D) For the purposes of this act apples packed in a closed package shall be deemed to be misbranded.

First. If the package shall fail to bear the statements required by this act.

Second. If the package shall be falsely branded or shall bear any statement, design, or device regarding such apples which is false or misleading, or if the package bears any statement, design, or device indicating that the apples contained therein are a given New York "standard grade" and said apples when packed or repacked do not conform to the requirements of such grade.

(E) For the purposes of this act apples packed in closed packages shall be deemed to be adulterated if their quality or grade when packed or repacked does not conform to the marks upon the package.

(F) Any person who misbrands or adulterates apples within the meaning of this act, or who violates any of the provisions of this act shall, upon conviction thereof, forfeit and pay to the people of the state of New York a sum of not less than twenty-five dollars nor more than fifty dollars for the first violation and not less than fifty dollars nor more than one hundred dollars for each subsequent violation.

(G) No person shall be prosecuted under the provisions of this act when he can establish a guaranty signed by the person from whom he received such articles to the effect that the same is not adulterated or misbranded within the

meaning of this act. Said guaranty to be valid shall contain the true name and address of the person or persons making the sale, and in such case the guarantor shall be liable to the penalties of this act.

(H) Definitions. The word "person" as used herein shall be construed to include both the singular and plural, individuals, corporations, copartnerships, companies, societies, and associations. The act, omission, or failure of any officer, agent, servant, or employee acting within the scope of his employment or office shall be deemed the act, omission, or failure of the principal. The words "closed package" shall mean a box, barrel, or other package, the contents of which cannot be seen or inspected when such package is closed.

(I) No person shall on behalf of any other person pack any fruit for sale or transportation contrary to the provisions of this act.

(J) This act shall not apply to apples actually transported in barrels to storage within this state until the same are sold, offered, or exposed for sale.

§ 2. Chapter four hundred and eighteen of the laws of nineteen hundred and fourteen, entitled "An act to regulate the grading, packing, marking, shipping, and sale of apples," is hereby repealed.

§ 3. This act shall take effect July first, nineteen hundred and fifteen.

Methods of grading. Some growers advance the idea that the grading of apples should begin with the picking of the fruit from the trees. By this method the pickers, after removing the apples from the trees and placing them in bags, pails, baskets, or the like, should then be required to empty them into the boxes in which the fruit is to be stored or packed. The apples may be transferred separately by hand, each apple being handled as if it were an egg; they should not be poured into the boxes. During the picking and the transfer from basket to box, the pickers should carefully sort out fruits that are badly blemished, placing them to one side. The choice, selected apples may then be stored or made ready for packing, according to the convenience of the orchardist.

Another method is to have the apples graded by hand as they are received from the pickers at the packing tables or stands. This method consists in putting in one grade the fruits of a certain size, shape, and color, conforming closely to some rule like those mentioned above, each apple being as nearly like the others as possible. To do this the grader must know the rules for grading and must have had experience in the selection of specimen apples for each grade.

The sorting tables are generally made about 3 feet wide and from 6 to 8 or more feet long. Legs of 2 × 4's, or trestles, are used to raise the table above the ground, the height of the table being from

3 to $3\frac{1}{2}$ feet. The tables have boards nailed to the sides, making a boxlike structure with the sides from 6 to 8 inches above the top of the table. To prevent bruising the fruit the sides and bottom are padded. From two to three barrels of apples may be spread out upon this table, thus allowing the grader a large enough quantity to insure a uniform grade and to make rapid work possible.



FIG. 129. Fall work in the orchard

Grading the fruit and packing in barrels. Notice the simple device for heading, near the man at the left

The man who starts the grading should finish the job, in order to maintain a uniform grade of apples. Frequent shifting of graders is sure to prove unsatisfactory.

Each apple is carefully inspected by the grader and rated as first grade or second grade according to some one of the many rules used as a standard. A good deal of the grading also depends largely on the common sense of the grader.

Recently large growers have begun to use grading machines. After many years of experimenting, fairly satisfactory machines

have at last been produced. The obstacles which have had to be overcome in the perfecting of such a machine have been very great, and a brief account of them will be given here.

Apples of different varieties differ widely in shape. For instance, a Rhode Island Greening is flat, the diameter from stem to calyx being much less than the cheek-to-cheek diameter, while a Spitzenburg is of the opposite shape. Decided differences in shape are also common in apples of the same variety. For instance, in some districts the Spitzenburg will closely resemble the Jonathan in form, while in another district it will be a decided Sheepnose. Not only this, but apples of the same variety grown in the same district, or even in the same orchard, may differ materially in shape. Such cases can sometimes be traced to a difference in the conditions under which the apples are grown, the soil often playing an important part in the character of the fruit. These shape irregularities are confined almost exclusively to the blossom end of the apple. Regardless of the variety, the greatest cheek circumference of the apple is in all cases an almost perfect circle.

These facts concerning the various shape peculiarities explain why the greatest cheek-to-cheek diameter of the apple has become the recognized size-determining factor in systematized packing. Prior to 1911 there was no mechanical deciduous-fruit sorter, because the problem of cheek-to-cheek measuring by machinery had not then been solved.

Spitzenburgs which ranged in cheek-to-cheek diameter from $3\frac{3}{4}$ inches to $3\frac{5}{4}$ inches pack out 96 in a box having an inside measurement of $10\frac{1}{2} \times 11\frac{1}{2} \times 18$ in. However, it is clear that a 96 Rhode Island Greening of the same cheek-to-cheek diameter would not have filled the box; in other words, a 96 Esopus must have a smaller cheek-to-cheek measurement than a 96 Rhode Island Greening, because the Rhode Island Greening, being shorter from stem to calyx, has a greater cheek-to-cheek diameter to compensate. Similar differences are found in apples of the same variety which are grown under slightly different conditions. For example, a certain section of an orchard one year produced apples having a much greater development at the blossom end than had the apples from the other parts of the orchard. The entire crop, which amounted to about twelve thousand boxes, was handled

by one of the grading machines. No difference was discovered in the shape of the apples until the packers began to complain that the boxes were too full. Upon investigation it was found that the driver had just commenced hauling apples from a different section of the orchard. This led to a careful examination of the apples, which showed the cause. After adjusting the machine so as to make a slight reduction in the cheek-to-cheek measurements, the packing was resumed and no further trouble experienced.

The style of pack also affects the cheek-to-cheek dimensions of the pack containing a given number of apples. Another difficulty in establishing standard measurements is the many different shapes and sizes of the packages used, all of which are standardized to some extent in one or more districts. In the Western apple-producing states alone there are several different boxes used, the cubical contents being different in each case. Two which are used more than any other are the Standard, a box $10\frac{1}{2} \times 11\frac{1}{2} \times 18$ in., and the Special, a box $10 \times 11 \times 20$ in. The parcel post has opened a new field to the grower—that of shipping fruit in paper containers, of which there are many makes and sizes.

The tier rating of apples, namely, 3-tier, $3\frac{1}{2}$ -tier, 4-tier, $4\frac{1}{2}$ -tier, and 5-tier, which was used to considerable extent, proved unsatisfactory from both the grower's and the buyer's viewpoint. It has been gradually dropped by the associations and growers, and now the number of apples in a box is stamped on the box end, together with the grade, the variety, and the grower's name.

When the apple buyer is familiar with the size of the package, and is given the number of apples which are systematically packed in it, he knows without seeing them what their size is.

From the foregoing it is clear that it is impossible, on account of the numerous general shape differences and irregularities existing not only between apples of different varieties but between those of the same variety, to establish size measurements which are capable of more than occasional application. There are many angles to the size problem of apples alone, to say nothing of peaches, pears, etc. What the market demands is a uniform size and grade of fruit, systematically packed so that it will not be damaged in shipment, and so that it will present an attractive and tempting appearance when opened.

MECHANICAL SORTERS

The Schellenberger machine and how it works. What the fruit-grower requires in the way of a mechanical sorter is one that will meet every condition presented by the shape of the fruit and by the size and shape of the packages, which range from the barrel to the paper carton. A machine that will meet these conditions must not only do accurate check-to-check measuring but must be capable of quick and fine adjustment, so that the sizing is done when the apples reach the packing table. When the box is full it must represent a perfect pack having the proper bulge, regardless of the experience or lack of experience on the packer's part.

Transferring apples to the hopper. This work is accomplished by first placing a piece of burlap about 20 inches wide and 3 feet long over the top of the orchard box. This burlap is held in position while the box is placed upside down upon the hopper bottom. The box is then slowly lifted from the apples, allowing them to settle gently upon the hopper bottom just back of the color and blemish sorters. The burlap is then drawn out from under the apples, leaving them on the hopper bottom in a single layer.

Color and blemish sorting. This feature of the work has been given most careful study, in order to eliminate any chance of bruising and still permit accurate and rapid work. The machine is so designed that the feeding and the feed-regulating are done automatically, thus leaving the sorters with only the sorting to attend to.

The sorting is accomplished in this way: The degree of coloring and the blemishes on the upturned sides of, say, five apples are noted; then, with fingers extended, the sorter rolls them half over, thus bringing to view the sides not already inspected. A glance is sufficient, and they are pushed to the near end of the feedway, one section taking the first grade, another section the second grade, and the machine doing the rest. Culls are picked up by the sorters and dropped into the cull box. After a few hours' practice at color and blemish sorting with the machine, a beginner will do more and better work than an expert sorter without the aid of the machine. Since the sorter does not handle the marketable apples, there is no chance to drop the fruit or to cause

stem punctures and bruises by squeezing apples together, as is inevitable when sorting is done entirely by hand and two or more apples are picked up at one time. In picking apples up a large portion of them is obscured by the fingers, with the invariable result that many worm and other blemishes are overlooked.

This system of sorting for color and blemish has been developed as the result of practical experience at our own orchards, and is highly commended.

Feeding. The machine automatically places each piece of fruit in position and then deposits it in the gauge in such a manner as to accomplish cheek-to-cheek sizing. In units of four the gauges move into position, the feedway moving forward at exactly the same speed and gently depositing one piece of fruit in each of the four gauges. It makes no difference what shape or size the fruit may be, only one piece is passed to each gauge, which accurately sizes it and deposits it in the proper division of the packing table.

Sizing. The sizing is accomplished by 88 expanding gauges operating in 22 units of 4 gauges each. These units are mounted on two endless sprocket chains, and travel from the feeding mechanism over the entire length of the packing tables.

Each gauge is constructed like a basket with tapering sides made of 8 fingers, which are hinged to the top in such a manner that the lower ends form a circular opening, the size of which is smallest when the fruit enters the gauge and gradually increases in circumference until it is large enough for the fruit to pass through to the packing table. The fingers are hinged to rings and held in position by them, and are so designed as to shape that the circular opening at the bottom will be smallest when the lower ring is close to the upper ring. This circular opening gradually and uniformly increases in size as the lower ring is lowered from the upper ring, and at the lowest position of ring the opening is larger than the opening of the ring, so that anything that can enter the gauge will surely pass out on the last packing table. The upper rings of all the gauges travel horizontally along the length of the machine, while the lower rings are guided by a slightly inclined track which brings them close to the upper rings when the gauges are under the feedway, and gradually lowers them, thus increasing the size of the gauge openings until the gauge is

emptied. This expanding circular opening at the bottom of the gauge is necessary to accurate size sorting.

The track which guides the lower rings of the gauges is just inside the machine and cannot be shown in the cuts. The amount of incline given this track is governed by four adjusting screws. From the time the gauges leave the feeding mechanism until they have passed over the entire length of the packing tables, the size of the circular holes and their range of expansion is controlled by these adjusting screws. By turning them the entire range of all the 88 gauges can be instantly regulated to give any sizes from $1\frac{3}{4}$ to $4\frac{3}{4}$ inches. For instance, assume that the machine is adjusted to grade apples ranging in size from 2 to $3\frac{1}{2}$ inches, the variation between the smallest apple and the largest being $1\frac{1}{2}$ inches, which variation is evenly distributed over the entire length of the packing tables; if the grower then desires to adjust the machine for peaches, it can be instantly done by simply turning the adjusting screws to give a range of, say, $1\frac{3}{4}$ to $2\frac{3}{4}$ inches, or a variation of 1 inch. It will be readily seen that this feature provides for a perfect distribution of work among the packers, regardless of what range of sizes is represented by the fruit.

Packing tables. Particular attention is directed to the ideal arrangement of tables, which is patented. First of all, the fruit is deposited by the gauge directly upon the table and within easy reach of the packer, thus avoiding the necessity for a chute or runway. Second, this table arrangement permits the fruit to be packed directly into the box or other package used. As all deciduous fruit is damaged by handling, the machine is so designed that such injury is reduced to an absolute minimum. The fruit is automatically and evenly distributed over each packing table in a single layer. This feature not only permits of an unobstructed view of each apple on the table, but it prevents stem punctures and other bruises which always occur when apples are piled on top of one another. The partitions which divide the tables are adjustable, which allows the packer to make quick and accurate minor size-adjustments in the fruit coming to his table. It will be remembered that the gauges expand gradually as they move over the tables. It therefore depends upon the location of the table as to what size of apples are delivered to it, so moving a partition is equivalent to

moving that section of the table forward or backward, as the case may be, and this effects a corresponding change in the size of the fruit delivered to the table by the gauges.

The fruit can be divided between the tables on each side of the machine as follows : Either unit of tables can be adjusted to receive all the fruit, or 75 per cent can be delivered to the unit of tables on one side of the machine, leaving 25 per cent for the unit of tables on the opposite side ; or 50 per cent can be delivered to each unit of tables. These changes can be made in a few seconds' time, so that any varying condition in the ratio of the Fancy grade to the Extra Fancy grade can be provided for, thus insuring equal distribution of work among the packers.

Padding. All parts of the machine which come in contact with the fruit are well padded, so that there is no possibility of bruising or other injury. The sides of the hopper and packing tables are padded with thick wool felt, and the feeding mechanism and gauges with rubber. The bottoms of the hopper and packing tables are made of the best quality of burlap, which experience has shown to be superior to canvas or any other material because it permits dust and small dirt to pass through and away. The sanitary condition of a machine needs as careful attention as other considerations.

Power required. The machine is very light-running, requiring less than one-half horse power to operate it. As practically all growers have a power-spray outfit, the machine has been arranged especially for connection with any ordinary gasoline engine used for operating a sprayer.

Capacity. The feeding mechanism is arranged to pass four apples to the gauges at each operation. The average number of such feeding operations per minute may safely be placed at 50. However, conditions must govern the speed at which the machine is operated. Large apples take a slightly longer time per apple than small apples, so while but 50 feeding operations per minute may be required for a large variety of apples, a small variety like Jonathans would allow much faster work. By taking an average feeding speed of 50 operations per minute, at four apples per operation, exactly 200 apples will be sorted for size in a minute's time, or 12,000 apples per hour. This is equivalent to from 800 to 1200 boxes per ten-hour day.

While the capacity of this machine is greater than what is required by the average commercial grower, it is always well to have ample capacity. Experience shows that best results are obtained, especially from packers hired by the day, by setting the machine to a lively pace and requiring the packers to follow the machine.

The Woods grading machine and how it works. This machine has the appearance of being a large wheel with triangular pockets or attachments fastened to the edge or side of the wheel, some of which may appear to be opened and others to be closed.

The wheel is 44 inches in diameter. The center or hub part is a large, flat, metal disk from which eight arms extend. At the outer end of these arms the wheel is bound by a heavy steel rim. A series of triangular pockets are fastened to the edge of this steel rim, each pocket having a hinged side also attached to this rim. The metal bearings on either side of the framework of the machine support the wheel at its center, which places the weight and operation of the whole grading mechanism on one center, with friction in but one place.

In the rotation of the wheel the hinged sides of the triangular pockets open and close automatically. Ascending, and passing under the hopper, or conveyer, they are sufficiently opened to receive the fruit and are then held in proper position by small wheels or rollers. These small wheels or rollers are adjusted so that the hinged sides gradually open and discharge the fruit into chutes leading to the packer's table. The position of these sides is such that after having discharged their fruit, they are automatically closed by their own weight.

We will now assume that we have fruit in the conveyer, one piece resting on the wheel. The operator starts the wheel, and the first piece of fruit is caught in the first triangular pocket, the next piece of fruit follows in the second pocket, and so on. At the first chute the hinged side is opened, we will say, 2 inches. If the fruit is too large to pass through, it remains in the pocket until it arrives at the second chute, over which by an adjustment of the small wheels or rollers the hinged side is opened from $\frac{1}{4}$ inch to $2\frac{1}{4}$ inches wider, or as required by the sizes of the grades, and so on to the third and fourth chutes. All fruit over the fourth size is carried to the end table.

After the pocket passes the chute leading to the end table it is overbalanced by its own weight and position, and is closed, ready to ascend to the conveyer. In the complete operation of the machine it will be observed that there are no springs, belts, chains, or similar machinery—only small adjustable wheels or rollers, and hinged, automatically operated bottoms to the triangular pockets.

The perfectly balanced wheel is practically operated by the weight of the fruit. All the grades of fruit, except the culls, are at the opposite side of the wheel from the conveyer, so that even when the fruit is of medium size, the unloading side of the wheel is the heaviest, and this will cause the wheel to revolve. The wheel, however, is under the absolute control of the operator and may be started or stopped by the hand; it may also be controlled by the foot, so that the operator may use both hands in feeding the fruit from the conveyer into the pockets. Thus the use and cost of motive power is entirely eliminated, and the turning of the machine by hand is done away with. In the operation of the machine as described above, the largest fruit is handled as gently as the smallest, and without bruising, as every piece is conveyed or carried to its proper grade as gently as though by hand.

In grading apples, larger holes or openings, through which to pass the fruit, are required than for peaches. The size is always determined, regardless of shape, with strict reference to cheek-to-cheek diameter, and it is impossible to put up a tier pack until the fruit has been so sorted or graded. The pockets on the large wheel of the grader form equal-sided triangles. No matter what the shape of the fruit, it is properly graded by the hinged-bottom feature of these triangles. The corners of the triangles furnish openings for fruit stems, long ends of fruit, etc., and at the same time the largest space in the pocket will catch the cheek of the fruit, which determines its grade, regardless of its position in the pocket, that is, whether lengthwise, crosswise, or endwise.

Feeding. The fruit is emptied into a hopper, from which it is introduced into an inclined conveyer. Here it lies, one piece behind another, until it is picked up by the cups (or pockets) as they arrive at the point directly under the conveyer. There is no complicated machinery to control the feeding, and but one piece of fruit is delivered into a cup or pocket at a time.

Sizing. The sizing is accomplished by means of expanding hexagonal cups attached to metal crosspieces, which are fastened onto the rim of the wheel. In a single-column machine there are 16 of these expanding cups, and in a double-column machine 32. They expand over each chute as the wheel turns, and the size of the expansion or opening remains the same the entire length of each subtrack or chute, making an exact sizing or grading of the fruit for that particular chute. The cups are constructed of three stationary sides, fastened to the outer ends of the crosspieces, and three movable sides made of one piece, which are hinged at the inside ends of the crosspieces and taper toward the bottom of the cup, thus forming a pocket of six sides and measuring the same distance across in any direction. Adjustable subtracks support the hinged sides of the cup in the proper position over each chute, and the subtracks are attached to a stationary main track of steel by thumbscrews. By these means the adjustment or expansion of the cup is easily accomplished.

As the cup arrives at the conveyer the hinged side is carried onto a subtrack, which is so adjusted that it will hold the cup in position to let through the smallest-sized fruit. The cup is then carried by the wheel to the second subtrack, and is expanded $\frac{1}{4}$ inch, or whatever is necessary for the next grade or size of fruit. This expansion takes place as the hinged sides of the cup pass from one subtrack to the next, over the entire set of chutes. These chutes are stationed underneath the track so as to catch each division of fruit, giving five sizes of fruit and delivering each size separately to the packing tables.

The six sides of the cups expand equally, thus making the distances across the pocket the same in any direction. It can be readily seen that this arrangement gives the correct cheek-to-cheek grade of fruit, regardless of the position the apple takes in the pocket.

Adjustment. Owing to the irregular shapes and sizes of apples, as compared with peaches and other fruits, the amount of expansion of the cups required will differ; but this is accomplished by adjusting the subtracks. The adjustment is a simple process and is made by merely loosening the thumbscrews and moving the subtracks forward or backward the desired distance, and again securely fastening them in place by tightening the thumbscrews.

Packing tables. The packing tables are a very important and practical part of the grading outfit. They extend 6 feet from the chute into which the fruit is delivered by the cups, and have a separate section for each size of fruit. Each section is 3 feet wide at the outer end, where the packer stands, which gives ample room for four packers on each side of the machine and one or two at the end table.

Sizes and grades. The machine is designed to grade five sizes, but a grading of only three sizes can be secured by the adjustment of the pockets as before described. On the two- and four-column machines color sorting can be done by the operator at the conveyers, by feeding the light-colored fruit into one conveyer and the dark-colored into the other, without picking it up. Every part of the machine which comes in contact with the fruit is well padded with heavy felt, and the bottom of the hopper and the bottoms of the tables are of canvas, so that there is no possibility of the fruit being bruised or otherwise injured.

Power. The machine is designed to be run by foot power, assisted by the weight of the fruit, much on the principle of the old-time water wheel. However, the machine can be arranged to be operated by any other power. Many other grading machines equally as valuable are in general use, and the orchardist is urged to study them carefully before purchasing.

CHAPTER XXIV

PACKING

Which package to use. In recent years there has been a decided tendency among Eastern fruit-growers to make the box the apple package, as is universally done in the West. This has resulted in a vigorous controversy as to the relative merits of the box and the barrel.

Fastidious people do not care to place on their tables an imperfect article, and no apple that has been in a barrel is perfect. It is a bruised specimen, although good methods of packing the barrels may prevent bruising somewhat. With the hard winter varieties the bruising is not serious, and with highly colored apples it is not so noticeable, but with both soft and light-colored varieties every bruise becomes an eyesore. The Fameuse, the yellow Bellflower, the Northern Spy, and other tender apples are spoiled by being packed in barrels.

Added to this is the objection that the barrel is not attractive. With the general trade this is of no importance, but the high-class retailers recognize the sales value of an attractive package. The barrel is the receptacle for the grower who sells his apples in bulk to the commission man, and who does not have the time or the inclination for strict sorting and grading. To such men quantity means money, — the more barrels the more money, — and quality means the throwing away of a large part of their apples and the consequent loss of so much money. The grower who approves of the box idea is one who raises apples that are healthy and well-formed, and who appreciates the possibilities for money-making in catering to the high-class trade. As a rule the "barrel man" does not spray, prune, or cultivate as carefully as does the "box man."

It is, then, not the intrinsic merits of the packages but the type of orcharding and the variety that really determine which package ought to be used. For the greater part of the apple crop in the East the barrel is the desirable receptacle.

The box is a smaller package, and the pressure required to secure tightness is not so great as with the barrel, therefore, as already stated, the fruit is not bruised and keeps better. Boxes can be easily handled by the retailer, and a number of them can be stacked in a small space. By means of the box the grower gets his brand directly before the consumer, which is not always possible with the barrel. The box should be used only for the best apples for best trade. Such varieties as the Northern Spy, Tompkins County King, McIntosh, Fameuse, Esopus, Twenty Ounce, Wagener, Yellow Newtown, Jonathan, Albemarle Pippin, York Imperial, and the like should, if possible, be marketed in the box.

In the following list an attempt is made to separate the varieties into box or barrel stock, the classification in each case being based on the quality and appearance of the fruit. Some are adapted to both styles of package.

BOX	BARREL OR BOX	BARREL
Grimes	Rome Beauty	Ben Davis
Jonathan	Arkansas	York Imperial
Winesap	Baldwin	Gano
Stayman Winesap	Wealthy	Willow
Delicious	Winter Paradise	Fallwater
Yellow Newtown	Oldenburg	Roxbury
Yellow Transparent	Northwestern	
Akin	Rhode Island Greening	
McIntosh	Alexander	
Northern Spy	Gilliflower	
King		
Hubbardston		
Fall Pippin		
Fameuse		
Esopus		
Twenty Ounce		
Wagener		
Albemarle Pippin		

BOX PACKING

To pack all sizes of fruit it has been found necessary in the West to use two sizes of boxes. These are the Standard and the Special, with inside dimensions of $10\frac{1}{2} \times 11\frac{1}{2} \times 18$ in. and $10 \times 11 \times 20$ in., respectively.

A third size of box is offered for sale in the East. It conforms to the requirements of the bill to regulate the size of barrels and boxes and the grading of fruit, which has been pending before Congress for two years. This bill specifies that the box shall contain 2342 cubic inches, and the inside dimensions shall be approximately $10\frac{1}{2} \times 11\frac{1}{2} \times 19\frac{1}{2}$ in. A few other sizes are sold by manufacturers in the East, but odd sizes should be avoided. The boxes are delivered in the shooks, and nailed up by the growers themselves.

Box material. To make the box an attractive package it is necessary to get clean, bright lumber free from knots. Spruce and

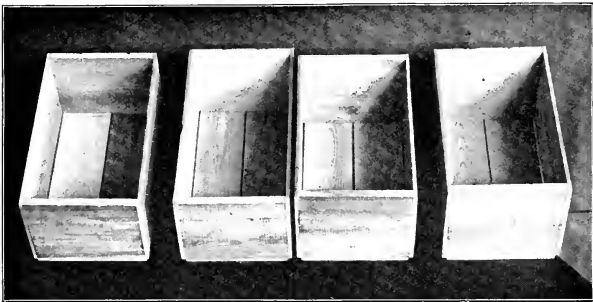


FIG. 130. Boxes for apples

Different types of boxes used for packing apples. (After Cornell University)

pine are two common timbers which have proved very satisfactory. The best boxes are made of one-piece ends $\frac{3}{4}$ inch thick, one-piece sides $\frac{3}{8}$ inch thick, and two-piece tops and bottoms from $\frac{3}{16}$ to $\frac{1}{4}$ inch thick, depending upon the strength of the material. A slightly cheaper box, and yet a very serviceable one, is made of two-piece ends and sides, the two parts being united with a Linderman joint and securely glued. If, in setting up the box, care is taken to prevent the joints of sides and ends from coming together, the box will be very strong. All box material should be dressed, at least on the outside. Boxes are usually purchased in the knocked-down form and are made up when desired, the price ranging from \$13.00 to

\$18.00 per hundred. The nails should be cement-coated to prevent pulling out, and of the fivepenny or sixpenny size. The small cleat used in nailing down the ends of the tops and bottoms should be soaked before using to prevent splitting. Four nails are needed for each cleat, and four at each end of the sidepieces.

Several boxes made of veneer material are being placed on the market. All that have come under our observation have been inferior in appearance, durability, and strength. The greatest objection is to the ends. These are usually composed of a frame of $\frac{3}{4}$ -inch material, to one side of which is nailed a thin veneer. These frames are too light to hold the nails for the tops, bottoms, and sides, and will almost invariably split at some point during the nailing. The nails frequently project through the frame enough to tear the hands or clothing. If the box becomes damp the veneering is apt to warp out of shape. As small pieces and waste material are utilized in these boxes, they are usually cheaper than those made of sawed lumber.

Lining paper. To help protect the fruit and keep it clean, the boxes are lined with white paper, two sheets being required for each box. For the standard box the paper should be $17\frac{3}{4} \times 26$ in., and for the special box, $19\frac{3}{4} \times 26$ in. The sheets cost from \$1.25 to \$2.50 per thousand.

The paper is placed so that one sheet covers about two thirds of the bottom, extends up the side, and is bent back over the outside of the box. Another sheet is placed on the opposite side in the same manner, overlapping the first on the bottom. When the box is packed, the two loose ends hanging over the sides are brought together so that they overlap on top of the fruit. When the cover is nailed in place, the thin bottom boards spring down, and to prevent the lining paper from tearing, a fold or plait is made in it at the bottom. Some packers secure the necessary slack by jamming the paper into the crack between the bottom and side boards.

Layer paper. The general practice in the use of the layer paper is to place one sheet on the bottom and one on the top, inside the lining paper. In some cases, however, it is necessary to use it between the layers of apples to make the pack of the right height. Colored manila tagboard is used for layer purposes, the size being $17\frac{1}{2} \times 11$ in. or $19\frac{1}{2} \times 10\frac{1}{2}$ in., according to the box, and the cost about \$7.50 per thousand sheets.

Wrapping paper. It is advisable to wrap all boxed fruit. The wrapper protects the fruit from bruising, makes it easier to pack, keeps it clean, prevents the spread of decay from one apple to another, and makes a more sanitary package. The additional cost of wrapping is slight in proportion to the benefits derived from it. Unless the beginner wraps his fruit, he will have great difficulty in making a firm, tight pack.

The wrapping paper is of light manila, smooth or glazed on one side and rough on the other. The rough side is placed next to the fruit and readily absorbs any moisture that may be on the surface; the glazed side is effective in preventing the entrance of moisture, dirt, and germs from the outside. The size of the wrapper varies with that of the fruit. For very large fruit, 11 × 11 in. is used; for medium to large fruit, 10 × 10 in.; and for small stock, 8 × 8 in. or 9 × 9 in. Strength and lightness are essential to a good wrapping paper. Some papers are so tender that it is difficult to avoid tearing them. A good quality should be purchased for between 30 and 50 cents per thousand, according to the size. Some growers have their name or brand stamped on each wrapper.

Wrapping the apple. To wrap an apple smoothly—without the waste of unnecessary movements—requires considerable practice, although the operation is simple in itself. Very few packers use exactly the same method in wrapping. Some fail to get a smooth, well-finished effect through lack of attention to minor details, and others waste time because of unnecessary motions. The paper should be held in the left hand with the thumb and little finger pointing toward opposite corners. A rubber thumbstall, which can be purchased at almost any drug store, is worn on this hand to aid in picking up the paper. The apple is dropped or thrown with some force into the center of the paper, and the thumb is brought up over the apple as far as possible, and with it the corner of the paper. If the fruit is to be packed on end, it should be dropped blossom end down, for the stem would tear the paper; if it is to be packed on its side, it should be dropped onto its side. The next movement is to gather a second corner of the paper between the extended thumb and first finger of the right hand and fold it in with a sliding forward and upward motion. The fingers of the left hand now sweep upward and backward, bringing in a third corner,

which leaves the apple firmly gripped in the left hand. This hand should roll the fruit against the curved palm and fingers of the right hand, to fold in the fourth and last corner. The apple is now held

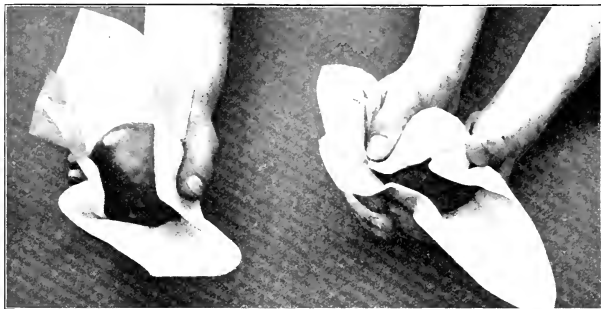


FIG. 131

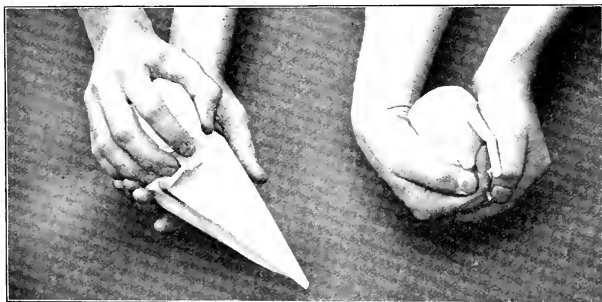


FIG. 132

The four steps necessary in the process of wrapping an apple properly
(After Cornell University)

between the thumb and first three fingers of the left hand in the exact position in which it should be placed in the box. This wrapper when properly made leaves no loose ends and can be rapidly executed.

Packing table. A convenient packing table for two packers can be easily built by any grower. The sides of the top are made of 6-inch boards 4 feet long. The end boards of the table project 1 foot from alternate corners (as shown in Fig. 133) to afford rests for one end of a box, thus making the actual size of the table 3×4 ft. The box should be in an inclined position for packing, and therefore a

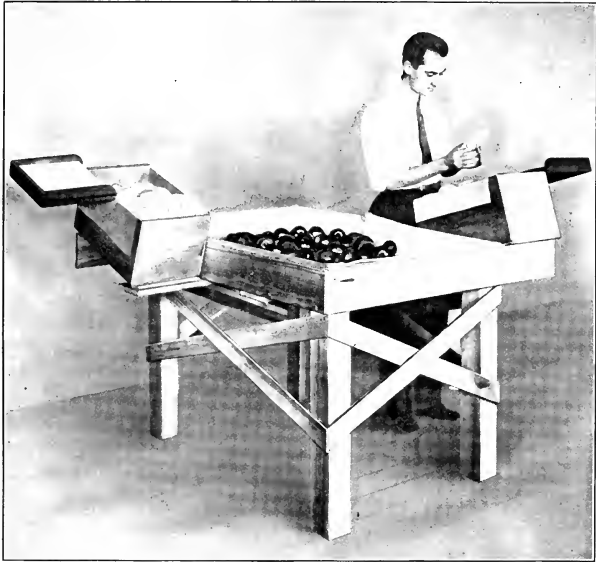


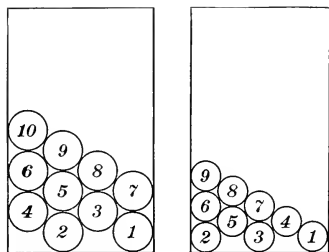
FIG. 133. A good packing table and stand for properly selecting the fruit for box packing. (After Cornell University)

rest for the other end is made by a 6-inch board parallel to the lower edge of the projecting end board and fastened to the bottom of the side boards. Shelves on which to place wrapping paper, lining paper, or layer paper are often built beneath the table. The legs are 3 feet high, and should be well braced for orchard work. The top of the table should be covered with canvas or strong burlap. It

is a good plan to use a double layer of canvas and have the upper piece fastened only at one side, to enable the packer readily to shake off the dirt and leaves that accumulate.

The position of the packers at work is facing the boxes. The paper should be conveniently held at their left in a small tray hooked over the edge of the box. The fruit is at their right, and is selected and picked up in the right hand. A left-handed packer should have his box rest on the reverse corner, which will bring his left side to the table.

Packing the box. Before placing the apples on the packing table, they are usually graded into different sizes. The workman adapts



Starting a 2-2 diagonal pack

Starting a 3-2 diagonal pack

FIG. 134. A Northwest Special box

the pack to the size of the apple and the box. In the West two kinds of packs are commonly used—the diagonal and the square or straight. Of these two the diagonal is much to be preferred, for it permits a wider variation in the size of the apples. In the square pack the apples must be fairly uniform, since every apple rests against the center of another; in the diagonal pack

the apple rests in the center of the space between two or four others. Hence, when the top of the box is nailed down a certain amount of pressing could take place in the diagonal pack without bruising the fruit, whereas only a slight pressing would bruise the fruit in the square pack. With a certain few sizes of apples it is necessary to use the square pack.

The diagonal pack shown at the right in Fig. 134 is known as the 3-2 pack, and the box at the left is called the 2-2 pack, the figures referring to the number of apples in the cross rows. The packs are further distinguished by the number of apples in the rows running lengthwise. The rows in the 2-2 pack may be of equal length, or two of them may each contain one apple more than the others. Thus, to describe the pack more fully one would say

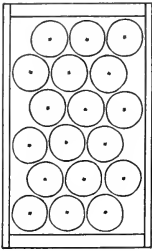
2-2, 6-6, or 2-2, 6-7, indicating that in each layer there are, in the first instance, 4 rows with 6 apples in each row, making a total of 24; and in the second instance, 4 rows, two of which contain 6 apples and two 7, making a total of 26.

To start the 2-2 pack, place the first apple in one of the lower corners of the box. The second apple should be placed about midway between the first apple and the opposite side. The third should be placed against the first and the second, and the fourth against the second and the side of the box, as shown in Fig. 134. These first

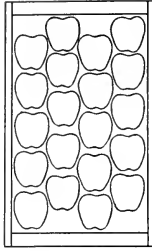
BOX-PACKING TABLE

DIAMETER OF FRUIT	STYLE OF PACK	HOW PACKED	NUMBER OF APPLES PER ROW	NUMBER OF LAYERS	TIES	NUMBER OF APPLES IN BOX	BOX
$2\frac{5}{8}$ in.	3-2 diag.	flat	7-7	5	$4\frac{1}{2}$	175	Special
$2\frac{5}{8}$ in.	3-2 diag.	flat	7-6	5	$4\frac{1}{2}$	163	Standard
$2\frac{3}{4}$ in.	3-2 diag.	flat	6-6	5	$4\frac{1}{2}$	150	Standard
$2\frac{3}{4}$ in.	3-2 diag.	flat	6-6	5	$4\frac{1}{2}$	150	Special
$2\frac{5}{8}$ in.	3-2 diag.	flat	5-5	5	4	125	Standard
3 in.	2-2 diag.	side	7-7	4	$3\frac{1}{2}$	112	Special
$3\frac{1}{8}$ in.	2-2 diag.	side	7-7	4	$3\frac{1}{2}$	112	Special
$3\frac{1}{8}$ in.	2-2 diag.	side	7-6	4	$3\frac{1}{2}$	104	Standard
$3\frac{1}{4}$ in.	2-2 diag.	side	6-6	4	$3\frac{1}{2}$	96	Standard
$3\frac{1}{4}$ in.	2-2 diag.	flat	6-6	4	$3\frac{1}{2}$	96	Standard
$3\frac{3}{8}$ in.	2-2 diag.	flat	5-5	4	$3\frac{1}{2}$	80	Standard
$3\frac{1}{2}$ in.	2-2 diag.	flat	5-4	4	$3\frac{1}{2}$	72	Standard
$3\frac{5}{8}$ in.	2-2 diag.	flat	4-4	4	$3\frac{1}{2}$	64	Standard
$3\frac{3}{4}$ in.	2-2 diag.	flat	4-3	4	3	56	Standard
$3\frac{3}{4}$ in.	3 straight	side	6-6	3	3	54	Special
$3\frac{7}{8}$ in.	3 straight	side	5-5	3	3	45	Standard

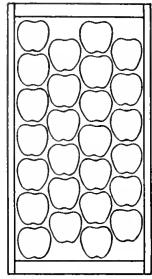
four apples should be carefully placed and the rest of the layer will pack easily. In starting the second layer, place the first apple in the corner space nearest to the second apple of the first layer. The 3-2 pack is started by placing an apple in each lower corner and one midway between them. In the two spaces between these three apples the fourth and fifth apples are placed. It is of the utmost importance that the apples in each row be kept tight end-ways. A good test of this is to set the box on end after the first layer is in place. If the fruit falls out it has not been packed tightly enough. Care should also be taken to get the rows straight both lengthwise and diagonally. A carelessly packed box will rarely sell



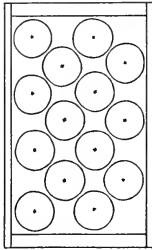
Standard box, 72 apples



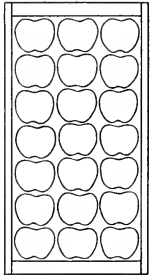
Standard box, 80 apples



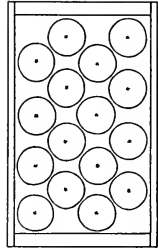
Special box, 104 apples



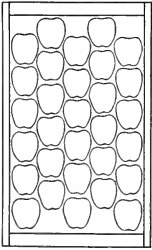
Standard box, 56 apples



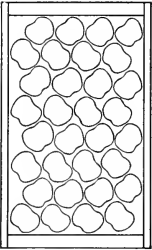
Special box, 63 apples



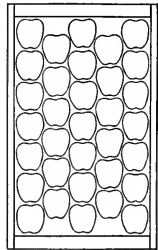
Standard box, 64 apples



Standard box, 150 apples

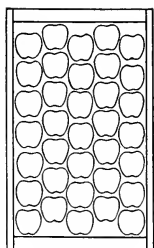


Standard box, 160 apples

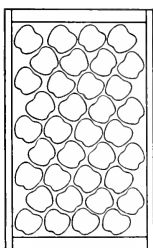


Standard box, 165 apples

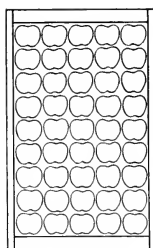
FIG. 135. Types of Special and Standard Northwest boxes



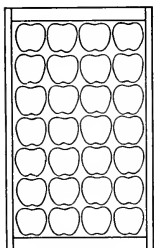
175 apples



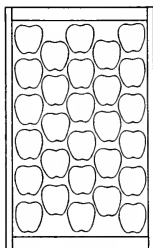
180 apples



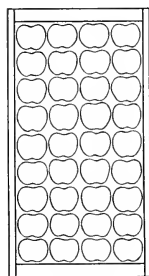
225 apples



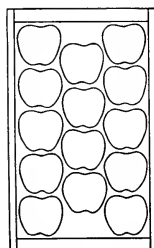
112 apples



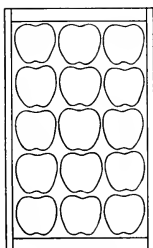
138 apples



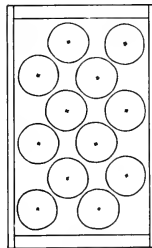
144 apples



41 apples



45 apples

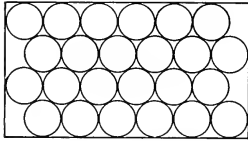


48 apples

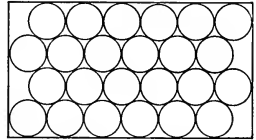
FIG. 136. Northwest Standard boxes

for enough to pay for the expense of packing, so poor will be its appearance on the market in comparison with well-packed fruit.

All apples under 3 inches in diameter are packed flat; those from 3 to $3\frac{1}{4}$ inches are packed on the side; those from $3\frac{1}{4}$ to $3\frac{3}{4}$ inches flat; and all above $3\frac{3}{4}$ inches on the side. The 3-inch

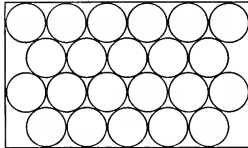


First and third layers

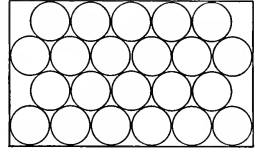


Second and fourth layers

2-2 diagonal pack, four layers, 96 apples

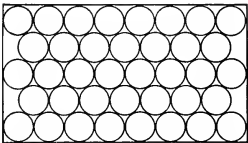


First and third layers

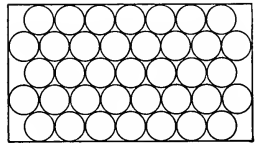


Second and fourth layers

2-2 diagonal pack, four layers, 88 apples



First and third layers



Second and fourth layers

3-2 pack, five layers, 4-2 tiers, 188 apples. Reverse layers will give 187 apples

FIG. 137. Northwest Special boxes

apple is an extremely awkward size to pack in either box, but if necessary it can be put in the Special size. In practice it is customary to grade the fruit with variations up to $\frac{1}{4}$ inch; therefore the 3-inch fruit may be placed with the $2\frac{7}{8}$ -inch or $3\frac{1}{8}$ -inch grades. It will be noticed that the smaller apples may be packed in either box, but the larger ones will usually pack well in only one size. This shows the necessity of having both sizes on hand.

The bulge. In packing, it is not difficult to make the ends of the box come out right at the top, but to secure the proper bulge at the center, which should be about $1\frac{1}{2}$ inches, is not so easy. The packer should begin the bulge with the first or second layer, and may proceed in several ways. A common way is to choose for the center of the box apples which are a little larger or thicker than those at the ends. In the case of flat apples, they may be packed bottom down at the ends of the box and on their side at the center. After a little practice this phase of the packing will cause no trouble.

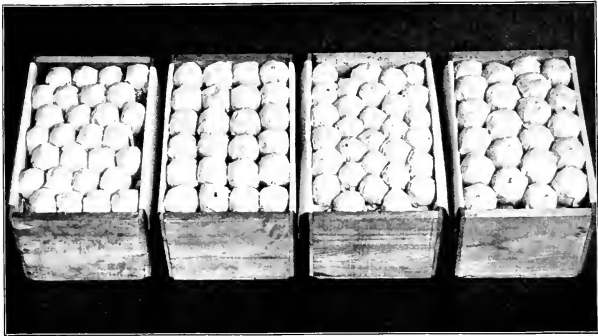


FIG. 138. Apples wrapped in paper and packed in boxes
Four methods of packing. (After Cornell University)

When the top of the box is nailed on, a bulge of $1\frac{1}{2}$ inches at the center gives $\frac{3}{4}$ inch on both top and bottom, which acts as a spring to take up any slack or shrinkage during transportation. When the boxes are piled up they are placed on the side, where there is no bulge, and thus no bruising can result from the weight of one box on another.

The box press. After the box is packed, it is taken to the press. A box press can be made in various ways, the essential points of construction being (1) to rest the clamps on the ends, so that when the top is nailed down the bottom is free to bulge; (2) to catch and press down the top pieces from the ends so that a minimum amount of bruising will result.

A simple and serviceable press can easily be made at home. The four legs are 2×4 's cut $2\frac{1}{2}$ feet long. The bed piece is a 2-inch plank of hardwood 4 feet long and 1 foot wide. The cross cleats are arranged to accommodate both the standard and special

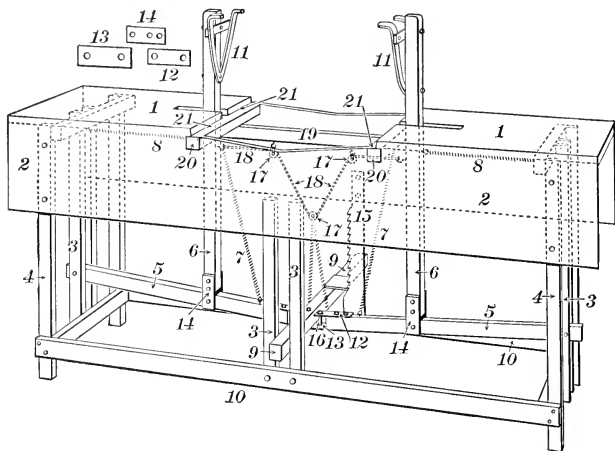


FIG. 139. A homemade box press

1, cover boards to table (length of table, 64 inches); 2, side board to table; 3, uprights for attachment of levers 5 and 9; 4, legs of table, $28\frac{1}{2}$ inches long, $1\frac{1}{2}$ inches square (all the arms, legs, and levers of the press may be made of $1\frac{1}{2} \times 1\frac{1}{2}$ in. material); 5, levers, 27 inches long; 6, upright arms, 32 inches long; 7, steel springs (small screen door springs may be used); 8, spring attached to upright arm 6 and support 3; 9, foot lever, bolted to uprights 3 at back, and working with catch plate and ratchet in front (it is fastened to plate 13); 10, brace for legs and lower support for uprights (3 inches from ground); 11, horseshoe plate for gripping box cleats and cover; 12, iron plates bolted to levers 5, with large holes in projecting ends, allowing the bolts 16 to slide freely; 13, lower plate under lever 9, to which it is bolted loosely, with large holes in each end for free play for bolts 16; 14, side plate joining lever 5 and arm 6 (loose joint); 15, iron ratchet to engage plate on the front lever 9; 16, $\frac{1}{2}$ -inch bolts, $2\frac{1}{2}$ inches long, working loosely in the holes in the plates 12 and 13; 17, three small pulleys for rope attached to arms 6; 18, strong $\frac{1}{8}$ -inch cord that will not stretch; 19, spanner running parallel with side; 20, crosspieces, providing support for box; 21, grooves for holding box in place (they are a trifle over 18 inches apart). (After Cornell University)

boxes, the two inner cleats being about 18 inches apart and the two outer ones 20 inches. This allows the boxes to project over the cleats $\frac{3}{4}$ inch at each end. The iron clamps may be made by any blacksmith, and should pass through the lower plank, to which they

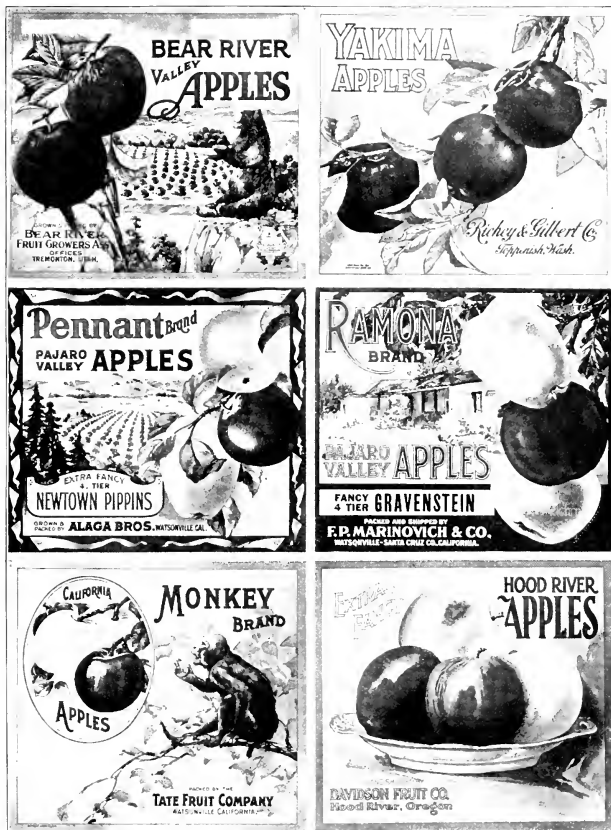


FIG. 140. Box labels

A few of the best box labels used on Western fruit. One of the modern ways by which the West has advertised its fruit

are attached by means of an iron pin inserted through a hole in the plank and clamp. It is well to have several holes at half-inch intervals in the clamps, to enable the operator to adjust them to the proper height for any box. The coil springs throw the plank up and loosen the clamps when the pressure is released. When the pressure is applied to the ends of the covers, the bulge is distributed about equally between bottom and top. Four nails driven through each cleat are sufficient to hold the cover in place.

Labeling. An attractive label pasted on the end of the box aids materially in marketing the product and, if used persistently, becomes a valuable advertising agent. The label should not be of the gaudy circus-poster style, but should give such information as the grower's name, the variety of fruit, and the number of apples in the box. To guard against mistakes the number of apples and the other items required by the Sulzer law should be marked on the box by the packer before the cover is nailed in place.

BARREL PACKING

The standard barrel. Congress has recently passed a much-needed measure regulating the size of apple barrels for all states. It specifies that the length of stave shall be $28\frac{1}{2}$ inches, the diameter of head $17\frac{1}{8}$ inches, the distance between heads 26 inches, and the outside circumference of the bulge 64 inches. All barrels not coming up to this standard must be so marked. The act also provides for three standard grades of apples of minimum sizes of $2\frac{1}{2}$, $2\frac{1}{4}$, and 2 inches, respectively. The fruit in any of these grades must be sound, well-colored, and of a normal shape. Any barrel marked Standard Grade must also be plainly marked with the minimum size of the fruit, the name of the variety, the locality in which it was grown, and the name of the grower or packer. This act became effective July 1, 1913. The barrel material required should be fairly free from knots and cross grain. A hard, tough wood like elm makes the best barrels, but much latitude may be followed in the choice of material.

Packing table. A table for barrel packing differs from that used in box work and may be constructed as follows. The size is 6 feet long by 4 feet wide, with sides 8 inches high. In the bottom of

the bed are slats 1 inch square spaced 1 inch apart. The legs of the lower end of the table are 39 inches high, to allow the bottom of the bed to clear the top of the barrel, and the legs at the upper end are 45 inches high, giving a 6-inch pitch to the table. The apples can be easily inspected as they roll into the apron, and imperfect ones thrown out. When the apron is filled, it should be slowly lowered into the barrel without bruising the fruit. This packing table may be mounted on wheels for use in the orchard, or may be built larger, with two funnels, allowing two barrels to be filled at once.

To face a barrel properly requires some skill and care. The real object of facing is to give the barrel an attractive appearance when opened and not, as is too often the case, to deceive the purchaser. The fruit used for facing should represent, so far as size is concerned, the general run of the whole barrel. One reason for not picking out the largest apples for facers is that these are often poorly colored and do not make so good an appearance as the medium-sized specimens. All the face apples should be of uniform size and well colored. Beginning on the outer edge, they should be arranged stem down in concentric circles until the head is covered. Care should be taken to select fruit that will fill the circles without leaving spaces or requiring any to be placed on edge. When the center is reached, it should be filled with one, three, or four apples. Never use an apple that is larger or smaller than the others to fill out the center space, for this would spoil the looks of the whole face. Of apples measuring from 3 to $3\frac{1}{8}$ inches in diameter, the outer circle will require 15, the second ring 9, and the center 3. The next smaller size that can be used measures from $2\frac{3}{4}$ to $2\frac{7}{8}$ inches in diameter. It will take 17 of these to fill the outer circle, 11 to fill the second, and 4 to fill the center. A size of fruit intermediate between these two could not be used. Many growers face all their barrels with these two sizes.

If the fruit runs smaller than either of these two sizes, it will be necessary to select that size which will make three circles and leave the center to be filled with one apple. In the case of very large apples, like the Fallawater, they may be arranged in two circles with one apple in the center. Only one layer of facers is necessary, but the packer should place over the interspaces of this layer a few

fruits with their colored sides down, so that when the barrel is opened a solid mass of color will greet the eye.

Filling and tailing. The filling of the barrel should be accompanied by vigorous shaking after every half bushel of fruit has been added. This settles the fruit into its permanent place, so that there will be no loosening and rattling after the barrel is packed. When the barrel is nearly filled, the upper layer must be arranged by hand to form a level surface against which the head may press. This operation is known as "tailing." The barrel should be filled



FIG. 141. Harvesting, grading, and packing

In the orchard of Edward Van Alstyne at Kinderhook, New York

one inch or more above the chime to allow for shrinkage and to tighten the fruit when the head is pressed into position.

Papering. A circle of plain or white lace paper placed in the bottom of a barrel before the facers are laid will greatly increase its attractiveness. If, in addition, a layer of corrugated paper or an excelsior pad is placed under each head, the bruising of the fruit will be much lessened. Lace paper costs \$5.00 per thousand and corrugated paper \$7.00, small items that greatly increase the effectiveness of the package and often result in attracting customers and retaining them.

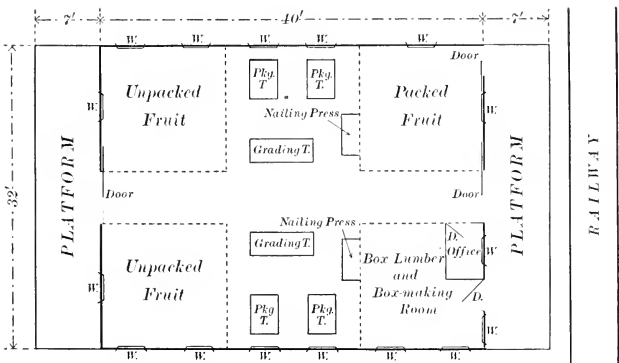
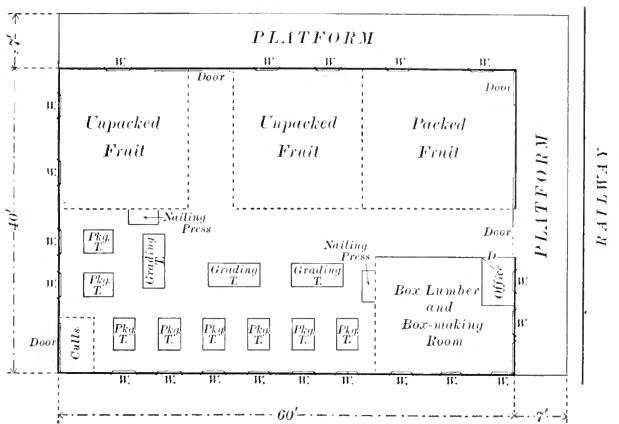


FIG. 142. Floor plans of packing houses

Two plans of houses used in Ontario. (After Department of Agriculture, Ontario, Canada)

The barrel press. Several types of screw and lever presses are on the market. The requisites of a good press are strength, durability, power, simplicity, and compactness. The lever presses are more rapid than the screw type, which is being used less and less. The iron circle used on some presses to force the head into place is often in the way of the operator; a single wooden block extending crosswise of the head is far more convenient. If the press has to be carried about the orchard frequently, it may be made much lighter by turning up the bottoms of the iron uprights in the form of a hook to clamp under the edge of the barrel, and discarding the heavy base.

Labeling. Neat and attractive labels should be placed on each end of the barrel, the requirements being the same as for boxes.

Comparative cost of boxes and barrels. In comparing the cost of the two packages, there are three points to be considered: (1) the actual cost of the package itself; (2) the cost of filling it; and (3) the cost of handling the package from the orchard to the consumer. Compared from these points of view, there is found a slight difference in favor of the barrel. In the East the cost of a box varies between 10 and 15 cents, and the cost of a barrel between 25 and 35 cents. Three boxes, which together will hold as much as one barrel, cost between 30 and 45 cents, leaving a margin of from 5 to 10 cents in favor of the barrel. When the apple crop calls for a thousand or more barrels the saving becomes a considerable item.

The approximate cost of packing a box and a barrel of apples is shown by the following figures:

BOX	BARREL
Box \$0.10 to \$0.15	Barrel \$0.25 to \$0.35
Paper05½	Cushion heads04
Packing05 to .06	Packing09
Box making01	Nailing01
Wiping and grading05	Picking22
Hauling03	Wiping and grading05
Nailing01	Orchard hauling03
Orchard hauling01	Help in packing house01
Picking07	Hauling03
Help in packing house01	Total \$0.73 to \$0.83
Total \$0.39½ to \$0.45½	

Compared on the basis of equal quantity the relative costs of filling the two packages and handling them are from 73 to 83 cents for the barrel and from \$1.18½ to \$1.36½ for three boxes. It takes longer to fill a box than it does to pack a barrel, for a higher degree of skill is necessary, as will be shown later. It is likely, therefore, that four packers and graders will in a specified time put up a fourth or perhaps a third more apples in barrels than in boxes.

In transportation and handling, there is a slight saving in favor of the barrel, which can be handled by one man in about the same time that is required to handle half the quantity of fruit in boxes. So, too, in loading onto cars and steamships, and in handling on docks, in auction rooms and warehouses, the barrel involves less labor.

Most men would much prefer to handle boxes than barrels, because boxes are much lighter, requiring less effort or strength on the part of the laborer. Where the boxes are particularly smooth they do not offer the hand as good a hold as do the ends of barrels, with their protruding parts.

CHAPTER XXV

MARKETING

General conditions. During the year 1912 probably 40,000,000 barrels of apples were ready for market. It seemed that every apple-producing section in the United States had an exceptionally large crop. This was a condition that does not frequently occur. A great many of these sections grow ordinary varieties of apples, generally of poor to fair grade both as to edibility and keeping quality; such fruit will sell for enough at home to justify harvesting, but will not bring enough to pay for harvesting, grading, packing, and freighting, and leave a profit to the orchardist. Some of these districts would, therefore, in years of large yields cause low prices to prevail, and for a certain time would not offer a profitable market for high-grade goods. If any of these districts should produce a light crop of poor-quality apples, the surrounding sections would afford a market for apples of good quality at prices high enough not only to justify the expense of growing and marketing the crop but to yield a good profit. In seasons when certain localities produce short crops of apples, the waste in sections producing heavy crops is greater than usual because much of the fruit is too poor to justify shipment. Therefore, correspondingly better prices prevail.

Very little effort to further the sale of apples has been made by growers. The West until recently had only light crops, and generally shipped all its product to a few large cities, such as Chicago, New York, Philadelphia, and Boston, which offered satisfactory prices. The crop of 1912 was the largest yet harvested, and as new markets were not looked up, shipments to the large cities were in excess of the demand, with the result that the apple market was depressed and prices were very low. All the surrounding towns followed the lead of the large cities, and it was impossible anywhere to receive good prices for the apples. A little planning in regard to wider distribution might have averted this glutting of the market.

More careful attention should be given to organized selling. A properly centralized apple organization patterned after the Orange Growers' Association in California and other similar ones, to help regulate shipments of apples to meet the demands of the markets, is the paramount need.

Proper advertising and education are also vitally important. Cannot the business principles utilized by some of our most successful manufacturing houses be applied? Various breakfast foods and brands of canned goods have attained great success by their extensive advertising. In many cases educational receipts for cooking the product have been included in the package. Why not receipts for cooking the apple?

Some legislation is needed to adjust the charges of commission man, jobber, retailer, railroads, and all others handling the apple between the grower and the consumer — perhaps regulations fixing the percentage each may charge. It now costs too much to get the apple from the grower to the consumer, thereby making the price to the consumer much greater than it should be. The consumer often pays \$3.00 per box for first-grade apples for which the grower has received only from 80 to 90 cents. Where medium or second-grade apples are sold for \$2.25 the grower often receives only between 60 and 65 cents.

The following table will serve to illustrate where the difference goes between what the consumer pays and what the grower receives.

	FIRST-GRADE APPLES	SECOND-GRADE APPLES
Retailer sells for	\$3.00	\$2.25
Grower gets . . . . .	.80, or 27 per cent	.60, or 27 per cent
Association or agent gets . . .	.10, or 3 per cent	.07, or 3 per cent
Railroad gets . . . . .	.50, or 17 per cent	.43, or 19 per cent
Commission man gets . . . . .	.25, or 8 per cent	.25, or 11 per cent
Retailer gets	1.35, or 45 per cent	.90, or 40 per cent

In both cases the consumer pays 275 per cent more than the grower gets, this condition being caused by the demands of the retailer for large, unreasonable profits. Public sentiment created by proper advertisement and education could be so aroused that the retail prices of apples would be brought down to a reasonable rate which would still give a fair profit to all.

Production in the United States. The total production of apples in the United States for 1912 was approximately 38,310,000 barrels. This yield was divided among the different fruit sections as follows :

1. New York, 6,900,000 barrels, being about 18 per cent of the total yield.

2. The district comprising the southern Piedmont region, West Virginia, Virginia, Maryland, Kentucky, and Tennessee, 5,900,000 barrels, being about 15.4 per cent of the total yield.

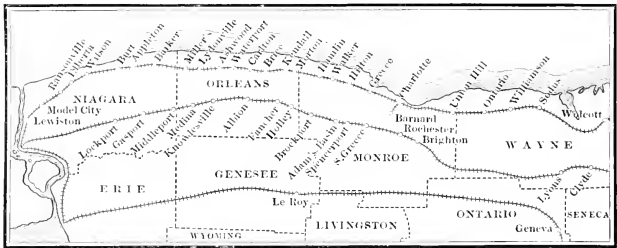


FIG. 143. Western New York apple belt

Showing the principal shipping points. This fruit region produced more apples in 1909 than Oregon, Washington, and California combined, more than any two states combined with the exception of Michigan, or Pennsylvania, and Missouri, and more than any one even of these three

3. The West (California, Oregon, Washington, Colorado, Utah, Idaho, and Montana), 4,425,000 barrels, being about 11.5 per cent of the total yield.

4. New England, 3,060,000 barrels, or about 8 per cent of the total yield.

5. Pennsylvania, 2,100,000 barrels, or 5.7 per cent of the total.

6. The major part of the remaining yield was produced in Arkansas, Kansas, Nebraska, Missouri, Iowa, Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio.

These yields did not differ materially from those of the preceding year (1911), although the total crop of 1912 was about 2,500,000 barrels larger than that of the preceding year. In 1902 the total yield was 46,625,000 barrels; in 1903, about 42,626,000; and in 1904, about 45,360,000. In 1900 the total number of barrels was 63,780,955, and in 1890 it was 52,038,432.

According to the census of 1910 the following facts concerning apple growing are brought forth :

Decrease in number of trees of bearing age. At the census of 1900, taken as of June 1, there were reported 201,794,000 apple trees of bearing age, against 151,323,000 trees in 1910 (census taken as of April 15), a decrease of 50,471,000 trees, or 33.4 per cent.

In 1910 there were 2,980,398 farms reporting the growing of apple trees, or 46.8 per cent of the total number of farms in the United States. The average number of trees per farm as reported is 51.

No figures were given in 1900 to show the number of farms reporting, neither did the returns of the 1900 census specify the number of trees under bearing age. In 1910, however, 1,498,746 farms, or 23.6 per cent of the total, had 65,792,000 trees not of bearing age, or an average of 44 per farm.

The present census shows that in 1909 there were produced in the United States 147,522,000 bushels of apples, having a total value of \$83,231,000. The production at that time was a little less than it was ten years previously, when 175,397,000 bushels were gathered. The reports of the 1900 census give no information as to the value of apples.

Number of apple trees and production by states. In 1910 almost 25 per cent of all apple trees of bearing age in the United States were in Missouri, New York, and Illinois. The number of trees of bearing age in Missouri at the census of 1910 was 14,360,000, this being a decrease since 1900 of 5,680,000 trees. The production of apples in 1909 amounted to 9,969,000 bushels, while in 1900 it was 6,496,000 bushels, a gain of 3,473,000 bushels. The value of the 1909 crop was \$4,886,000.

New York reported 11,248,000 trees of bearing age in 1910, against 15,055,000 trees in 1900. This state alone produced more apples in 1909 than the entire East North Central division, the yield being 25,409,000 bushels valued at \$13,343,000. In 1899 a crop of 24,111,000 bushels was gathered.

In 1910 there were 9,901,000 trees of bearing age in the state of Illinois, while in 1900 the number was 13,430,000 trees. Over 3,093,000 bushels of apples were produced in 1909, against 9,178,000 in 1899, a falling off of over 6,000,000 bushels. The value of the 1909 crop was \$2,112,000.

While the states of Pennsylvania and Michigan did not report as large a number of trees in 1910 as the above-named states, each produced a considerably greater quantity of apples than Missouri or Illinois.

All these figures go to show the size of the apple industry and the great need of thorough, practical knowledge of market conditions in all its branches, in order to secure to the growers a reasonable profit.

Shipping. There are several ways in which the fruit may be brought to market. If the orchard is located near a city or town



FIG. 144. Ship by motor

The ownership of a large auto truck simplifies the problem of placing the product of the orchard cheaply and quickly on the market

a good spring wagon will prove a satisfactory conveyer. The motor truck is now being used by some growers, either to transport the goods to market or to carry the apples from the orchard or packing shed directly to the railroad, and has been found to be quite practical for this purpose. A man living a mile from the cars has found out that with a truck of 35-horse power, a capacity of 3 tons, and running loaded, at the

rate of ten miles or a little more per hour on fair roads, the following results can be obtained and a great saving in money made :

1. Only one gallon of gasoline will be consumed for each ten miles.

2. Thirty barrels of apples may be hauled each trip.

3. Two men can do as much work as four men and three teams.

Electric freights have proved to be great aids in the shipping of apples in sections where orchards are located near the car lines, and usually give lower rates and quicker delivery than any other method of transportation. In certain localities boats are utilized to convey the fruit to market. In New York State the new barge canal offers a quick, cheap, satisfactory means of shipping apples.

Sections near the Great Lakes or other bodies of water have the advantage of cheaper shipping rates to market. Western apple-growers believe that the Panama Canal will offer a cheaper means of transportation than the railroad. They see no reason why, via the Canal, they cannot place their fruits on the Atlantic seaboard, either of the United States or of Europe, at a saving of from a third to a half the rates charged at present.

The Panama Canal is another bright star in the future of the apple business for the Northwest grower. We now pay 50 cents freight to New York, but when the Panama Canal is completed, our rate will probably not exceed 20 or 25 cents per box. Our freight to European points, including the cost of transferring in New York City, is now about 70 cents a box. Freight per box through the Panama Canal will probably not exceed 35 cents per box. In other words, we shall lay our apples down at the Atlantic coast at 25 or 30 cents per box less, or abroad for 30 or 40 cents per box less.¹

The present-day shipments, however, are chiefly by railroad, for which cars of special design, such as cold-storage cars, are used in some cases and in others ordinary box cars. The apple barrels are packed either on their side or standing on end, and securely fastened by boards nailed across the car. Some shipments made in bulk are merely placed on the floor at each end of the car and secured with boards near the doors; sometimes they are divided into two bins with a passageway between; and at other times they are put in one large bin and boarded up part way at the doors. Apples in bulk are generally not more than 4 or 6 feet deep. Bulk shipments are unsatisfactory for high-grade fruit, but cider, evaporated, and other low-grade, cheap stock may be shipped profitably in this manner.

The important item in shipping is to have the cars, boats, trucks, etc. at hand when wanted. This should be attended to long enough ahead to avoid delays. Such matters as loading and icing the cars and making out the necessary shipping papers require careful attention. Each freight car will hold from 180 to 190 barrels of apples, and if the weather is warm, each car will require from $\frac{1}{2}$ ton to 5 tons of ice.

The exact method of loading a car with boxes will depend on the kind of fruit, the season, and the distance from the market.

¹ *Better Fruits*. Published at Hood River, Oregon.

The number of boxes per car will also vary with these conditions. Where the standard-size boxes are used, from 500 to 800 will be required, and for half-size boxes twice as many. Summer and early-fall apples must be handled carefully when sent a considerable distance. Where refrigerator cars are used and icing is necessary the car should be loaded as quickly as possible to prevent its becoming heated, and thus reduce the ice bill. Heated fruit should never be placed in an iced car, for it will sweat and thus raise the temperature of the car. Fruit should be gradually chilled before loading.

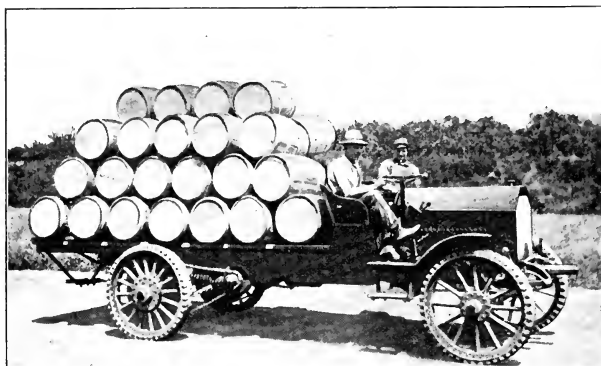


FIG. 145. An Avery truck

Loaded with apples on the way to market

All boxes must be laid on their sides and never on the top or bottom. Cleats are nailed to the floor of the car to hold each row of boxes in place. Formerly every layer of boxes was firmly cleated, but good results have been obtained from cleating only the bottom layer and every third layer. The fruit should be loaded so as to prevent shifting. The two halves of the car should be firmly braced. If the cars are to cross the mountains during severe weather, they should be lined with paper to prevent freezing.

Consignments on commission. The most common way to dispose of fruit is to consign it to a commission man. Shipping tags with the consignee's and consignor's names and addresses should be

attached to each barrel or box if the shipment is small, or the car or several cars may be consigned outright to one commission house.

So much swindling has been done by certain commission men that as a class they have come into general disfavor, and often unjustly. Commission men are human; some are honest and others are not. Many times the growers are at fault. They think they have handled their product well, but it arrives at the market in a deplorable condition, and the commission man is blamed for the low price. A great deal of thanks is due the commission men,

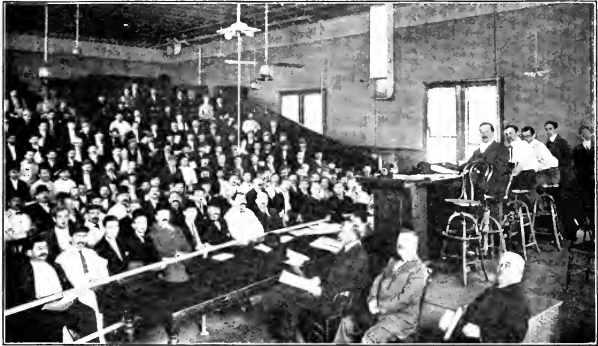


FIG. 146. Selling at auction

The auction room of the Erie Railroad, where thousands of dollars' worth of apples and other fruit are sold annually

for in many localities the fruit industry owes its growth to their efforts, and it will be a long time before we can dispense with them entirely, if indeed we ever can. However, it is true that the commission business is so conducted that there is ample opportunity for swindling. The grower must rely entirely on the honesty of the commission man, who can easily return fake accounts. Only in those cases where the fruit is bought outright for cash is there assurance against fraud. It is no wonder, then, that much swindling is done, and as a result the whole family of commission men must bear the stigma. It is largely their own fault, however, for often they conduct their business on the plan that if there is

any profit it is theirs, and any loss must be the grower's. They should change their methods if they desire confidence, but this they will not do so long as they have a large business under present methods. Before patronizing a commission man, be sure of his integrity; then try to follow his suggestions, and do not desert him if he does not bring you the highest price the first season.

A busy commission market is Washington Market on West Street, in the lower part of New York City. It is about 780 feet long, allowing as many as 125 cars to unload in one morning. The commission men are at work early in the morning, selling



FIG. 147. On the dock

The Erie Railroad pier in New York City, where the apples are sold

direct to the highest bidder—whether consumer, retailer, or jobber. Barrels are there opened for inspection, reheaded, loaded onto wagons, and drawn away. Apples, for the most part, are handled by the commission men on a 10-per-cent basis, and if reasonably satisfactory prices cannot be obtained at the pier, they are taken to storehouses. Sometimes an extra profit of 25 cents per barrel can be obtained by so doing. It costs from 6 to 10 cents a barrel to move apples from the dock to Washington Street.

The commission men have teams and trucks of their own, the average cost of each being \$1000.00. The horses last from one to five years and the expense of keeping them is \$35.00 each per

month, to which \$5.00 must be added for shoeing. The truckmen are paid about \$20.00 a week, porters (those who load and unload the trucks and move fruit in and out of the storehouses) from \$18.00 to \$20.00 a week, and salesmen all the way from \$25.00 to \$75.00 a week. The rent of a store in Washington Street, consisting of a room on the ground floor 30 feet wide and 100 feet deep, is about \$350.00 a month; other expenses, such as electric lights, are, of course, additional.

To meet these heavy expenses and make a profit the commission man must do a large amount of business without many



FIG. 148. New York apple market

Drays waiting in front of the Erie Railroad fruit wharf at New York to take away the apple crop after being sold in the covered dock

losses. He generally opens his store before midnight, and keeps it open until about five o'clock the next afternoon. He is as ready to sell fruit to one man as to another if the price is good, and it is for his interest to do the best that he can by everybody. When the market is crowded with a certain kind of fruit and the prospects are not favorable for good prices, he may decide to put some of it in cold storage, but this is not advisable unless the fruit is of first-class quality, because the city rates for storage are 25 cents a barrel, whether for one month or for three months, and it is therefore not profitable to store goods for only a short time.

Each consignment is carefully recorded, and returns on sales are made by the commission man, minus his commission, cartage, handling, and, in some cases, freight charges. Returns are made daily or later with check to balance, or a check is given at certain stated periods. Large amounts of fruit are handled in this way.

The jobber. Sometimes another middleman handles the apples. He purchases from the commission man, and is known as the jobber. These men or houses generally have a patronage of retail stores, clubs, hotels, etc., which they keep supplied with produce. They are often forced to purchase on the market if they do not have enough consignments. They frequently make from 25 to 40 cents on each barrel of apples. The cartage from the commission men to the jobbers and from the latter to the retailers, clubs, hotels, etc. must be paid for, and between 10 and 25 cents per barrel is charged for this labor.

The retailer. At times, by coming in direct touch with the retailers, a grower can find a good market and often realize the highest returns. Good advice is to deal with only one retailer in a place, and ship nothing but first-class material in the form that will best suit the retailer. Some growers enjoy soliciting this trade, while to others it is distasteful.

Some retailers are equipped with horses and wagons or with auto-trucks, and can easily go to the larger wholesale markets and purchase directly from the commission men, loading the goods at once and thereby saving the expenses of the jobber. When the retailer lacks transporting facilities the jobber will deliver the apples directly to the store at an advance over the prices of the commission man. The jobbers keep teams, wagons, and men, and must, of course, charge for delivery in order to maintain their equipment.

The push-cart men and hucksters in the large cities also purchase most of their fruit from the jobbers. However, at times both these classes of venders are able to obtain from the commission men fruit of poor quality at very low prices, or a better quality when the market is glutted.

Association selling. Another way of disposing of the fruit is through a union or an association. This is simply an organization formed to help the grower realize a fair profit by doing away with some of the middlemen who eat up the profits and leave little.

The Western or Northwestern fruit farmer usually devotes all his time to one crop. If the fruit chosen is the apple, this is the grower's specialty, and it is on this one crop that he depends for his income. Because of their great distance from market, to make a profit the Western growers have been forced to form selling organizations. These have in most cases been successful, for they



FIG. 149. The ideal in store arrangement

Harrod's stores, London, England. (Courtesy of the Northwestern Fruit Exchange)

have been able to place the apples grown in these regions not only in all the large markets of the United States but in those of foreign countries as well.

It has been easy to form such organizations, particularly in the Pacific States, where the farms are conducted on an intensive basis and are confined to small agricultural districts which are far removed from the best markets. The best system is for each locality to have an association consisting of the local growers. These organizations then furnish a representative to the larger central organization.

The many advantages of association will be treated in Chapter XXVIII.

Efficient distribution. That distribution is most efficient which most thoroughly and evenly covers the field and keeps the cost of service at a minimum. Such a distribution cannot be attained through half a hundred selling associations acting independently of one another. They load the same markets, duplicating each other's expense accounts and receiving no additional return. The unsatisfactory results of present methods were conspicuous in 1912 (see p. 314). The greater consuming ability of large cities tempts shippers to concentrate there; but in the United States there are only 180 cities of more than 25,000 population, and in the rush

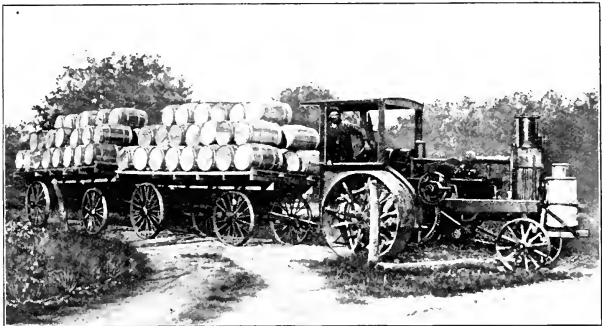


FIG. 150. Modern marketing in Illinois

Consider the saving in horses and time

to supply these markets many smaller ones, whose aggregate capacity for consumption is large, are altogether overlooked.

Individual shippers and weak associations cannot afford the expense necessary to keep in touch with all markets and to know the financial standing of the dealers there. They prefer to take their chances at the big centers and with firms whose responsibility they know. Therefore prices are hammered down to an unremunerative basis, while at the smaller markets there is an undersupply, or a supply at prices covering so many middlemen's profits as to be unattractive to the average consumer. In fact, if conditions of distribution were what they should be, consumers in interior towns

would be provided with apples at a lower price than that charged in large cities, because retailers there are under less expense.

There can be no doubt that evenness of distribution, by which all the lesser markets would be provided with their due share, with the elimination of unnecessary middlemen, would result in vastly increased consumption. Apples would then be within the means of many more consumers than at present. The great bulk of the apple crop should be consumed by the common people.

The most efficient distribution can be secured only through centralization of distributive agencies. Great credit is due to those few well-organized, well-managed, and successful shipping associations which have brought the grade and pack of Northwestern apples up to their present high mark, so that they have won supremacy in Eastern markets. But these heretofore efficient organizations are no longer able to cope with the situation. Production has outstripped their facilities. Output has overtaken the outlet which they are able to provide. They must combine their plants. The merging of facilities in one central selling agency affords the only hope of escape from the chaos which confronts the apple output of the near future.

Apple-growing is a business. Why should we assume that this business can succeed on other lines than business lines? Manufacturers appreciate the advantage of combining their resources and of centralizing their distributive efforts. Why should not apple growers do the same?

New markets. It may be well here to emphasize the fact that individual dealers do not as a rule develop new markets. This development requires time and money, — both of which the fruit merchant is loth to give, — and it must be admitted that an individual merchant can seldom hope to reap an adequate reward for a large outlay in the development of new markets. This work properly belongs to the fruit-growers, with what aid and assistance they can get from the consumers concerned. No better use can be made of a surplus stock than to apply it to the development of new markets. It is a common experience to find that after a year of extraordinary production in fruit, and consequent low prices, the demand in many quarters has increased. Market development is the work of fruit-growers as a whole, and can be done by a

union of coöperative associations better than in any other way. This is not a matter of theory. The best-organized selling coöperative associations have recognized that the development of new markets is a most important part of their work, and large quantities of surplus fruit are frequently used for this purpose by such organizations as the California Fruit Exchange and the Georgia Peach Growers' Exchange.

Export. Large shipments of apples from the United States and Canada are made each year. Practically all the apples grown in the famous Annapolis valley, Nova Scotia, are exported to England. The development of the apple trade in Nova Scotia is similar to that in Ontario, and began about the same time. About 1870, shipments from Nova Scotia to London were in large enough cargoes to attract attention. Later, Halifax secured a direct line of steamers that has served the needs of the trade more or less satisfactorily up to the present time. The exports in 1880 were only 24,000 barrels, and in 1886, 177,500 barrels. The phenomenal crop of 1896 gave a surplus of something like 500,000 barrels, and the 1911 crop gave an output for export and long-distance shipments of 1,500,000 barrels, representing a total yield of about 2,000,000 barrels.

Large numbers of barrels are consigned from the ports of Portland, Boston, New York, and other cities. The Pacific coast growers are watching with eager eyes for the opening of the Panama Canal and the low rates by boat direct to Europe and other foreign countries. The demand for export apples is ever on the increase.

In selling consignments of American apples in Liverpool not only is the head of the barrel opened, but the contents are poured out on a platform for inspection by the buyers, sometimes several barrels being so inspected. The shipment is sold on the showing of these sample barrels.

Hamburg is becoming one of the best foreign markets for American-grown apples. Probably from 2000 to 5000 boxes a week could be utilized there. Before Christmas such varieties as Extra Fancy Jonathan, Ben Davis, Gano, and similar apples could be sold in boxes and are in good demand. After Christmas it is difficult to sell them, for the demand is then for the barreled product. Thousands of barrels are shipped annually from Canada, New

England, and New York to supply this trade. Boxed apples for the after-Christmas trade should be the finest Winesaps, Rome Beauties, Orange Yellow Pippins, and other high-grade goods. Of all the Western boxed apples, there are none that equals the Orange Yellow Pippin and the Winesap in the eyes of the Hamburg consumer. Often \$4.00 or \$5.00 a box is paid for this choice fruit. If Ben Davis were offered for sale at the same time in March, probably \$1.75 to \$2.00 would be all that could be obtained. The ocean rate is 22½ cents per cubic foot for apples in cold storage and fifteen cents in common storage. The railroad charges per hundred from the point of growing to New York City, and the commission in Hamburg, should be subtracted from these figures.

Owing to its geographical location, Hamburg is destined to be a great distributing center, as it has good communication with many other parts of continental Europe, north, south, and east.

Selling fancy apples. There are two kinds of consumers that must be catered to — one is the family which buys by the box or barrel, the other is the individual living in an apartment, a boarding house, or a hotel, who buys by the dozen. To reach this individual buyer, growers must put their apples up in attractive pasteboard boxes — half a dozen or a dozen apples in a box — with neat handles, so that the purchaser can conveniently carry the package. The average individual will not buy a dozen apples if put up in a paper bag.

In 1912 a grower in Missouri sold 500 boxes of fancy apples for \$50.00 a box. Each box was divided into twelve compartments, each holding one apple, at least 3 inches in diameter, wrapped in paper. The apples were hand selected at the trees, and were wrapped at once in tissue paper and placed in the compartments of the box. Each box was supplied with a label which gave the name of the variety and the name and address of the grower.

A still more fancy article has been placed on the market — one apple with stem and two leaves attached, well wrapped in tissue paper and packed in a separate box. The boxes are sealed with a small band of paper and neatly labeled with the name of the variety, the locality, and the grower. These individual apples are in demand at certain select hotels and restaurants in the large cities, where they are served to the guests without breaking the

seal. The apple with the two green leaves (the leaves are dipped in a solution that preserves their natural color) makes a very attractive appearance. Fifteen cents each at wholesale has been received for apples put up in this manner.

Cost of selling compared with cost of growing. A good average cost of growing apples in barrel lots is as follows :

Labor	\$0.50 to \$0.75
Interest and other charges . . . . .	.10 to .15
Incidental cash outlay . . . . .	.15 to .25
One barrel	<u>.35 to .40</u>
Total	\$1.10 to \$1.55
 If stored	 <u>.25 to .40</u>
	\$1.35 to \$1.95

The average cost of selling apples in barrel lots is as follows :

Freight	\$0.10 to \$0.15
Commission . . . . .	.06 to .25
Cartage . . . . .	.15 to .25
Jobbers . . . . .	.25 to .40
Retailers	<u>.50 to 3.00</u>
Total	\$1.06 to \$4.05
 If storage is necessary	 <u>.25 to .35</u>
	\$1.31 to \$4.30

In other words it costs as much at a low average to sell a barrel of apples in barrel lots as it costs to raise it, and sometimes the selling costs are twice those of the highest average production costs.

Advertising. A campaign of advertising called the "Stamp Plan" has been started by the International Apple Shippers' Association. The plan is patterned after that used by the various governments when it becomes necessary to raise large funds ; for instance, during the Spanish-American War.

The stamps will be issued in two denominations — one-cent and two-cent. A one-cent stamp will be required for every box of apples and a two-cent stamp for every barrel. The money derived from the sale of the stamps will be placed by the Equitable Trust Company of New York City to the credit of the advertising fund. The stamps will be placed on sale at various distributing agencies

August 1, 1915, which will give sufficient time to create adequate funds for advertising the apple crop of that year.

This plan will provide the means of carrying on a continuous country-wide campaign through trade papers, magazines, newspapers, circulars, and other agencies, that will acquaint the masses with the great food and health-giving value of the apple. It will furnish the money for an educational propaganda among retailers, convincing them that moderate profits and many sales is in the end the most profitable policy. It will forever settle the question as to the amount any one individual ought to contribute, since it provides that each man shall contribute in proportion to the size of his output.

For many years the problem of advertising has been studied diligently, especially in America. Some of the mysteries of the science have been solved, and many more are in process of solution. But thus far no one has struck the keynote in advertising the apple, perhaps because growers have not felt the need of high-class publicity in the selling of so common a product.

The story of the apple, if told and retold, will prove as fascinating to people as the story of the pineapple, the banana, or the orange. The trouble is that the story has not been told at all as it should be, and the people have lost sight of the apple because of its common origin and its careless display at the corner grocery. Familiarity has bred contempt in the case of the apple, as truly as mystery in production and care in distribution have brought to the orange and the banana the elements of luxury and dignity. Yet, the plebeian apple is eaten all over the world, and is used by as many people, perhaps, as all other fruits put together.

In advertising the apple the appeal must be made directly to women. As the housewife buys practically all the provisions for the family, it is essential that comprehensive and reliable knowledge of the value of the apple as a food and as a substitute for medicine be given the housewives of the country. To do this a fund of large proportions must be made available, and producers, distributors, and dealers must combine their efforts in a well-laid plan to expend it.

A start must be made, and it should be made quickly. The apple industry demands such a movement, and every man in the

trade who has given thought to the matter recognizes the necessity for action. Now is the time to plan and execute. A broad plan is essential, but, above all, hearty coöperation will be needed to carry the scheme to success.

Methods of attracting attention. A good method for attracting attention would be a reproduction of a standard box of apples.

Labels are another factor to be considered. A standard label for eating apples should be used, and a different one for the best cooking varieties. In addition, each box or package should contain a card or have a label, giving the variety of the apple, its color, its quality, its value for cooking or eating, and the period during which it is at its best for consumption. In this way the housewife may be able to learn just what to ask for when ordering at the store, and by the label she would know what she was receiving.

An advertising scheme already introduced is that of publishing a small book containing 209 ways of serving apples. Copies of this booklet are given free to each purchaser, or one is inserted in each box of apples. The educational value of these books is enormous. Where issued, consumption would naturally increase.

Apple shows, fairs, land shows, and other exhibitions offer opportunities for advertising the apple. Electric signs in the large cities, editorial paragraphs and articles in the newspapers, setting forth the value of the apple as a food and as a dietetic aid to better health, advertisements and articles in the many high-class journals or magazines, especially those which reach the greatest number of women, all are means that should be used. The advertisements in current publications could be small, but they should be educational, giving the names of the best apples, a good description of each, the place where grown, the rating as to quality for eating, and the time at which they are best eaten. Lists should also be given of the apples specially adapted for baking and other cooking purposes. Perhaps all these ideas should not be included in one article, but all are important and should be emphasized in due course.

CHAPTER XXVI

STORAGE

Apple culture has attained such proportions in the United States that the harvesting and disposition of the crop have become matters of national importance. To preserve the crop until it is distributed to consumers in a sound and wholesome condition is probably one of the most important questions of commercial apple-growing. Through the warm months of September and October a large part of the crop ripens rapidly, and is thrown on the market in perishable condition before midwinter, causing a disastrous glut and low prices, followed by abnormally high prices to the consumer in late winter and early spring.

The beginning of refrigerated cold storage, which was welcomed by growers and dealers as the solution of the problem, dates back to about 1890. Experience has demonstrated, however, that in many instances fruit held in cold storage in the fall has failed to come out in good condition in the late winter or spring. Observations show that different lots of fruit in the same storage room behave differently, some keeping well, while others spoil. Since 1900 the Department of Agriculture and several experiment stations have taken up the question of cold storage, with a view to reducing the uncertainty and loss. It was found necessary to study into the whole problem of orchard location and cultural treatment, as well as the methods employed in picking, packing, and shipping the fruit — all of these having important bearing on the availability of the product after it reaches the storage house.

Cold storage is having such an important influence in developing the apple industry as a staple business that in many sections it is now becoming the principal crop instead of an incidental one.

Apple storage. An apple, to have the best keeping and commercial qualities, should usually be fully grown and highly colored when picked. When harvested in this condition it is less liable to scald, is of better quality, more attractive in appearance, and is

worth more money than one picked in a green condition. An exception to this statement seems to exist in the case of certain varieties when borne on rapidly growing young trees. Such fruit is likely to be overgrown, and under these conditions the apples may need picking before they reach their highest color and fullest development.

Uniform color may be secured by pruning to let the sunlight into the top of trees, by cultural conditions that check the growth of the tree early in the fall, and by picking over the trees several times, taking in each picking the apples that have attained the desirable degree of color and size.

Apple storage is not always profitable. When the picking season is very hot and there are delays in getting the fruit into storage, the subsequent losses are sometimes very heavy. On the other hand, the autumn may be unusually cool and favorable for storing large quantities of apples in common storage. As a result, the markets will be well supplied with this fruit through the winter, causing the cold-storage stock to be held back till late in the season, when it has to be rushed onto the market and sold at a sacrifice on account of the approaching warm weather and the use of early apples from the South.

Apples should be stored as quickly as possible after picking. The fruit ripens rapidly after it is gathered, especially if the weather is hot. The ripening that takes place between the time of picking and storage shortens the life of the fruit in the storage house. The first stage in this ripening is the transformation of starch into cane sugar, then the change of cane sugar into invert sugar, and finally a slow decrease in the total quantity of sugars. The acid content gradually grows less, there being most in the unripe fruit.

The best fruit keeps best in storage. When the crop is light, it may pay to store fruit of inferior grade, but in this case the grades should be well established when the fruit is picked. The bruising of fruit leads to premature decay.

Temperature for storage. A temperature of 31 or 33 degrees F., depending on the condition of the fruit and the variety, retards the ripening processes and favors the fruit in other respects, such as quality, aroma, and flavor, and when removed from storage the fruit keeps in good condition for a longer period.

The results of experiments would seem to indicate that apples frozen in cold storage at temperatures of 24 degrees or above would remain uninjured if thawed out gradually at a temperature below freezing—between 29 to 31 degrees. If proper care is given to fruit accidentally frozen, the claims for damage against the storage men will be less.

Function of temperature. The behavior of different apples or lots of apples in a storage room is largely dependent on their condition when they enter the room. If they are in different stages of ripeness or have been grown or handled differently or vary in other respects, they will show different conditions as they slowly ripen in the low temperature. If the fruit is already overripe the low temperature cannot prevent its deteriorating sooner than would otherwise be the case. If the fruit has been bruised or is covered with rot spores, the low temperature may retard but cannot prevent its premature decay. If there are inherent differences in the apples, due to the character of the soil and methods of orchard management, or variations due to methods of picking, packing, and shipping, the low temperature must not be expected to obliterate them; it can only retard their normal development.

Time for storing. A delay between harvesting and storing is responsible for the deterioration of large quantities of fruit. The extent of this loss depends on several things, the most common of which are the temperature during the period of delay and the condition under which the fruit is held, whether in piles in the orchard, in tight buildings, where the warm air cannot pass off readily, or in transit in tight cars. Fungous diseases get started and develop rapidly while the fruit is warm, and cannot be checked entirely when placed in storage. However, if the weather is cool enough to prevent after-ripening, a delay in the storage of the fruit may not be injurious to its keeping qualities.

From the standpoint of the orchardist or the apple dealer who cannot secure quick transportation to the large storage centers, or who cannot obtain refrigerator cars, or who is geographically situated where the weather is usually warm in apple-picking time, the local storage plant in which the fruit can be placed at once and distributed in cool weather offers important advantages. Many of the large apple centers are supplied with storage facilities.

Removal from storage. Apples should be in a firm condition when taken from storage, and should be kept in a low temperature after removal. A high temperature hastens decomposition and develops scald. Comparisons at the New Hampshire Agricultural Experiment Station indicated that the length of time apples keep when taken out of cold storage is in direct proportion to the height of the temperature to which they are subjected. When the fruit is taken out of storage at a time when conditions are especially favorable for decay, it decomposes faster than in the fall or winter, when the temperature is low.

Wrappers. Apple wrappers tend to delay apple scald on most varieties with which they have been used. They also postpone the breaking down of fruits and prevent the spread of decay. They are out of the question, however, except where apples are packed in boxes or where packed for special purposes in barrels. The cost of wrappers amounts to from 3 to 4 cents per bushel in addition to the expense of wrapping. With fancy boxed grades the wrapper is of considerable value in preserving the fruits in cold storage; and its use is advisable for the finest grades of fruit placed on the market in small packages.

There appears to be no decided preference for any particular kind of wrapper. Wrapping fruit in paraffin paper and then in newspaper has been advocated. This is perhaps a trifle bulky, but the danger of mechanical injury will be lessened and the loss in transportation reduced to a minimum. For commercial use but one wrapper is needed.

Packages. Apples that are to be stored for any length of time should be placed in closed packages. Delicate fruit and that in which the ripening processes need to be quickly checked should be stored in the smallest practicable commercial package. The fruit cools more rapidly in small packages.

Professor Ernest Walker of the Arkansas Agricultural Experiment Station says :

It does not pay to store inferior grades of fresh fruit for marketing, no matter how short the fruit crop may be in your section. Such fruit does not keep well and it is a blunder to try to get the public to pay a good price for poor fruit. Grade the fruit according to size, color, and quality, and pack so that the contents of packages are the same from top to bottom. Mark and seal

according to grade, and (if the conditions are favorable) store only the best grades. But do not store even these grades if the price at the orchard is fair, and you have an offer at a reasonable price. Let those who have the capital, and who make a specialty of storage, take the risks, unless you are carefully studying the fruit supplies and markets over the country.

Good cold-storage stock should not be overgrown fruit. In a number of varieties the larger apples are noticeably shorter lived in storage than medium-sized fruits of the same variety.

Differences have been noticed in boxes where the size varied only by 40 or 50 apples to the box. In almost every variety the larger apples will not keep so long as the smaller ones. They also lose their flavor earlier. Just why this is true is a matter of discussion. Doubtless the flesh is coarser and will break down more quickly than in the smaller fruits. Further investigation along this line should be undertaken.

Importance of an unbroken skin on apples for cold storage. The importance of storing only fruits which are entirely sound has been demonstrated in numerous instances. Apples which had been russeted with spray mixture, by frost, or by limb rubbing shriveled much earlier than those which had a smooth, clear skin. Some apples have a tendency to crack, while in others there is a natural roughening of the skin. In seasons when the cracking is bad, it is not well to include affected fruits in cold-storage stock, for they will shrivel before the end of the season, since any break in the skin allows the cell sap to evaporate more rapidly. This only emphasizes the importance of having strictly first-grade stock for cold-storage purposes. Where the fruit has been burned by spray mixture or scarred in any other way, it should not be included in storage stock that is to be held after February 1.

Apple scald. Scald is not well understood, but is probably caused by a ferment or enzyme which works more rapidly in a high temperature. After the fruit is packed its susceptibility to scald increases as the ripening progresses. Apple scald is not a contagious disease, but, according to the Department of Agriculture, a physiological disturbance not connected in any way with the action of parasitic or saprophytic organisms such as molds or bacteria. It is a brownish discoloration of the surface not extending into the flesh of the apple, though scalded fruit will break down earlier than

unaffected apples. The greatest damage from the trouble is the lessening of the market value of the fruit due to its unattractive appearance.

The interest in apple scald among growers and shippers was especially keen during the season of 1912-1913, when much loss from this cause was experienced in parts of the United States. There is much difference in varieties in regard to their susceptibility to scald. Investigations and observations seem to show that maturity is one of the main factors in this trouble. Well-matured, well-colored specimens scald very little, while immature and poorly colored specimens suffer greatly. The appearance of the scald also seems to be closely connected with the changes that occur in ripening after the apples are packed, and is most injurious as the fruit approaches the end of its life. The ripening that takes place between the picking of the fruit and its storage makes it more susceptible to scald, and delay in storing fruit in hot weather is particularly injurious. The fruit scalds least in a low temperature. Scald quickly develops on fruit removed from storage late in the season, especially when the temperature is high.

From the information at hand at this time, it would seem that such varieties as Grimes, Sheriff, Winesap, Arkansas, and others which scald badly should be picked as late as possible, but before heavy dropping begins or there is danger of freezing, thus securing well-matured specimens. If good storage facilities in the way of cellars or caves are at hand, varieties of good keeping qualities, like the Winesap and the Arkansas, can be handled profitably in common storage.

There is a difference of opinion as to how much scald injures the apples, some dealers claiming that it does not affect the sale of the fruit to any appreciable extent. Scalded fruits may find a ready market for culinary use at bakeries, restaurants, and hotels.

Preventing scald. It does not appear practicable to treat the fruit with gases or other substances to prevent scald. From a practical standpoint the scald may be prevented to the greatest extent by producing highly colored, well-developed fruit, by storing this fruit as soon as it is picked in a temperature of 31 or 32 degrees F., and by removing it from storage in the coolest possible outside temperature.

A variety may differ in its keeping qualities when grown in different parts of the country. It may vary when grown in the same locality under different cultural conditions. The character of the soil, the age of the trees, weather conditions, and the care of the orchard are factors modifying the growth of tree and fruit, and may affect the keeping quality of apples.

Frost-proof building for apple storage. Frost-proof construction for the storage of apples generally comprises a building wholly or partially below ground, with insulated side walls and ceiling. It

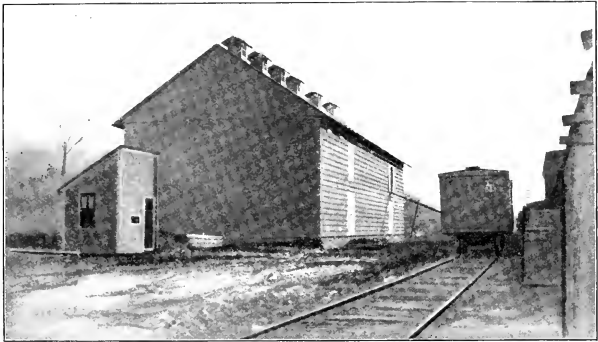


FIG. 151. A fine type of concrete storehouse

Adapted to the farm or organization of farmers. By properly ventilating and arranging for the taking in of cold air during the night and the release of warmer air, apples may be very successfully stored during the fall and winter

is sometimes built entirely aboveground, but in this case some means of heating may be necessary during extreme periods of cold weather. For insulation the old-style construction consisting of air spaces should be abandoned and the modern construction of filled spaces substituted. Mill or planer shavings, perfectly dry sawdust, cut straw, or any similar material may be used for filling. Whatever is used must be protected, both on its interior surface toward the storage room and on the exterior surface toward the outer air, by water-tight, air-tight insulating paper. The thickness of insulation desirable depends on the type of construction, the

exposure, the capacity of the room or rooms, the arrangement, the local conditions, etc. A thickness of from 8 to 16 inches divided into one or two spaces would probably cover the extremes.

Frost-proof buildings are fairly satisfactory for both small and large orchards when the apples are to be held for a short time only. One of the best buildings of this type is located at Rochester Junction, New York. It is built of concrete, with three walls and two dead-air spaces. Ample ventilation is provided through the roof, after a modification of the King system. Apples have been kept here very satisfactorily and at a low cost.

Storage of apples in the home. Where only cellars are available — especially warm cellars — it will be found a decided advantage to wrap the apples in paper. Regular wraps may be bought at retail for between 16 and 24 cents per thousand sheets, or newspapers may be used, cutting each newspaper into 12-inch squares. The apples when wrapped should be stored in boxes.

The advantages of wrapping the apples are as follows :

1. Wilting is stopped.
2. Temperature changes are lessened.
3. Ripening processes are retarded.
4. The spread of disease is prevented.
5. Bruising is prevented.

On the farm the apples may be stored in the root cellar or the storage house if care is taken to give proper ventilation and to prevent freezing.

Commercial cold-storage houses. Most commercial cold-storage houses are owned or controlled by people who are not fruit-growers. The business then is carried on as a strictly money-making proposition, and eggs and other commodities are stored as well as apples.

The construction of these buildings is somewhat complicated. The walls may be of wood, concrete, stone, or brick. Several spaces filled with mineral wool, hair, felt, mill shavings, or some other material are built in the walls. Other measures for thoroughly insulating the building are also used. The insulation extends not only around the building, but through the floors and ceilings.

Ice cold storage. The first successful ice cold-storage houses were built with ice above the storage chamber, and a large majority of those now in use are of this kind. They are chiefly useful for

short-time storage. When placed in competition with a house equipped with a system which gives positive control of circulation, moisture, temperature, and purity of atmosphere they soon lose business and fall into disuse.

The Fisher system. One of the oldest systems of ice cold storage is the Fisher system. The main essentials are an ice chamber located above a storage room, with an insulated waterproof floor separating the two. Openings are provided for the circulation of air from the ice chamber to the storage room, and flues extend from the storage room to the top of the ice chamber. One who is familiar with the operation of this system says that these houses would do fair work when new, but when they became old the results were very unsatisfactory.

The Wickes system. The Wickes system has been largely introduced in the refrigerator-car service. The Wickes company some years ago installed a number of cold-storage plants, but it is believed that they do not now recommend their system for such use. The essential feature of the Wickes system consists in a basketwork ice bunker composed of galvanized iron strips. Attached to the strips, where the air flows into the ice bunker, are projecting tongues, which, it is claimed, give largely increased cooling and moisture-absorbing surface, and dry and purify the air more thoroughly. Where the air flows out at the bottom of the ice bunker, it passes over a network of galvanized wire, which is kept cold and moist by water dripping from the melting ice above.

The Stevens system. This differs somewhat from other systems of overhead icing in having an arrangement of fenders and drop troughs that form an open pan over the entire floor of the ice room except at the ends and sides, which are left open for the flow of warm air upward from the storage room. The cold air from the ice works down through the open pan. The pan is formed by a series of gutters suspended between the joists and the capping pieces over the joists — an arrangement which causes the water to drip into the gutters and, at the same time, allows a circulation of air between gutters and capping pieces. This system has the advantage of maintaining fairly uniform temperatures, regardless of the amount of ice in the ice chamber.

The Nycce system. In this system the cooling effect of melting ice and the drying and purifying effect of chloride of calcium are depended upon to produce the desired result. It is an overhead ice system, but the air is not circulated from the ice chamber into the storage room. The air of the storage room is cooled by contact with the metallic ceiling, which also forms the floor of the ice chamber. To absorb the moisture which is given off by the fruit and is admitted by the opening of doors, the well-known drying

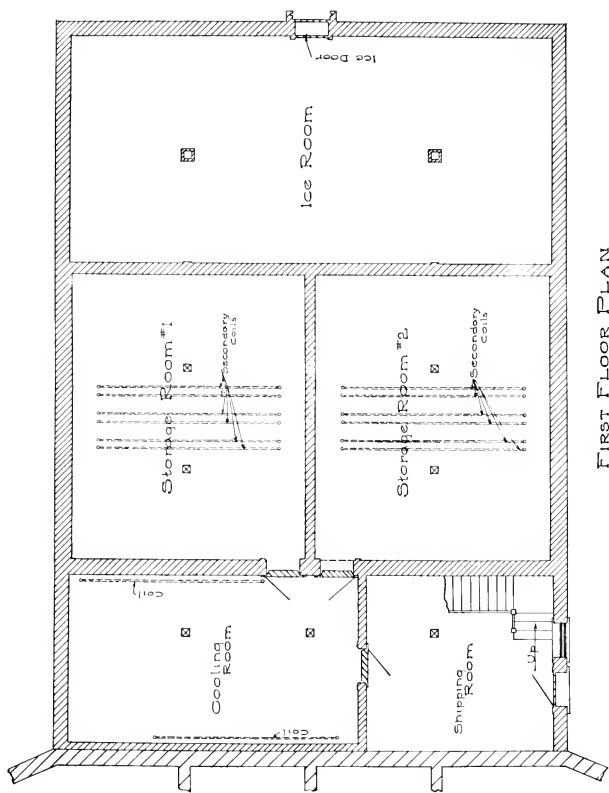


FIG. 152. Exterior of a good farm storage

On the farm of George Smith, South River, New Jersey. (Courtesy of Madison Cooper, Calcium, New York)

qualities of chloride of calcium are used. The results obtained in this way are quite satisfactory and compare favorably with those of any of the other ice systems in general use.

The Jackson system. The Jackson system of cold storage is one of the most commonly used, and is quite simple. It is, of course, an overhead ice system, with air circulating from the ice chamber down into the storage room. The spaces between the joists supporting the ice are left open, and aprons of galvanized iron protect the girders which support the joists and conduct the drip to the removable pans. In some cases cylindrical tubes or



FIRST FLOOR PLAN

FIG. 153. Plan of storage building shown in Fig. 152. (Courtesy of Madison Cooper, Calcium, New York)

tanks of galvanized iron are provided. These are filled with ice and salt for the purpose of reducing the temperature still lower than is possible with the ice alone.

The Dexter system. The Dexter patents cover a much more complicated apparatus than any system of earlier invention using ice as a refrigerant. It consists of a series of air flues between the exterior and interior walls of the cold-storage room. The cold air from the ice chamber flows down through one set of flues, and as it is warmed returns through another set located outside of the first set. This effectually prevents the penetration of outside heat, and makes the regulation of temperature comparatively easy, even in warm weather. This is practically like putting one cold-storage room inside of another. To bring down the temperature to the desired point, Dexter also uses the galvanized tubes or tanks filled with ice and salt.

Other systems. Some houses are cooled entirely by the galvanized-iron tanks. These are built in a variety of shapes and sizes, and are usually placed around the sides or through the center of a room and filled with ice and salt from above. Sometimes the ice is stored above, but usually in a separate building, and hauled up to the floor above the storage room as needed. This system is not adapted for houses of more than one story, although in some cases the tanks are filled from a corridor of the upper floor.

Mechanical refrigeration. *The ammonia system.* A great variety of machinery is being patented and manufactured for use in refrigeration. The aim of all these machines is practically the same — to produce a given temperature at a lessened cost. The ammonia process (which is being used in very large plants with satisfaction) is, briefly, as follows :

1. Ammonia gas (not the "ammonia" of commerce) is liquefied by high pressure in a condenser surrounded by cold water.

2. The liquid ammonia is run into pipes where it is under less pressure ; it then becomes a gas again, producing intense cold.

3. These pipes are surrounded by double pipe coils containing brine, which is cooled by the ammonia and is then run through the storage room. The temperature is easily controlled by increasing or decreasing the brine flow.

4. The gas is either pumped back to the condenser by an air pump (compression system) or run into a tank of water in which it

dissolves (absorption system). In the absorption system the water is then heated to drive the gas out of it to the condenser.

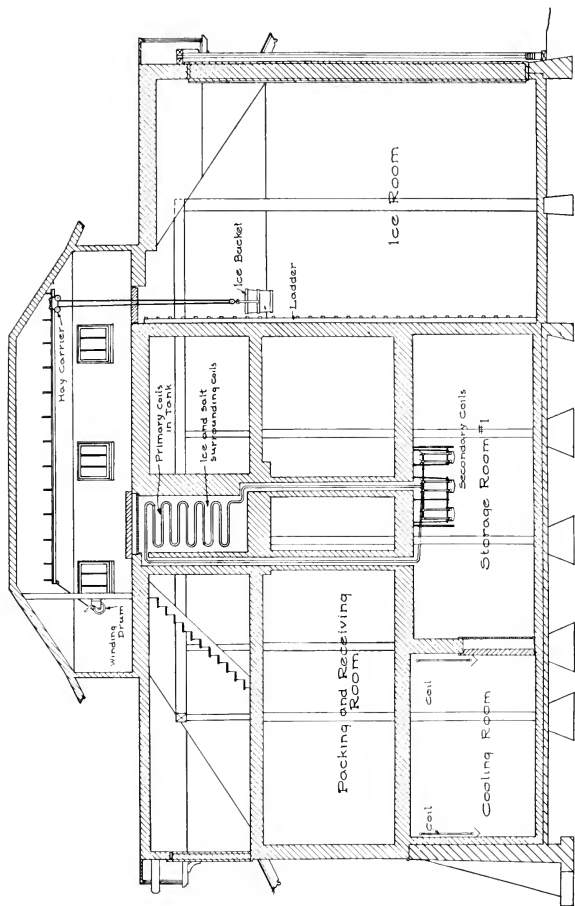
5. A one-ton machine will cool $197\frac{1}{2}$ pounds of water at the rate of 10 degrees a minute, or 12,000 cubic feet of space can be maintained at 40 degrees F., or 6000 to 8000 cubic feet at 34 to 36 degrees F.

In the place of ammonia, sulphur dioxide (sulphurous acid) and carbon dioxide (carbonic acid) are also used.

The Cooper brine system. In the gravity brine system the tank which contains the ice and salt and the tank coils are located at a higher level than the pipe coils which do the air cooling in the rooms. The brine standing in the tank coil is cooled by contact with the ice and salt which surrounds the pipes to a lower temperature than the brine contained in the secondary coils, and consequently flows down into these secondary coils. At the same time the brine from the secondary coils rises into the primary coils.

The circulating brine is entirely independent of the brine which runs out of the tank as a result of the mixture of ice and salt. The refrigeration in the waste brine is utilized for cooling purposes by running it through a coil of pipe of suitable size at any convenient place in the building; it is afterwards led to the sewer. The chloride of calcium brine, on the other hand, remains always in the pipes, the only loss being from leakage. In operation, it is usually necessary to fill the tank once each day with ice and salt, and the circulation will remain continuous and automatic through the twenty-four hours. The ice in the tank will melt down four feet per day.

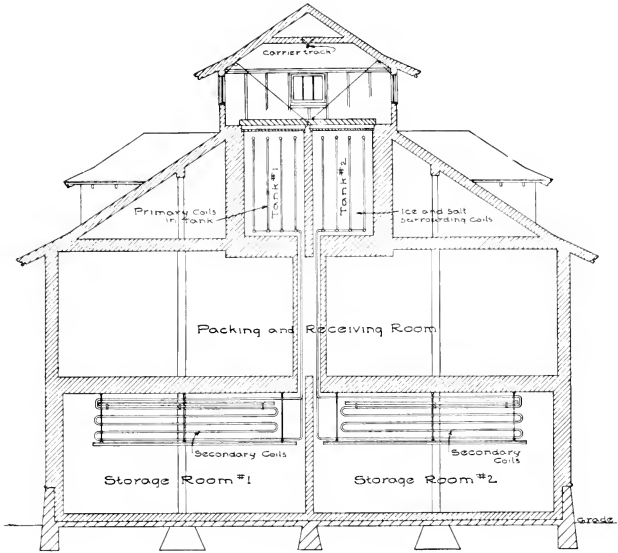
The machine for crushing the ice is generally located at (or near) the floor of the ice house. From the crusher, in pieces not larger than a hen's egg, the ice drops into a bucket elevator, which is raised to a point near the tank and somewhat above it, and dumps the ice into an inclined tube terminating in a flexible spout. This spout is pivoted, and will deliver ice to any part of the tank without shoveling. The only hand labor necessary on the ice is in the chopping and shoveling into the chute. Two men will easily handle two tons of ice an hour in this way, and two tons of ice a day will cool a storage house of 20 carloads' capacity during average summer weather.



LONGITUDINAL SECTION

FIG. 154. Section of storage building shown in Fig. 152. (Courtesy of Madison Cooper, Calcium, New York)

The Cooper chloride of calcium process for preventing formation of frost on refrigerating surfaces and for drying and purifying the air of cold-storage rooms is a very simple and effective improvement. The chloride is made to perform two distinct duties — that of keeping the pipes free from frost during warm weather, and



TRANSVERSE SECTION

FIG. 155. Section of storage building shown in Fig. 152. (Courtesy of Madison Cooper, Calcium, New York)

that of maintaining the air of the storage room at its correct degree of humidity during cold weather, at the same time helping to keep the air pure. The process is applicable not only to the gravity brine system but to any of the mechanical systems of refrigeration in which a refrigerant is circulated through coils of pipe, or to any system in which the rooms are cooled by refrigerated metal surfaces.

A much smaller amount of surface is required to do a certain refrigerating duty when the pipes are clean than when the frost has been allowed to accumulate, and the economy of a device that will keep the refrigerating pipes free from frost at all times will be appreciated by any person familiar with the business, for it is well known that frosted pipes are partially insulated, the degree of insulation depending on the thickness of the coat of frost. The Cooper chloride of calcium process consists simply in placing a quantity of chloride of calcium so that the brine resulting from a union of the moisture in the air of the storage room with the salt will drip over the refrigerating pipes. After passing down over the pipes the brine falls into a water-tight floor, which is provided with drip connections to the sewer. This effectually and continually disposes of the brine, which contains the moisture and impurities from the air of the storage room, therefore making contamination from this source impossible.

The indirect circulation system. The auxiliary method of cooling, known as the indirect circulation system, consists of a space for the circulation of air between the inner and outer insulation of the cold-storage building. It has been demonstrated that this space need not be more than one inch in thickness to accomplish the desired result. The air is drawn from near the floor of the ice house by a fan and forced through the space provided for it. After accomplishing its work by absorbing the heat which penetrates from the outside, it is returned to the ice house, where it is let in near the ceiling. The circulation not only covers the outside walls of the building but the ceiling as well. The air of the indirect circulation system does not enter the rooms; it merely circulates around them in a thin sheet between the interior and exterior walls of the building. The penetration of outside heat during the summer is effectually prevented, and even in extremes of hot weather no variation of temperature is noticeable in the rooms.

Ventilation of cold-storage rooms. Though most of the impurities natural to the air of cold-storage rooms are disposed of by being frozen onto the pipes, there are certain gases for which moisture has little or no attraction, and these will remain in circulation if not displaced by forcing in fresh air.

The fresh air from the outside is first taken through water to wash and rid it of germs and impurities of various kinds. The water bath also lowers the temperature of the air to some extent if moderately cool water is used. From the washer the air goes to the tank, where it is cooled to about the temperature of the room to be ventilated, and a greater part of the moisture, which contains the impurities, is frozen to the surface of the cooler. From the cooling tank the air is passed through the drying tank, to rid it of any surplus moisture, and then goes to the coil room or storage room, as the case may be. A dry and pure air may be assured for the storage rooms by passing it last over chloride of calcium.

When the temperature of the outside air is about the same as that of the storage room, and the atmosphere is clear and dry, it is safe to force large quantities of fresh air into the rooms directly from the outside without previously treating it. When the outside air is too cold to use in this way, it should be warmed by passing over a steam coil, or in some other way, to make it of about the same temperature as the room to be ventilated. If it is desired to heat the storage room to prevent freezing, the air may be heated to a somewhat higher temperature. In a fairly large house separate systems are used for warm and cold weather ventilation, but in a small house one may answer for both purposes by a proper arrangement of air ducts.

Cold storage in transit. Sometimes the apples are stored for a short time when part way to their destination. This is called storage in transit. Apples shipped from the West are often placed in cold-storage plants at Duluth, St. Paul, or Minneapolis, pending shipment to a more distant market. The cost of this transfer is 10 cents a hundred above the rate to the final destination. This method may help the growers to wait for a better market, but it is not the best practice, owing to the expense involved. The growers would do much better to have several community storage plants in the various Western fruit regions, in which they could store at reduced cost and with more certainty of proper handling than in the other storage plants mentioned.

Precooling. The Western apple-growers have found it to be a decided advantage to precool the fruit. Three methods for accomplishing this are in use: (1) the apples may be precooled in an

ice-making factory; (2) they may be pre-cooled in a cold-storage plant; (3) they may be pre-cooled in cars.

Combination of ice making and precooling. The first arrangement of combined ice making and precooling seems to be advantageous for an ice plant located in a fruit-growing district. It makes business for the ice plant and furnishes desirable facilities for the grower at storage rates that are less than could be obtained at a

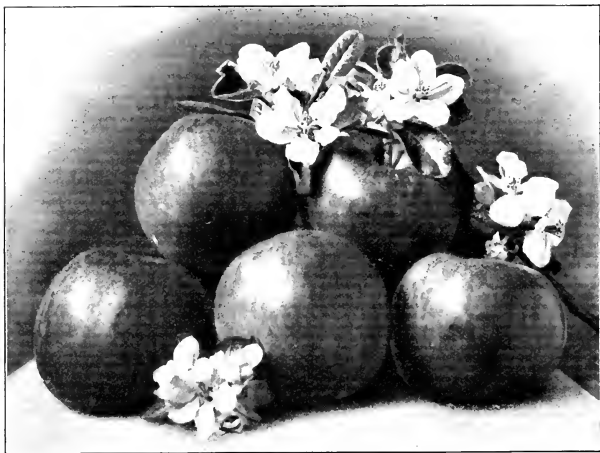


FIG. 156. Storage brings fruit and flowers together

Through the process of modern storage certain varieties may be kept over winter until blossoming time the following year

plant that is operated only for precooling and is therefore able to use its full capacity during only a comparatively small part of each year.

Cold-storage precooling. Certain rooms in a cold-storage plant may be given over to the precooling of apples. In this way the fruit is brought to the best temperature for shipping, and generally carries through long shipments much better. Only from four to six hours are required to cool the fruit, although a day is much better.

Precooling in cars. The precooling of fruit in cars is carried out in the following manner: As soon as the cars are loaded, or at least as soon as possible after loading, they are brought to the refrigerating plant and connected with the system by flexible ducts, which provide for the passing of a current of cold air through the car. The duct which carries the inlet (or cold blast) is attached to a false door which exactly fits the open door of the car. The outlets (or suction ducts) are fitted in the same manner into one of the hatches of the ice bunker at each end of the car. Fans are used on both the inlet and the returns to promote a rapid circulation of the cold air. Canvas baffles are temporarily hung in the car to deflect the air current so as to force it between the packages of fruit instead of merely passing over the surface.

The number of cars which may be cooled simultaneously is limited only by the capacity of the refrigerating plant and the number of connections. The refrigeration required per car is equal to about 12 tons for twenty-four hours; that is, if five cars are to be cooled at once and within a reasonable time, it would require a refrigerator plant of a capacity of 60 tons of refrigeration for each twenty-four hours.

With sufficient refrigerating power, cars should be well cooled in four or five hours, including the time required for connecting and disconnecting the air ducts and filling the bunkers with ice after cooling is finished.

Precooling in cars saves handling, and the fruit is not exposed to changes of temperature as when being transferred from warehouse to cars. When there is plenty of refrigerating power a low temperature can be employed to extract the heat rapidly from the fruit. It is quite safe to employ temperatures below the freezing point while the heat is still in the fruit. A precooled car will carry much farther without being re-iced than one started with warm contents.

Coöperation in storage. No part of apple-growing better illustrates the need of coöperation than the establishment of storage facilities at the point of production. Only the large growers are able to have individual storage plants, but by coöperative methods one or more storehouses can be built that will accommodate the fruit of all the members at a reasonable cost. Such a storehouse

is built *first* for storage of apples, other articles taking second place. It should be conveniently situated, both centrally for the members and with a view to ease of shipping.

A storehouse 40 × 100 ft. will store 18,000 barrels and will take care temporarily of a crop of 25,000 barrels. The cost of such a building will vary according to the material used, location, labor, and other factors; but a good storehouse built of wood, well insulated, can be completed for between \$3000.00 and \$3500.00.

A large concrete storehouse using ammonia system of refrigeration has just been completed at Sodus, New York. It accommodates 75,000 barrels of apples and was built at a cost of about \$125,000. Generally speaking, storage buildings of this type should be built at a cost not to exceed one dollar per barrel.

CHAPTER XXVII

BY-PRODUCTS

The utilization of the poorer grades of fruit is frequently of great importance to the apple-grower. That portion of the crop which is of too low a grade to market in the ordinary way can often be made to pay a large part of the expense of maintaining



FIG. 157. Power cider mill

A good type of a cheaply constructed cider mill. (Courtesy of *St. Joseph Fruit Grower*)

the orchard if it is converted into some such form as cider, jelly, or canned goods or evaporated apples, all of which are easily marketed.

Cider. Cider or fresh apple juice is obtained from the apples by any one of a large number of machines, all of which are built on the same principle. The apples must be ground or shredded, and enough pressure applied to extract the juice from the torn pulp.

With the best hand grinders and presses only about 2 gallons of cider can be obtained from 1 bushel of apples, while with a medium-sized grinder and press run by an 8 or 10 horse-power engine about 4 gallons may be obtained. It has been found in most cases that there is little or no profit to be derived from small hand presses, with which the grinding and pressing often cost from 6 to 7 cents per gallon; while with the larger grinder and press the cost is only from $2\frac{1}{4}$ to $2\frac{1}{2}$ cents per gallon.

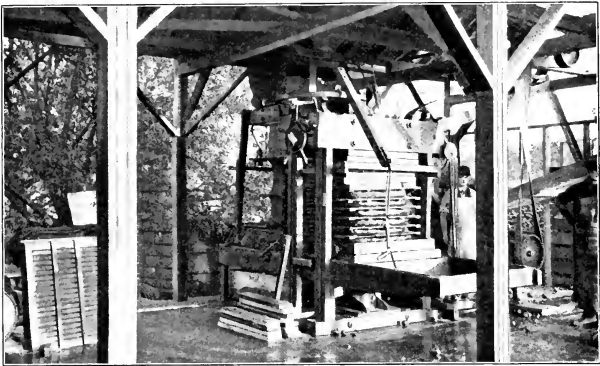


FIG. 158. A cider press at work

One of the ways by which culls may be utilized. (Courtesy of *St. Joseph Fruit Grower*)

There is a difference in the quality of apple juice, due in many cases to a difference in the cleanliness of apples, grinder, or press. Small sound apples are much to be preferred to decayed, dirty fruit. The early varieties of apples and the lighter-colored, softer-meated ones do not, as a rule, make as good cider as the solid, well-colored winter apples.

Preservation of cider. By sterilizing the apple juice and putting it up in air-tight vessels the cider may be kept sweet and in good condition the year round. It may be sterilized in wooden containers as follows: Apply paraffin to the outside of the wooden containers, then sterilize the inside and fill with cider heated from 149 to 158 degrees F.; seal the containers, taking measures to relieve

the vacuum produced by the contraction of the juice on cooling, by filtering the air through cotton. The best treatment for sterilizing in glass consists in heating the cider in the jars for an hour at 149 degrees F. or half an hour at 158 degrees.

Champagne cider. Champagne cider is a clear, sparkling fluid that is considered delicious by some people. It is an intensive product derived from cider by the process of filtering the apple juice through a large body of clean, sharp sand, and then allowing the product to age in bottles until it has the correct flavor.



FIG. 159. A large, well-equipped vinegar and preserving factory. (Courtesy of *St. Joseph Fruit Grower*)

Vinegar. For pure cider vinegar no mature apples are considered too poor. Vinegar-making in the ordinary way — by allowing the cider to ferment at will in casks without controlling the surrounding conditions — is not considered a profitable business. By regulating the temperature and adding mother of vinegar and cultures of acetic-acid ferment, fairly good vinegar may be made, although the process is both slow and wasteful. The processes of fermentation can be greatly hastened by the addition of equal parts of fermented cider and old vinegar, but this will require a large stock of old vinegar.

A very good vinegar can be made by using a vinegar generator, in which the cider passes slowly through a mass of shavings and

is thoroughly aerated, thus hastening fermentation. The generator may consist of a wooden tank 4 × 8 ft., with holes near the bottom for the admission of air, which is filled with beech shavings and is fitted, about a foot from the top, with a wooden disk perforated to allow the entrance of the cider, which should be evenly distributed over it by means of a dumper. The vinegar can be drawn from the tank by means of a siphon of glass tubing inserted in a hole near the bottom. The temperature in the generator should be as near as possible to 95 degrees. This may be controlled by regulating the supply of air, some of the air holes being shut off when the temperature rises too high and opened when it falls too low. In order to acidify the shavings and start the process of fermentation, the generator should be charged with strong vinegar, and again with vinegar in which some concentrated grape juice has been mixed. This generator will take care of about 20 gallons of the stock solution (a mixture of weak vinegar and fermented cider) every twenty-four hours.

Jelly. A jelly suitable for table use can be made by adding 1 pound of sugar (granulated) to 5 pounds of cider. One hundred pounds of cider with 20 pounds of sugar will make about 40 pounds of jelly at a cost of about 3 cents per pound for the finished product.

Pomace. Apple pomace, or the residue left after the cider or juice is extracted, is thought by many to be of little or no value. This is a mistake. Germany, France, and other foreign countries every year import large quantities of pomace from America to use in the manufacture of wines and for other purposes. In 1912 apple pomace packed in barrels was quoted in the Halifax, Nova Scotia, market at 1 cent a pound.

Pomace is sown by some nurserymen in furrows, and the seedlings thus produced are used for stock upon which to bud or graft well-known varieties. Sometimes the seeds are washed from the pomace and planted without the pulp.

Apple pomace as a food for stock has been considered too watery to pay for the hauling, although in point of fact it contains less water than many root crops. Although used for this purpose by a few farmers, the general opinion has been that it is of little value, and in some cases it has the reputation of being an unsafe

or unhealthy feed and, when fed to cows, of causing shrinkage in milk. This applies to the pomace containing straw as well as to that from the more modern mills in which no straw is used.

The fresh pomace ferments quickly when exposed to the air, and probably for this reason the trials which have been made in feeding it have not resulted satisfactorily. A Massachusetts farmer of the 40's is reported to have preserved pomace by placing it in a pit under his barn, thus anticipating the silo. It was kept in this way for months, and fed to cows during the winter. It has now been fully demonstrated that the pomace can be preserved in the modern silo without difficulty, and apple-pomace silage is getting to be appreciated as a cheap and altogether healthy feeding stuff. Its composition as compared with corn silage is shown by the following averages of several analyses :

AVERAGE COMPOSITION OF APPLE-POMACE SILAGE AND CORN SILAGE

CONSTITUENTS	APPLE-POMACE SILAGE	CORN SILAGE
	<i>Per cent</i>	<i>Per cent</i>
Water.	80.2	74.4
Ash . . . . .	.9	1.5
Protein	1.6	2.2
Fiber	4.5	5.8
Nitrogen-free extract	11.8	15.0
Fat	1.0	1.1
	100.0	100.0

Experiments with sheep have shown that apple-pomace silage compares favorably in digestibility with corn silage, over 70 per cent of the total dry matter, 40 per cent of the fat, 60 per cent of the fiber, and nearly 85 per cent of the nitrogen-free extract (starch, sugar, etc.) being digested. Dairy cows which were fed from 25 to 50 pounds per day of pomace silage for five months showed no ill effects of any kind either in health or in the flow of milk, and the quality of both the milk and the butter was not injured. These results from actual experiments by farmers and Station men seem to demonstrate that the feeding value of this material is worth considering. In fact, no farmer who has a silo and lives conveniently

near a cider mill where the material can be had for the hauling should fail to make use of it.

In ensiling apple pomace no special care is necessary. It is the general practice simply to dump or shovel it into the silo, either on top of corn silage or alone, according to circumstances. It should be leveled off, and may be allowed to lie uncovered and unweighted until wanted. A layer on top, about three inches deep, usually spoils, and in doing so protects the remainder and keeps it in good condition far into the spring.

Marmalade. A better class of apples is required for marmalade than for ordinary cider. It has been found advantageous to cook the apples in cider rather than in water. It has also been found more economical to cook the apples without previously paring and coring them, the cooked product being run through a colander. In this way the loss is not over 5 per cent of the weight of the fruit, while the loss from paring and coring the apples averages about 25 per cent, to say nothing of the extra time spent in the operation.

With apples at 30 cents a bushel, marmalade costs for material less than 3 cents a pound of finished product, an average of 116 pounds being made from 80 pounds of sliced apples, 8 gallons of fresh cider, and 35 pounds of sugar.

Evaporation on a small scale. The following article by H. F. Grinstead describes in a brief manner the evaporation of fruit on a small scale:¹

Instead of the old method of sun drying, we use a portable evaporator. We have been successful with all kinds of fruit.

Our evaporator is constructed of wood except the bottom and firebox, which are of sheet iron. The evaporator proper is three feet wide by five long, is two feet high above the firebox or furnace, has a partition in the center with cleats nailed on the sides to support the trays, there being ten of these, five fitting in on either side of the partition. It has a rooflike cover and small holes for ventilation both above and below the trays. We set it on top of the furnace, the evaporation being accomplished by radiation from the sheet-iron surface. No pipes are run through the evaporator, the draft from the furnace being carried off by a few joints of common stovepipe on the outside. Two doors on the side of the evaporator admit the trays, which are two inches deep and constructed of wood, except the bottom, which is of half-inch-mesh galvanized wire netting. During the process of drying, the trays are shifted in such a way that the top tier is brought nearer the fire, the drying being finished in the

¹ Copyright by Doubleday, Page & Company.

lowest position. For best results I find that the fruit should not be spread too thickly on the trays — less than two inches — and should be stirred once or twice during evaporation.

We do not undertake to peel any considerable quantity of fruit with knives, but use a paring machine, which also slices the apples into rings. However, it is necessary to do some hand work, and for this we have short-bladed knives with smooth wood handles that will not cramp the hand.

While it does not improve the quality, the trade demands that apples should be white. The fruit is subjected to the fumes of burning sulphur as soon as pared and sliced, and before being put into the evaporator. Any tight box with cleats nailed to the sides into which the trays may be placed will answer, the sulphur being burned below. We do this by placing a few live coals in an old pot, adding a few sticks of brimstone at a time till the bleaching is done, which is in from thirty minutes to an hour. We use half a pound of sulphur to a hundred pounds of green fruit.

We burn wood, but coal will answer as well if the furnace is constructed for its use. In our small evaporator about five or six hours are required for drying, depending, of course, on the kind of fruit. Where a sufficient force is kept at work it is possible to make two runs a day. The fruit that is pared and sliced in the afternoon may be dried the next morning, but in the case of apples the bleaching must be done before they discolor.

The fruit will not have the hard, dry appearance of the sun-dried product, as more of the juice is retained, the outside being sufficiently seared to preserve it. You can tell when it is dry by squeezing some of it. If it is spongy and falls apart when released, it has dried sufficiently. Compare it with the commercial product: it should not be quite so dry when removed from the evaporator, as it has to be cured for several days before packing. We pour the fruit on a clean floor of a room from which flies are excluded, and turn it over every few days, that the whole may become more uniform, the drier pieces absorbing moisture from those containing a surplus.

It may not be amiss to state here that we use all apple and peach parings for vinegar. They are put in a clean barrel and sufficient rainwater added to cover them. In a few days fermentation has begun, and as soon as disintegration has commenced the liquid is strained off, poured into another barrel, and allowed to stand till it is vinegar.

Evaporation on a large scale.¹ There is an increasing demand for dried apples of the highest quality. The tendency has sometimes been to make quantity at the expense of quality, but prices are governed by the grade as well as by the supply. The cleanest, whitest fruit, well cored, well trimmed, well bleached, well ringed, and well dried, is most in demand. Carelessness in any particular injures the product.

¹ After *Farmers' Bulletin No. 291*, United States Department of Agriculture.

The economic usefulness of an apple evaporator is chiefly through its utilization of windfalls and the poorer grades of fruit which cannot be marketed to good advantage in a fresh state, and it is these grades that are most often evaporated. But the magnitude of the apple crop also greatly influences the grade of the evaporated product. In seasons of abundant crops and low prices for fresh fruit, large quantities of apples that would ordinarily be barreled are evaporated and the grade of stock produced is correspondingly improved. On the other hand, in years of scanty crops, when all

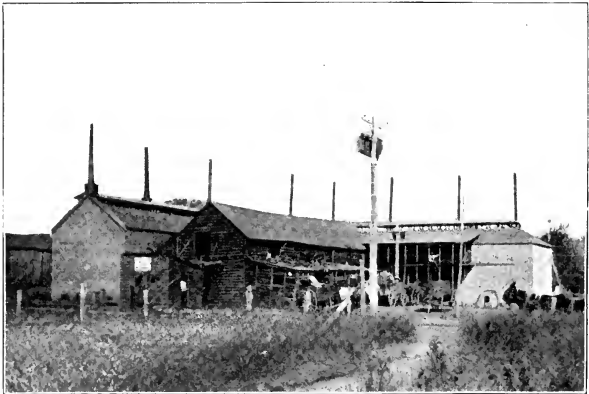


FIG. 160. Apple evaporator

A practical solution of bumper crops and culls. (Courtesy of *St. Joseph Fruit Grower*)

apples that can possibly be shipped are in demand at high prices, only the very poorest fruit is usually evaporated, thus lowering the grade of the output.

During the development of the industry the machinery and other appliances used have undergone great changes, until at the present time a high degree of perfection has been attained.

Apples suitable for evaporation. The commercial grading of evaporated apples is based primarily on appearance rather than on dessert quality, and the fact that one variety may make a better flavored product than another is not considered. As a rule, a

product of high commercial grade can be made from any sort which has a firm texture and bleaches to a satisfactory degree of whiteness. A variety of high dessert quality, such as the Northern Spy, may be expected to make an evaporated product of correspondingly high flavor.

In sections where the Baldwin apple is grown extensively, it is in demand at the commercial evaporators, as it meets the requirements in a fair degree and is available in relatively large quantities. In the Ben Davis sections that variety supplies a similar demand.

Most early varieties lack sufficient firmness of texture for the best results and are undesirable on this account. On the other

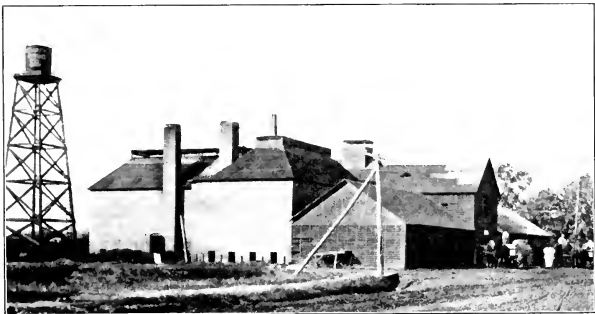


FIG. 161. An up-to-date evaporator

Evaporation and its application to apples is one of the profitable solutions to overproduction and wastes

hand, some comparatively early sorts, such as the Gravenstein and the Summer Pearmain, are considerably prized in some sections. The dessert quality of the latter is especially high.

Similarly, the product made from other sorts possesses qualities that are due more or less to varietal characteristics. For instance, that from the Esopus is said to be unusually white. The Hubbardston and varieties of the russet group also make very white stock, the latter giving a relatively large amount of stock, by weight, to a given quantity of fresh fruit. The Limbertwig is said to produce from $1\frac{1}{2}$ to 2 pounds a bushel more of dried stock than most sorts do, but it is not so white as that from some other varieties.

Paring. In power evaporating a long table common to all the parers is generally used. The necessary carriers for removing the apples and the parings operate beneath the table. If individual tables are used in such cases, a small sluice may connect each table with a carrier which works just beneath the floor, and delivers to an elevator that connects with the bleacher. By thus placing below the floor the carrier which takes the fruit from the tables, the space above is left unobstructed, which would not be the case were the individual tables connected with a common carrier. In nearly all the evaporators the paring and trimming are done by women and girls.

Trimming. In paring the fruit, there is usually more or less skin left around the stem and calyx of the apples and any irregular places that may occur. There will be wormholes, decayed spots, and other blemishes which will detract from the appearance of the product if allowed to remain. Even bruises are objected to by the most exacting operators. Hence all such defects are cut out as soon as the fruit is pared, if the highest grade of product is to be made. This is done with an ordinary straight-back, sharp-pointed knife having a blade about three inches long.

Bleaching. In order to make the fruit as white as possible, it is usually subjected to the fumes of burning sulphur. The apparatus in which the fumes are applied is called a bleacher. The form and manner of construction vary greatly, as do most of the other appliances. The requisites are a perfectly tight compartment having a capacity commensurate with the size of the evaporator and the necessary facilities for burning the sulphur.

Perhaps the most satisfactory bleacher for evaporators in which an engine is installed is the "power" (or "horizontal") type. Its characteristic feature is the movable bottom (or false bottom), on which the fruit is carried through the bleacher. This bleacher consists of a tight box about 3 feet square and 20 or more feet long.

The apples are conveyed from the paring room to the bleacher by a carrier or elevator, similar to those already referred to, and are dropped into one end of the bleacher, falling on the movable bottom, which consists of an endless belt of lugs turned by the proper gear attachment. The speed of movement is governed by the gearing, and is adjusted to correspond with the time it is

desired to keep the fruit in the bleacher and the length of the latter. When the fruit has been carried through the bleacher, it passes to the slicer, which is located near by; provision for the escape of the fumes may be supplied by ventilators above the operators. In the power bleacher, where in some cases it is more convenient to burn sulphur at some distance from the bleacher, a small sheet-iron stove about 1 foot square and 12 or 15 inches high is used; this is connected with the bleacher by means of a small stovepipe.

There are no definite standards as to the time required for bleaching, the amount of sulphur necessary to accomplish the desired end, etc. The aim is to treat the apples until enough of the fumes have been absorbed to prevent discoloration after they are sliced and exposed to the air. If it is found that the fruit is not retaining its clean, white appearance, either the length of time that the fruit is kept in the bleacher should be increased or more sulphur should be burned. In many cases the bleaching process is doubtless continued much longer than is necessary for the desired results. Until some definite standards are established and recognized, the greatest care should be exercised not to bleach more than the minimum required to maintain the desired color a reasonable length of time.

From the information at hand, it seems that the length of time necessary for bleaching varies from twenty minutes to an hour and a half, although it may be regulated in a measure by the amount of sulphur burned. The average time seems to be about forty-five minutes.

The estimates regarding the amount of sulphur used to bleach a ton of fruit vary from 4 or 5 to 20 pounds, though but little information of a definite character can be obtained at present.

Slicing. There are several styles of slicers now obtainable which are operated by hand, foot, or mechanical power. In general they consist of a table in which a series of knives is so arranged that the apples, when carried over them by a revolving arm, are cut into slices. In at least one type the apples are delivered to the slicing table by an attachment which works automatically.

The capacity of slicers varies somewhat, as does the industry of the men who operate them, but from 200 to 400 bushels for a day of ten hours may be expected of a good machine.

The slices are one-fourth inch thick, and should be cut, as far as possible, at right angles to the hole made through the axis of the apple when the core is removed by the parer, thus producing the "rings," which is the form most desired. Other things being equal, that fruit is sliced the best which contains the largest proportion of rings, and this point is given more or less weight in grading the finished product.

Quartering machines are used when it is desired to dry the fruit in quarters instead of in slices. When it is desired to evaporate apples in quarters or sixths, they are run through machines which cut them accordingly, the cutting being done in the opposite direction from the slicing; that is, in a direction parallel to the axis of the apple instead of at right angles to it.

If the apples are to be dried whole, they are transferred from the bleacher directly to the drying compartment without further treatment.

Crates and trays. Crates and trays are essential accessories in the drying. A relatively large supply facilitates the handling of the fruit both before and after it is pared, especially when there are no elevators or carriers to convey the fruit from one point in the evaporator to another. They are usually made to hold about a bushel. The bottoms, and preferably the sides also, of the crates in which the apples are bleached should be made of narrow slats to permit a free circulation of the sulphur fumes through the fruit.

Racks. In the construction of racks on which fruit is to be dried, only the best grades of galvanized-wire netting should be selected. If poorer grades are used, the acids of the fruit are likely to act on the metals, producing undesirable results.

When the fruit has been placed in the drying compartment of an evaporator, of whatever type it may be, it has reached the most critical stage in the whole process of evaporation, and it is here that the greatest care and skill are required to insure the best results.

Capacity of floor space and racks. In the case of kiln evaporators the sliced fruit is evenly spread on the floor to the depth of from 4 to 6 inches. A kiln 20 feet square will hold the slices of from 120 to 150 bushels of fresh fruit, depending upon the amount of waste in the apples and the exact depth to which they are spread on the floor.

If the fruit is in quarters or is dried whole, it may be spread somewhat deeper, since in these forms it does not pack down so closely as when in slices, and hence the circulation of hot air through it is not impeded if the depth is somewhat increased.

The fruit is generally put on the floor of the kiln as fast as it is sliced, and the fire is started in the furnace below as soon as the floor is filled, or, in many cases, before it is entirely covered.

Oiling the floors and racks. It is a common practice to treat the floor of a kiln with tallow to prevent the fruit from sticking to it. This is done every few days, or as often as conditions warrant. Sometimes a mixture of equal parts of tallow and boiled linseed oil is used for this purpose.

At each filling of the racks, where these are used, the surface of the wire netting is lightly wiped over with a cloth moistened in lard. This prevents the fruit from sticking to the netting and keeps it clean.

Turning the fruit. When kiln driers are used, the fruit is turned occasionally to prevent its burning or sticking to the floor by remaining in contact with it too long, and to insure the most uniform drying that is possible. The interval between turnings varies with different operators, with the condition of the fruit, and with the degree of heat maintained. For the first five or six hours it is generally turned about every two hours, and more frequently as the fruit becomes drier, until when nearly dry it may require turning every half hour.

The objects to be obtained by turning must be kept in mind. The fruit should be examined from time to time and turned often enough to prevent scorching or sticking and to insure uniform drying.

Heating apparatus. Satisfactory results are so dependent on the heating apparatus that this becomes one of the most important considerations with an evaporator. In the smaller types of evaporators, where comparatively little is involved and the question of fuel does not enter seriously into consideration, almost any small stove commensurate with the size of the particular evaporator in question may be used. In the kiln evaporators large furnaces are now most commonly used. These are specially designed for the purpose, and are provided with relatively large fire pots,

correspondingly large ash pits, and large radiating surfaces. As it is necessary to burn a relatively large quantity of fuel in a given time, the size of the grate is made with this end in view. For a kiln floor 20 feet square, or 400 square feet of surface, the grate surface is usually about 3 feet in diameter, containing from 5 to 7 square feet.

As to the most satisfactory length of pipe connecting the furnace and chimney, opinions differ. The furnace, with two flanges for attaching the pipe, is placed in the center; the pipe from each flange is then extended to the side of the room opposite the chimney, and from this point the two sections, extending in opposite directions, follow the wall, at a distance of 2 or 3 feet from it, to the chimney. In a kiln 20 feet square some 65 or 70 feet are thus required. Ten-inch pipe is a common size to use for this purpose, and is placed about 3 feet below the kiln floor.

In kiln evaporators the steam pipes are generally placed in as close proximity to the floor of the drying room as is practicable—within a foot or even closer. That every steam pipe nearest the floor may supply the greatest amount of heat, it should have its own return to the main return of the system.

One-inch pipe is generally used for such systems. No very definite data are available in regard to the amount necessary to supply the requisite heat. Several kilns, however, which are said to work admirably, have about 650 running feet of pipe for every 100 square feet of floor space. One half of this is "riser," the other half "return."

Fuel. For kiln evaporators using the common type of furnace, hard coal is probably the most satisfactory fuel, and requires less attention than any other. Coke is sometimes used, and if it were as satisfactory as coal, it would be the cheaper fuel; but it requires much attention, and even with the best of care it is difficult to maintain a uniform degree of heat. A combination of coal and coke is sometimes used with satisfactory results, in which case the faults and advantages of the one tend, in a measure, to equalize those of the other.

In a steam-heated plant soft coal serves the purpose in a satisfactory way, and in most apple-growing sections is probably cheaper than any other fuel that is readily available.

While the amount of fuel necessary to dry a given quantity of fruit will vary according to the conditions of the weather, the efficiency of the furnace, the construction of the kiln, the percentage of moisture to be left in the fruit, and various other things, it is roughly estimated that a ton of hard coal will make a ton of dried fruit. Probably the average requirement is more than this. Coke is a little more efficient, 2600 to 2700 pounds of apples being evaporated, it is claimed, by a ton of fuel.

A good steam system should require considerably less than a ton of soft coal to a ton of dried fruit, one estimate being about half this amount.

Temperature. A temperature which has been suggested by some operators is 150 degrees F. or more when the fruit is first put into the drying compartment, dropping to about 125 degrees as the drying process nears completion. Sufficient and proper provision for controlling the indraft of cold air below the fruit will aid in maintaining the desired temperature.

Time required for proper drying. A good kiln evaporator should dry a floor of slices in from ten to fourteen hours, twelve hours being the average time. Where the fruit is handled on racks the time required is much shorter, but the conditions are quite different, the fruit seldom being more than two inches thick on the racks; from four to six hours is the time required for slices.

It is estimated that quarters will require from eighteen to twenty-four hours in the average kiln, while the time for whole apples will range from thirty-six to forty-eight hours.

If the atmospheric conditions are heavy and damp the drying is retarded, and under some conditions it is almost impossible to dry the fruit thoroughly. During windy weather it is difficult to regulate the heat, especially if the walls are poorly constructed so that the draft of cold air into the furnace cannot be controlled.

How far to carry the drying. The fruit should be so dry that when a handful of slices is pressed together firmly into a ball, they will be springy enough to separate at once upon being released from the hand. In this condition, there will be no fruit, or only an occasional piece, that has any visible moisture on the surface. In a slice of average dryness, it should not be possible to press any

free juice into view in a freshly made cross section of it. The general feel of the fruit, as it is handled, should be soft, velvety, and leathery.

Curing room. When a quantity of fruit is considered dry enough, it is removed from the kiln and put in a pile on the floor of the curing room. Every day or two the pile should be thoroughly shoveled over to make the changes which take place uniform. Thus managed, the pile in a few days will become thoroughly homogeneous. The pieces that were too dry will have absorbed moisture, the superfluous moisture of other pieces will have disappeared, and the entire mass may be expected to reach the condition above described.

Waste. All waste, such as small apples, imperfect fruit, parings, and trimmings, in the large evaporators is generally used for vinegar stock.

It is generally estimated that the waste from a given quantity of evaporated apples will pay the cost of the fuel for evaporating that quantity of fruit; that is, putting it on a bushel basis, the waste from a bushel will pay for fuel to evaporate both the white fruit and the waste from that bushel. While in some instances, when the price of such stock is low, this estimate may be too high, it not infrequently happens that the waste more than pays for the fuel.

Proportion of evaporated fruit from a bushel of fresh apples.

An average weight of evaporated apples from a bushel of fresh fruit is about $6\frac{1}{2}$ pounds of white fruit and $3\frac{1}{2}$ pounds of waste. When dried whole, they will make from $7\frac{1}{2}$ to $8\frac{1}{2}$ pounds of evaporated fruit per bushel of fresh fruit.

Grading and packing. Evaporated apples should be graded as follows:

Fancy. This is very white, clean stock free from all pieces of skin and other objectionable portions, which should be removed in trimming, and with a good proportion of the slices in rings.

Choice. This denotes a grade intermediate between Fancy and Prime, not quite clean enough for Fancy, yet more nearly free from imperfections than the Prime grade demands.

Prime. This must be good stock, well cured, and of a generally attractive appearance. It must be comparatively white and shall

be quite free from undesirable portions, but stock having a small percentage of such defects is usually put in this grade.

Extra Fancy. As the name implies, this is a Fancy grade that is exceptionally fine. It must possess in a marked degree all the qualities mentioned in describing that grade. At least 85 per cent of the slices should be rings.

The side of the box intended for the face is packed first, as in the case of fresh fruit in boxes or barrels. The first step, therefore, is to face the top. The facers are slices which are perfect rings. These are usually selected from a quantity of fruit which contains a relatively large proportion of them; they are then placed on thin boards, the measure of which is slightly less than that of the inside of the top, overlapping one another in lengthwise rows. The facers are put in place by inserting the board on which they are arranged into the box, which is first lined with paraffin paper, and then with a dexterous movement of the hand flipping the layer of rings against the inner face or the bottom, which is to become the top of the box.

A press is generally used in filling the boxes. Three men compose a packing gang for each press: one to fill the boxes and weigh the fruit; one to operate the press; and the third to nail on the cover, which now becomes the bottom of the box.

In facing whole apples, they are placed on their side in rows lengthwise of the bottom (when packed, the top) of the box. The boxes are then filled the same as with slices. Quarters are handled in the same way.

Cartons are filled by hand, the work usually being done on a table of convenient height, and each package being weighed to insure the proper content of fruit.

The sun-dried fruit, of which quite large quantities are handled by some dealers, is usually packed in sugar barrels. This is largely exported. The waste is also generally put into barrels, about 240 or 250 pounds net being required for a barrel. Chops are handled in a similar manner.

The boxes used for the evaporated fruit are as follows:

For American trade a 50-pound wooden box, $10\frac{1}{2} \times 11 \times 22$ in. inside, and a 25-pound wooden box, $9 \times 9 \times 18\frac{1}{2}$ in. inside; for export trade a 55-pound wooden box, $11 \times 11\frac{3}{4} \times 22\frac{1}{2}$ in.,

marked "25 kilos," and 1-pound paper cartons, $2 \times 5 \times 7$ in., marked " $\frac{1}{2}$ kilo."

The cannery. A modern cannery under the present requirements is an up-to-date affair — no longer are rough, crude sheds considered fit places to can foodstuffs.

The requirements of a cannery are somewhat similar to those of an evaporator :

1. The location must be sanitary and away from objectionable manufacturing processes, such as soap making and tanning.

2. The water supply should be ample and pure, free from excessive hardness and iron, otherwise the finished product may be damaged.

3. The buildings should be designed to give the greatest efficiency, sanitation, and light. By efficiency is meant sufficient space, so arranged that every step of the work is progress. Sanitation means good, clean, tight floors, good sewage facilities, good ventilation, and, therefore, cleanliness.

4. There should be ample machinery, tables, steam, etc., so that rapid, economical, efficient work can be accomplished.

Canning. The steps in canning apples are simple:

1. The fruit should be of such varieties as cook well, — slightly acid, smooth, and sound, — and should be delivered in first-class condition fresh from the orchard and in a manner to prevent injury.

2. The fruit should be graded or sorted for quality. This may be done best by a few well-trained helpers.

3. The fruit is picked up and cut into pieces of the proper size, if so desired ; this may be done by hand or by machinery. The last work is that of coring the apple. Where machinery is used for peeling and coring, it may be necessary to have the fruit gone over last by the hand help to detect pieces of skin left near the calyx or stem, or bits of core.

4. The cans that are to be used should be thoroughly cleaned by washing. Machinery washing does this work very effectively.

5. The cans are now filled either by hand or by machinery. If by hand, the contents should be weighed rather than measured, so that the finished product will be uniform ; if by machinery, care should be taken to deliver the apples with the least possible amount

of crushing or injury. The fruit should be placed in cans at once or it will discolor. The amount of material used for each can should be all that can be put into it in first-class condition, with hot water added immediately to make the can full.

6. Sealing cans, such as open tops, by a special machine called a double seamer is practical in some canneries. The lid is pressed into place, and steel rollers crimp it on without acid or solder. This is all done at the rate of 30 cans a minute, or 1800 per hour. Cans with soldered tops are sealed by automatic machinery, 85 a minute and 5000 an hour. Such machinery will wipe the top of the can, place the cap on, apply the acid, solder and close the vent, all in one series of operation and without the hand touching any part of the can.

7. To test for leaks the cans are submerged in a bath of boiling water. A series of air bubbles issuing from the can indicates a defect.

8. Apples are processed about eight minutes at 212 degrees F. for No. 3 cans and about ten minutes for No. 10 cans. This processing consists of placing the cans in a vat or retort, sometimes submerging in boiling water, and then turning on steam for the required time.

9. After processing with water the cans should be cooled quickly. Unless this is done the processing may continue too long and overcook the contents.

10. The cans are stored away and later labeled, boxed, and shipped wherever required.

CHAPTER XXVIII

COÖPERATION

During the last few years much consideration has been given to the subject of coöperation. Producers are urged to coöperate, middlemen are forming organizations, and consumers have the "get together" spirit. There are many reasons for this tendency.

The producer receives only about a third of every dollar the consumer spends for food materials.

The consumer is constantly paying more for foodstuffs, but the farmer does not receive correspondingly higher prices.

The farmer pays from 8 to 12 per cent on borrowed money, while organized industries pay only from 4 to 6 per cent. Organization will materially increase the purchasing power of each dollar.

Apples are grown by the orchardist, but it is the middleman, not the grower, who sets the price on the apples. This is as absurd as it would be for a middleman to set the price on the product of an organized industry like the Standard Oil Company or the United States Steel Company.

The unorganized consumer is generally the one who pays the bills for the high cost of living.

There are many other reasons being brought forward in the attempt to make producers, consumers, and others coöperate. The old saying "In union there is strength" is still true.

How to coöperate. All apple-growers in a certain section should come together at a definite time and place and proceed to form a local organization. It is necessary to have some form of constitution and by-laws, and to elect officers, such as president, secretary, treasurer, and if a buying or selling organization, an agent or manager and a board of directors. An organization should be incorporated as soon as practicable after its formation.

The wording of the constitution and by-laws should be short, concise, and clear. The officers should be the broadest-minded,

most progressive members of the community. The manager should be the best man obtainable, regardless of the expense up to the limit of the association. An inefficient, poorly paid manager will do more harm and cost more in the end than a good man well paid and satisfied. The manager should have a broad view of the apple markets of the world and should be businesslike, keen, alert, forceful, and resourceful.

Relation of members to coöperation. The members should stand back of their officers, and particularly their manager, to the last man. This is very important if success is to be obtained. Each member should attend meetings and feel that the time to speak out is at the meetings and not afterwards.

Advertising. It is highly important that as soon as possible after organizing, a plan of systematic advertising be inaugurated. It is less expensive and more effective to advertise one unit, such as an organization, than to advertise a dozen or more individuals in a locality. The fruit has definite brand marks, probably not more than two or three for apples, although there may be several varieties for each brand. By advertising a particular brand, it soon becomes fixed on the market, and if the apples are of high grade, both dealers and consumers look for this particular brand when buying. This habit is especially noticeable in the case of various breakfast foods and other well-advertised products. The consumers are educated by systematic advertising to demand the particular brand. Apples may be as successfully brought before the public if organized, systematic advertising, backed up by quality, is undertaken.

Growers' and shippers' organizations. Organized primarily to obtain high prices in sales and low prices in purchases, the growers' and shippers' organizations formed in many places are working satisfactorily.

Spraying materials, such as copper sulphate, lime, sulphur, Paris green, arsenate of lead, and Black Leaf 40, all may be obtained at a lower price if the individuals of a community lump their orders in a local organization. A large order always demands a lower price, and the freight charges per hundredweight are less on a car lot than on individual orders. Spraying rigs, hose, baskets, boxes, barrels, ladders, labels, house foodstuffs, feed for stock, and

many other supplies may be more advantageously purchased by the organization than by individuals.

In a like manner, if the organization has the selling of all the fruit of the community, with its necessary uniform grading, packing, labeling, etc., it is able to distribute its produce more widely and more advantageously. If buyers come into a locality where there is a growers' and shippers' organization, it is possible for this organization to dictate the price which must be paid for the fruit. This is as it should be.

A good example of coöperative organization is found in the California Fruit Growers' Exchange, which practically controls the orange and lemon prices of its members' product. The Long Island Potato Exchange and the Long Island Cauliflower Exchange control to a marked degree the outgoing crops and the price received. The new organization known as the North Pacific Fruit Distributors is destined to be a potent factor in developing, managing, grading, packing, and selling the products of the great Northwest in the United States.

The success which the new central distributing body has met in arranging to deal with the storage question serves to illustrate the kind of encouragement and coöperation which the growers are receiving from the community at large. Very soon after the central body was organized, the trustees received offers of capital sufficient to construct all storage warehouses necessary to the efficient handling of the fruit crop of the Northwest. Steps toward popularizing the fruits grown in the Northwest for the purpose of increasing consumption are strongly urged by the growers, who are ready to set aside a fund for this purpose.

It is assured that selling agencies will be established or agents designated (probably the latter) in all the distributing centers in this country and abroad. It is felt that in handling fruit in large quantities through this kind of selling and distributing organization, the overhead charges will be greatly reduced and both the producer and the consumer will be benefited.

CHAPTER XXIX

COSTS, YIELDS, AND PROFITS

The cost of an acre of apple trees. Just what does it cost to grow an acre of apple trees to the age of twelve years? Estimates by practical growers vary from \$75.00 to \$150.00 or more each year, or from \$1000.00 to \$1550.00 for twelve years. It depends on many factors, such as the size of the orchard in which the acre

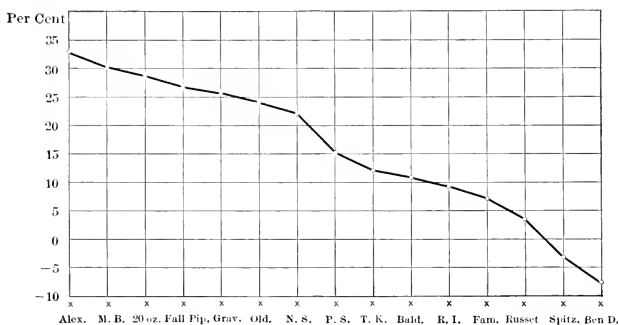


FIG. 162. Prices of apples on the New York market

Based on figures obtained by H. B. Knapp of Cornell University

Key to varieties: left to right, Alexander, Maiden Blush, Twenty Ounce, Fall Pippin, Gravenstein, Oldenburg, Northern Spy, Pound Sweet, Tompkins County King, Baldwin, Rhode Island Greening, Fameuse, Russet, Spitzenburg, Ben Davis

is contained, the cover crops, the number of sprayings, the kinds and cost of spraying rigs and materials, the amount, kind, and costs of the different fertilizer ingredients, the interest on the land, the necessary equipment, — such as horse, plows, harrows, pruning tools, ladder, and the like, — the efficiency and availability of the labor, and miscellaneous charges.

Average figures as to the cost to grow an orchard to twelve years of age, taken from yearly records of orchard management, are as follows :

	COST PER ACRE	
Starting the orchard	\$19.92 to	\$40.00
5 per cent interest on land valued at		
\$50 to \$100 an acre	30.00 to	60.00
Necessary equipment	58.80 to	75.00
Fertilizer	120.00 to	240.00
Spray material	31.20 to	42.00
Cover crops	36.00 to	60.00
Barrels	282.00 to	420.00
Labor	420.00 to	600.00
Overhead charges	9.60 to	15.00
Total	\$1007.52 to	\$1552.00

Cost of producing a barrel of apples. Mr. Roy D. Anthony of the Geneva Experiment Station has lately compiled some very interesting figures on the cost of growing a barrel of apples. These figures have been culled from the records of orchards which have been under the direction of the Geneva Experiment Station for from two to fourteen years. The results are as follows :

Fixed charges :

Interest	\$0.227
Taxes . . . . .	.02
Machinery . . . . .	.075
Buildings . . . . .	.03
Management . . . . .	.075

Materials :

Fertilizer . . . . .	.06
Spraying twice . . . . .	.05
Barrels . . . . .	.35
Cover-crop seed . . . . .	.03

Labor cost :

Pruning . . . . .	.045
Spraying twice . . . . .	.056
Applying fertilizer . . . . .	.015
Cultivation (plowing, hoeing, and the like) . . . . .	.094
Harvesting (including picking, grading, and packing) . . . . .	.025
Marketing (delivering at shipping point) . . . . .	.10

Summary:

Labor	\$0.56
Cost of materials . . . . .	.49
Fixed charges	<u>.42³/₄</u>
Total cost	\$1.47 ³ / ₄

The labor per acre is made up in the average orchard of 145 hours man's work and 55 hours horse work; in the better-managed orchard, of 195 hours man's work and 73 hours horse work.

It has been found that where better management is used, and where the total yield of apples per acre is above the average of sixty-six barrels, the total cost of producing is reduced from \$1.47³/₄ to as low as \$1.21 per barrel.

Cost of producing a bushel of apples. Taking into account the items necessary to the proper management, it is found that a bushel of apples on average trees can be produced for about 36 cents. The age and size of the tree will have much to do with this cost. This estimate is obtained from figures given above on the basis of a yield of about seventy or seventy-five barrels per acre. To summarize:

Interest	\$0.022
Necessary equipment . . . . .	.025
Spray material . . . . .	.013
Cover crops . . . . .	.005
Barrels . . . . .	.110
Labor . . . . .	.180
Overhead charges	<u>.005</u>
Total	\$0.360 per bushel

Cost of selling a bushel of apples. In New York the charges for selling a bushel of apples are as follows:

Railroad, from grower to New York City	\$0.10
Cartage, commission (10 per cent) . . . . .	.12
Retailer	<u>.50</u>
Total	\$0.72

Thus the grower receives from 15 to 50 cents per bushel.

In shipping from the West the following charges are made:

Association or agent	\$0.10
Railroad . . . . .	.50
Commission man . . . . .	.25
Retailer	<u>\$1.00 to 1.35</u>
	\$1.85 to \$2.20

In this case the grower obtains from \$1.15 to 80 cents per box.

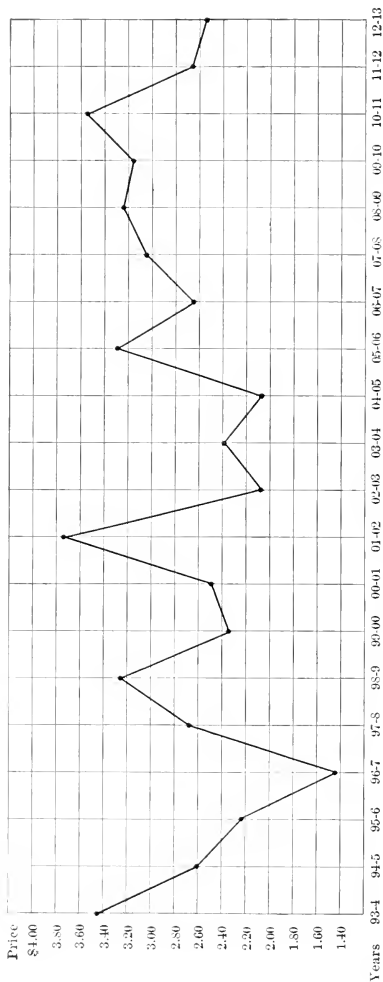


FIG. 163. Barrel prices by years for twenty years

Based on figures obtained by H. B. Knapp

Yields of apples.

Some instances of from 10 to 15 barrels of apples per tree have been reported by different orchardists. In such cases the trees are generally very large, and the crop may have been preceded by several years of short bearing. Few if any orchards are able under present systems of management to average such high yields.

In some years there is scarcely any apple crop, and the few apples that are produced are often not worth the cost of picking. However, the year preceding or following a poor year generally produces an abundant yield, although interference of frosts may modify this somewhat. Low yields are common with poor systems of management.

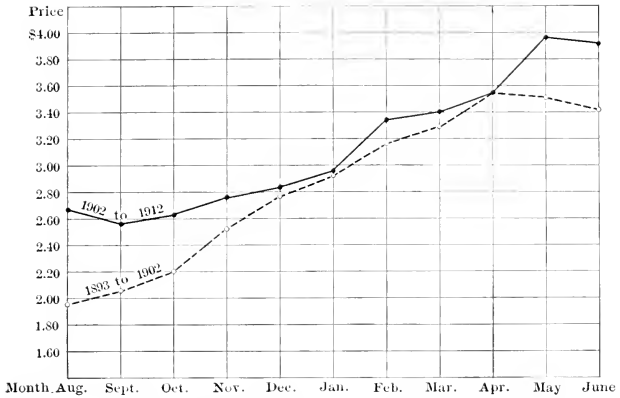


FIG. 164. Barrel prices by months for twenty years

Based on figures obtained by H. B. Knapp



FIG. 165. A fine country road

Good roads through the fruit section are essential in order to reduce the cost of marketing. A fine road at Hilton, New York, in the midst of the apple country. (Photograph by M. C. Burrett)

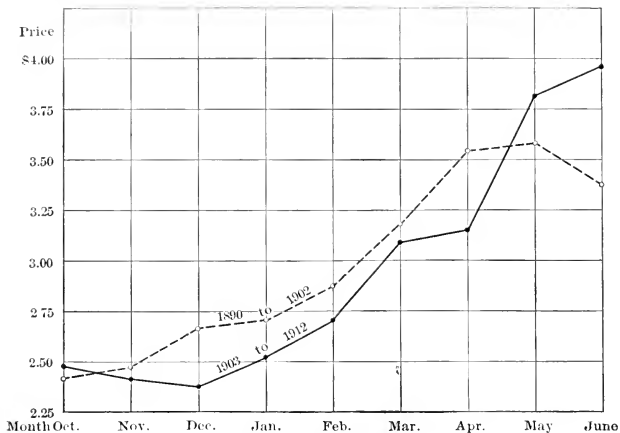


FIG. 166. Ben Davis

Based on figures obtained by H. B. Knapp

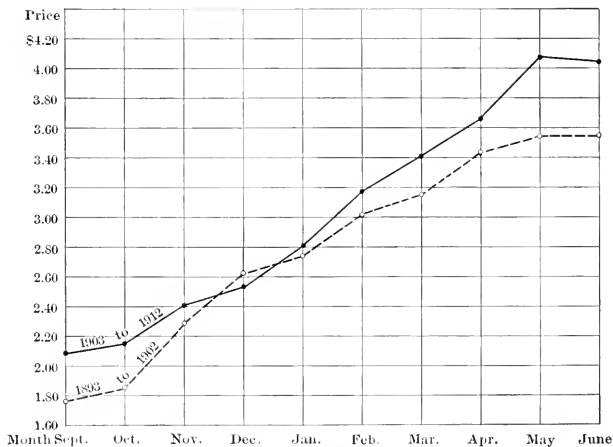


FIG. 167. Baldwin

Based on figures obtained by H. B. Knapp

AVERAGE YIELDS

For United States less than 1 bushel per tree.

For Missouri less than .7 bushel per tree.

For New York less than 2.2 bushels per tree.

For Illinois less than .3 bushel per tree.

For Pennsylvania less than 1.38 bushels per tree.

For Michigan less than 1.63 bushels per tree.

From 2 to 5 bushels per tree is a good average yield, and from 70 to 75 barrels per acre would be considered good.

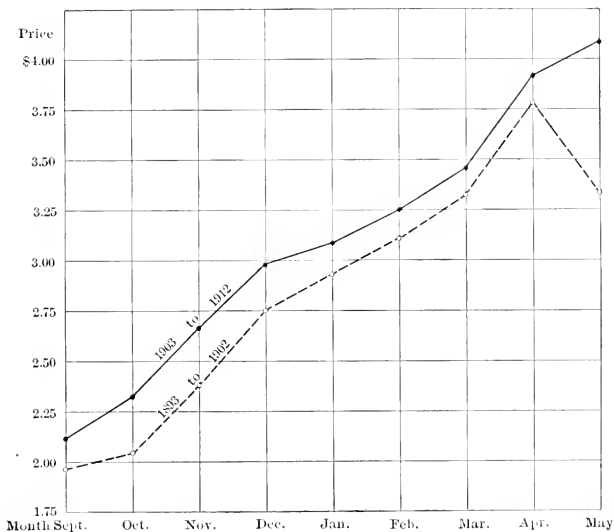


FIG. 168. Rhode Island Greening

Based on figures obtained by H. B. Knapp

Retail prices. The retail price of apples ranges from 5 cents each to 5 cents a quart. At 5 cents each, with 96 apples in a box, the price is \$4.80, about \$2.50 above the wholesale price of the box. At 5 cents a quart, with 88 quarts in a barrel, the price is \$4.40, which is about \$1.90 above the wholesale price of the barrel.

Wholesale prices. From \$1.25 to \$4.50 per barrel is paid for apples, according to the variety and to the quality, size, color, and other considerations. The time of purchase, whether early in the fall or late in the winter, and the conditions of purchase, whether in the orchard or delivered, also affect the price.

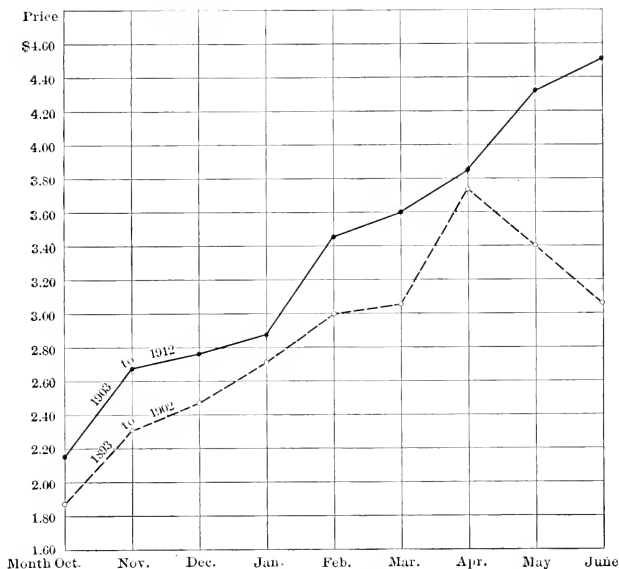


FIG. 169. Northern Spy

Based on figures obtained by H. B. Knapp

The price in boxes also varies in much the same way that the barrel stock does, although the variety and pack make the greatest difference. From \$1.00 to \$3.50 per box is received, sometimes more.

Profits. If a grower receives an average price of \$2.00 for ten years on his barrel crop and \$1.50 from his boxed fruit, he is getting fair returns.

Such high prices as from \$10.00 to \$12.00 for barrel stock and from \$5.00 to \$7.50 for box apples have at times been obtained, and, on the other hand, such low prices as from 75 cents and \$1.00 down for barrels and from 50 cents to \$1.00 or less for boxes, have prevailed.

From \$75.00 to \$100 per acre is a good profit to receive from an apple orchard. Some orchardists receive more, but the average return in the United States for fruit farms with trees of bearing age is \$27.93, or about 55 cents per tree, and this is gross, not net profit. The average return per fruit farm having trees of bearing age in New York State is \$49.11.

From \$250 to \$300 per acre is a very high profit to receive from an apple orchard. Few growers are able to reach this high figure. Still, it should be the goal of all commercial orchardists.

Take the yield (good) at 70 barrels per acre

Average price at \$2.50 per barrel	}	. . \$175.00
Cost of production at 36¢ per bushel		
Cost of selling wholesale at 22¢ per bushel		. . <u>111.65</u>
Net returns		\$63.35

CHAPTER XXX

GROWING APPLES FOR THE HOME

Many individuals have only enough land for a small garden or orchard. It is highly important that owners of small plots of less than an acre be encouraged to utilize these by planting fruit trees, especially the apple.

General advice. As a rule, in such cases there cannot be much of a choice of site for each apple tree. However, the planting being so small, the home grower can improve a poor site by drainage or irrigation, or some other means.

Trees should be purchased from reliable nurserymen or through reliable seed houses, and should measure up to the standards of first-class trees given in Chapter IV. Before planting, see that the roots are clean and the ends cut smoothly. Dig a hole large enough for the roots to lie in their natural position. It is generally best to have the soil at the bottom of the hole slightly loose for an inch or two. Place the tree in the hole, having it stand perhaps slightly deeper than it stood in the nursery. This depth may be easily ascertained by inspection of the trunk just above the roots, where a slight ring of dirt or discolored matter will be seen.

The soil should be firmed about the roots; first, the fine topsoil should be thoroughly worked in among the roots by the use of the hand and fingers, then the remainder of the topsoil should be trodden down by foot pressure after each two or three shovelfuls. Finally, the subsoil should be thrown in and trodden down until the hole is filled. The last two or three shovelfuls may be spread loosely over the soil near the tree and left in this condition to serve as a mulch to help conserve the moisture that is in the soil. Sometimes on sandy or gravelly soil, especially if it is comparatively dry, several buckets of water may be used to advantage.

The top of the tree should be cut back in order to give the tree balance. Leave three limbs with three buds on each, the topmost

or highest bud being on the underside of the limb. Sometimes five short stubs are left, and some men prefer to cut the whole top off, leaving nothing but a whip. However, for the inexperienced person three is quite safe and satisfactory.

When it comes to pruning, do not lose heart because it is necessary to remove so much of the tree. Remember that you must be fair to both parts of the tree, *so cut back the head*.



FIG. 170. The home road

Utilization of space at the sides of roads by planting apple trees is both remunerative and beautifying

Spring planting is generally preferred by the home gardener. It is the season of the year when almost everyone turns to nature and attempts the raising of some form of plant or animal life.

It is generally difficult to cultivate much in the home orchard because many times the location or soil condition is poor. However, when possible it should be done. Perhaps where the orchard cannot be cultivated, a mulch of weeds, leaves, straw, or other material may be used. If the tree is planted in the lawn, then no cultivation or mulch can be given. In the latter case, some attention to watering during the dry period should be given, remembering that a large amount of water at long intervals is better than a small amount more often.

Insects and diseases. The trees should be watched for insects and diseases, and if any are discovered, some treatment should be given. If the insect is seen eating the leaves, destroy the pest by putting poison on the leaves. If the leaves or other parts of the tree show any of the changes mentioned in Chapter XIX, apply the remedy prescribed for that particular disease. If other troubles

develop and it is impossible to diagnose them, write a full description and send a sample of the pest to your state experiment station or to the United States Department of Agriculture at Washington.

Pruning. Trees should be properly pruned. It is possible, if pruning begins when the tree is young, never to remove any wood larger than half an inch in diameter. However, most men, even experienced orchardists, cannot always foretell the growth and other changes that passing years will make, and it is sometimes necessary to remove larger limbs.

In pruning keep the tree low with a moderately



FIG. 171. Good products of the home

Young apple tree headed low, growing on the sands of central Long Island. (Courtesy of H. B. Fullerton)

rounded top, thus making the breadth of the top (where the limbs and twigs are) greater than the height of the tree. Do not allow the limbs to cross each other and rub, or to grow back into the tree, or to become too numerous. Keep the head of the tree somewhat open to admit sunlight. Sometimes one side of the tree grows faster than the other. Try to encourage the weaker side by pruning back the stronger. In other words, keep the tree symmetrical, well balanced, low, and open, and encourage correct growth.

Fertilizers. Fertilizers may be applied to the soil around the tree, care being taken to apply the material out under the spread of the branches (or even further), where the young feeding roots are, and not close to the trunk. Use small amounts at first, then larger quantities to correspond with the increase in size of the tree, following the suggestions on fertilization in Chapter XII.

Picking the fruit. Harvesting the fruit may be extended over quite a long period, especially if the apples are picked for immediate consumption. A pole-basket picker may be used to advantage on the old high-headed trees, while on the lower-headed trees, picking may be done by hand. To get within reach of the fruit one may use chairs, tables, stepladders, or regular ladders — anything that will bridge the space.

In picking or handling it is important to remember that apples are tender and will not stand rough treatment, such as pouring them out of a basket into a barrel and allowing them to drop several feet. Treat them sensibly and they will keep longer, look better, and be more satisfactory in every way.

Miscellaneous advice. Where the purchaser or owner of a small lot has one or two trees that have been neglected, he may renovate and make them profitable if he will give the necessary time and attention to them. Detailed information for renovating old trees or neglected orchards will be found in the next chapter. Special varieties for the home will also be treated in a later chapter.

CHAPTER XXXI

RENOVATING NEGLECTED ORCHARDS

In all the older apple-growing regions vast numbers of trees both old and young have fallen into neglect for various causes, such as lack of proper management, lack of interest, carelessness, diseases, and insect pests. Many such trees can be brought back to a yielding basis if intelligence is applied to the problem.

Many of the older trees are very tall (often 35 feet or more), which is probably due somewhat to the high-headed nursery stock commonly used in earlier plantings and also to the close planting practiced years ago. In some cases the trees are covered with moss, lichens, and old dead bark, probably harboring countless insects and persistent diseases. Frequently there is an overabundance of woody growth on the tree, and often shrubs, small trees, weeds, etc. surround the trees. In fact, conditions for fruit production are at their worst.

Is renovation practicable? Many factors must be considered before this question can be answered satisfactorily.

1. *Varieties.* If the orchard is largely made up of undesirable varieties, it may be best to leave it entirely alone, especially if the trees are old, high-headed, long-armed specimens. To graft over such trees would be a long, tedious, expensive job. In younger orchards it might be better to correct the variety by top-grafting. Where the larger part of the orchard is made up of a desirable variety such as the Baldwin, it may be advantageous to mix varieties somewhat by top-grafting, in order to insure proper pollination and prevent self-sterilization.

2. *Location.* Where the location or exposure of the orchard is poor, it may not be worth while to bother with renovation. Orchards on low lands, where they are likely to be injured by late spring frosts, may not be worth attention, and southern exposures, where sunscald and other troubles abound, may not be favorable. Cold,

springy hillsides which warm up in the late spring are not very desirable, but may be improved by proper drainage, whether of the tile, open-ditch, or other form of construction.

Orchards located on high ground, which are well protected from prevailing winds and do not show such disadvantages as frost pockets and poor drainage, are more satisfactory to renovate.

3. *Soil.* Where the character of the soil is a sandy or gravelly loam, the chances for success are much better than where the orchard is located on either a heavy clay or a light sand soil. A good clay loam is not very objectionable. The test is the thrift of the tree. Apple trees are known to thrive on a great diversity of soils if they are well drained and well managed; therefore, if the trees show signs of thriftiness, it will usually be worth while to renovate if other conditions are favorable.

4. *Age and vigor of the trees.* Apple trees exceeding thirty or forty years of age usually lack vigor and are seldom worth

renovating. Trees that have been robbed of their vigor by such enemies as the San José scale, that have been repeatedly defoliated by leaf-eating insects, or that have many decayed spots or dead limbs caused by a fungus, would probably not pay for the expense of renovation.

5. *Vacancies in orchard.* Where there are many vacancies in an orchard, that is, in orchards where less than 60 per cent of the trees remain, it will not pay to renovate. However, in some orchards the trees are so closely planted that it becomes necessary to remove a number of them. Under such circumstances a

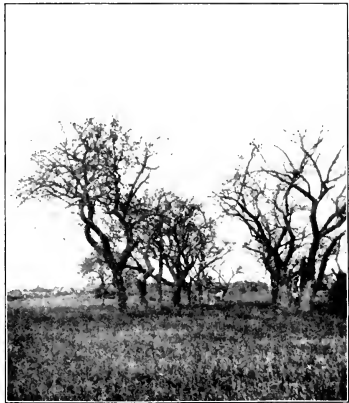


FIG. 172. Typical old high-headed New England apple trees

These trees are too high to renovate profitably

vacant space here and there might prove to be an advantage. It has not been found to be satisfactory to start young trees in an old orchard, nor has it proved profitable to grow other crops in the vacant spaces. Where the orchard is very small or along the roadside, vacancies may be filled or ignored, as is most convenient.

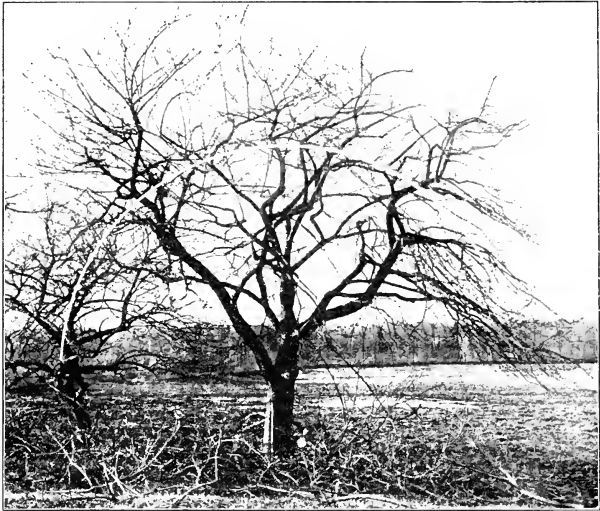


FIG. 173. Renovating a tree

A large amount of useless wood has been cut away from this neglected tree. Still more should be removed, as indicated by the arc

6. *Shape and position of head of tree.* Years ago high-headed nursery stock was commonly used, and the close planting of the trees had a tendency to make them still higher. On account of the difficulty of spraying high-headed trees and the added expense in harvesting the fruit, it is not advisable to undertake the improvement of an orchard composed chiefly of such trees. Provided, however, the trees are not too old, good results may be expected from the renovation of moderately high-headed and long-armed trees by severely heading in.

7. *San José scale*. Where the San José scale has become prevalent, it will be found difficult to control, especially on old trees. Unless the grower has had experience in fighting the scale and has unusual perseverance and determination, it may be unwise to renovate a scale-infested orchard. By scraping off the loose bark, de-horning or severely cutting back the branches, and by conscientious,



FIG. 174. A good type of tree to renovate

This is especially true if the variety is poor. It would be a paying proposition to top-graft such trees

thorough, repeated spraying, success can be attained. The work is expensive, discouraging, and dirty.

8. *The orchardist*. The most important factor of all is the orchardist. Is he determined, conscientious, thorough? Will he give the trees the best treatment through a series of years? Does he like orchard work? Not all men have a taste for fruit-growing. Not all men are successful orchardists. Has he the earmarks of a true orchardist? Will he make it pay? These are only a few of the questions which each orchardist should ask himself.

Method of procedure. It is impossible to lay down hard-and-fast rules to be followed in all cases of orchard renovation. No two orchards are just alike, therefore each may require special treatment. The best results will come from giving the best treatment in every respect. It would, indeed, be a very short-sighted policy to allow the apples to be disfigured by disease or consumed by insects after going to the expense of thoroughly pruning, fertilizing, and cultivating.

Orchard renovation is necessarily a rejuvenating process, and the treatment, with some modifications, is the same as that required for a young orchard. The trees, after being stimulated into activity, are maintained in a healthy condition only by regular methods of tillage, fertilizing, pruning, spraying, and the like.

Diagnosis. The first step is to look the orchard over thoroughly and outline on paper just what should be done in order to put it into proper condition, at the same time keeping in mind the question, Will it pay?

If it is decided that the orchard is worth renovating, the trees should be given a general awakening by pruning the limbs, by the addition of plant food, by breaking up and tilling the soil, by spraying, and by other means. The severity of treatment will depend largely on the condition of the trees. The index to the health of a tree is the amount of annual growth, which is from 6 to 18 inches with a normal tree. The spurlike growth usually observed on neglected trees denotes a lack of vigor. When the annual growth at the ends of the twigs is small, or not more than 2 inches, the treatment should be more severe in every way than when the yearly growth exceeds this amount.

Thinning the orchard. In many orchards or even among the few trees near a farmhouse the trees are often planted too closely. In most cases they have begun to crowd and grow upwards, or if this is not the case they lack vigor. If these trees are rejuvenated they will soon require more room. For the smaller-growing varieties probably from 25 to 30 feet will suffice, but the larger-growing sorts, such as the Spy, the Baldwin, the Rhode Island Greening, and the like, will very soon require at least 40 feet between trees. If the spacing is found to be insufficient, some of the trees will have to be removed. It is best to follow some definite or regular

order in removing these trees, so as to retain the general shape of the orchard.

Where trees are planted in squares, as is commonly the case in the East, every alternate tree in the row may be removed. If the first tree of the first row is retained, the first tree of the second row should be removed. This is done by taking out every second row diagonally, which leaves the rows cornerwise of the orchard. For instance, if the squares between the trees were originally 25×25 ft., they would now be 35.3×35.3 ft.; if originally they were 30×30 ft., they would now be 42.4×42.4 ft. It does not follow, therefore, as is commonly supposed, that by removing half the trees they will be twice as far apart as before.

In order to make sure that the diagonal rows removed are those containing the largest possible number of vacancies and inferior trees, it is well to draw a diagram of the orchard, designating all desirable trees by a certain sign, all weak trees and trees of undesirable varieties by another sign, and all vacancies by another. Whether one should start by removing the first diagonal row or the second may readily be determined by referring to the diagram.

An investigation by the Cornell Experiment Station shows that, within certain limits, the more trees per acre the less the yield. The figures are based on the records of hundreds of orchards and cover a period of four years.

Not over 30×30 ft.	186 bushels per acre
31×31 to 35×35 ft.	222 bushels per acre
36×36 to 40×40 ft.	229 bushels per acre

Pruning. The next operation will be that of pruning, provided the trees are of suitable varieties and are not to be top-grafted.

The trees that are very tall may be greatly improved by cutting back the highest branches. A tree that is 30 feet or over in height may often be shortened 10 or 15 feet, and one between 25 and 30 feet may be cut back to about 15 or 20 feet. The horizontal branches, as well as the upright ones, may be cut back to advantage, especially with trees seriously lacking in vitality, and also those infested with scale. In heading back the upright branches the cut is usually made just above a side branch that points outward. This tends to make the tree more spreading. With trees

that are naturally spreading and in cases where a more upright growth is desired, the cutting may be done just beyond an upright side branch. If this method is followed with all horizontal branches, a much stronger structure will be the result.

The severity of heading in will depend largely on the vigor of the tree. Nothing will start a tree into renewed growth like severe pruning during the dormant season. The cutting back, therefore, should be more severe with weakened trees. With moderately



FIG. 175. Expensive renovation

Trees very tall and therefore expensive to renovate. Often the purchaser of a farm practices renovating the old trees in order to have fruit immediately, at the same time planting young trees for the future

vigorous trees there is danger of producing a rank growth in the form of water sprouts. If it is desirable to head back such trees thoroughly, it is better to do it gradually, a little each year, and withhold all nitrogenous fertilizers. A still better plan is to remove about half of the required amount of brush during the winter and the remainder during the growing season. Summer pruning produces just the opposite effect of winter pruning on the vigor of the tree, and will counteract the stimulating effect of the latter. With many neglected orchards, however, the vitality is so low that most of the pruning may be done without fear of injury during a single dormant season.

The severity of cutting back will also depend upon the presence of scale. The work of spraying is greatly simplified, and the chances for success in controlling the scale are greatly enhanced, by extreme methods of pruning.

After the trees have been sufficiently headed in, all dead and diseased branches should be removed, and also such other branches as are necessary to produce a condition favorable to the free circulation of air and the admission of sunlight. While it is possible (especially with the best of neglected orchards) to overdo the pruning process, the average man is more likely to err in the other direction.

What to do with wounds. As a rule all the cuts made by pruning should be smooth and as close to the tree as practicable. The small wounds heal over very quickly and therefore do not need any attention. Large wounds of about one inch or more in diameter need some protective substance applied to them. After the larger wounds have dried it is a good practice to cover them with a coat of paint in order to exclude wood-decaying fungi. A combination of white lead and linseed oil is a good one for this purpose. If the white is objectionable, lampblack or other coloring matter may be mixed with the white lead and oil to make the spots less conspicuous. On very large cuts annual painting may be necessary.

Scraping. Where the San José scale is common or where the trees are barkbound, scraping is to be recommended. This means removing the loose bark scales from the tree; it does not mean skinning the tree. An old hoe or a three-cornered scraper may be used. A rainy or moist day is best for the operation, for the loose bark is then removed more easily. Begin at the highest point to be scraped and work down. *Do not dig in.* Collect the scrapings and destroy them, as they may contain insects or diseases.

Cavity work. Where decayed spots are found in the tree it may be best to dig out the decayed wood with a chisel or gouge. The live wood should then be treated with a weak, copper-sulphate solution, and a mixture of cement and sand filled into the hole. The cement mixture may be retained by driving nails inside the cavity, or by using wire screening or pieces of steel lathing fastened inside the cavity. The surface of the cement mixture should be smooth and rounded, being lower near the edges to permit the bark to grow over it.

In some cases it may pay to fill very large cavities, but not often. The cement mixture should include gravel and possibly large stones when such cavities are to be treated.

Bracing. Generally a tree that requires bracing is of little value. However, bracing is advisable sometimes. Where there is an opposite pull between two branches the bracing is simple. Two eyebolts with a ring through the eyes will do. Bore holes through each limb in the same plane. Insert the ends of the bolts in these holes ; place washers on the bolts, and screw the nuts until tight.

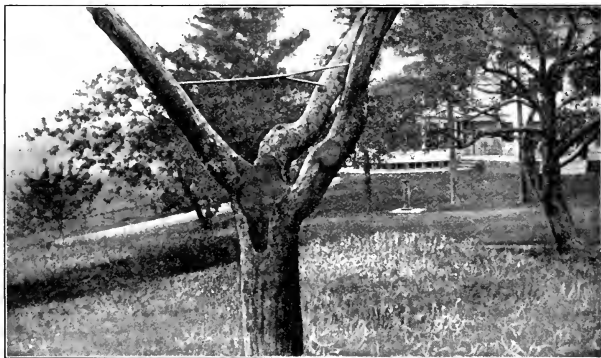


FIG. 176. Tree surgery and tree bracing

A practical feature where trees are used both for fruit and for ornament

In the case of a three-limb brace another bolt and perhaps two or more may be placed on the iron ring. However, a balance must be found between the branches. Where long stretches are made between limbs, shorter bolts and chains may be used in place of the ring and larger bolts. Other methods of bracing may be employed to suit conditions.

Soil. While under some special conditions an orchard may be renovated without breaking up the sod, the average orchard can be most effectively revived by thorough cultivation. As with pruning, the severity of the treatment is largely dependent on the condition of the trees. In the most extreme cases of neglect

the proper treatment would be severe pruning, thorough cultivation, and liberal feeding, but the severity of each operation should be modified in accordance with the vitality of the trees. In some cases it may be advisable to do the pruning the first year and leave the cultivating and fertilizing till the second year, or to do the pruning and cultivating the first year and leave the fertilizing till the second year. The important point of the whole matter is to avoid seriously disturbing the trees.

Plowing and harrowing. When advisable to cultivate, the plowing should begin as early in the spring as practicable. The sod should be plowed under, and the soil cut up with a disk harrow. The spike-tooth, spring-tooth, Acme, or some other similar harrow should then be used. Cultivation should continue throughout the spring and early summer. Between the first and the fifteenth of July cultivation should be stopped and a cover crop sowed.

The plowing should not be too deep at first, for, as previously noted, the roots in a sod orchard are very near the surface. If good general treatment is given, however, the breaking up of some of the roots will not seriously injure the trees; on the contrary it may tend to offset the possible stimulating effect of excessive pruning and feeding during the first season. The harrowing is best done soon after a rain, so as to keep a loose soil mulch on the surface of the ground and thus prevent excessive evaporation. The soil should not be worked while wet, for this will injure its physical condition.

Under favorable conditions, such as thin sod or sandy soil, the sod may be subdued by using a cutaway disk harrow without the need of plowing. Some orchards cannot be plowed, and some owners do not wish to plow them, in which cases hogs may be turned out and allowed to root at will. By burying corn seed in the soil or by digging up the soil in different parts of the orchard, they will soon learn to plow the orchard thoroughly.

Dynamiting. Dynamite is sometimes employed to break up the soil in an old orchard, but it should not be used too close to the trees nor in too large quantities. Under some conditions it may be the best means of bringing the soil into a usable state.

Fertilizers. Fertilizers are needed because, as already explained, the soils in most abandoned orchards are depleted by exhaustive cropping. It is well to remember that nitrogenous fertilizers, like

sodium nitrate, ammonium sulphate, dried blood, etc. produce a vigorous growth and should be used only where rapid wood growth is desired. The production of too much wood results in a soft, succulent growth that will not ripen up well in the fall, and is likely to be injured by winter freezing. As a rule it is not safe to apply nitrogenous fertilizers during the first season of the renovating process, except in some such form as raw ground bone that will become available very slowly.

Stable manure. Stable manure is not suitable, for the reason that it contains a large proportion of nitrogenous material, and applications carrying the required amount of mineral elements would furnish an excess of nitrogen. If it should be necessary to use stable manure during the first season of renovation, it should not be applied in large quantities, and its use should be accompanied by a quick-growing cover crop to utilize the surplus nitrogen in the fall.

Potash and phosphoric acid. While it is seldom necessary or expedient to apply nitrogenous fertilizers, it is usually advisable to give a liberal feeding of potash and phosphoric acid. Hardwood ashes, when they can be obtained and when their composition is known to be up to standard, are suitable for orchard use. They contain about 5 per cent of potash, from 30 to 40 per cent of lime, and a small amount of phosphoric acid. Potash may be obtained in the form of muriate or sulphate of potash. Where immediate results are required, a readily available form of phosphoric acid, such as acid phosphate, will give best results. For subsequent use, however, one of the slower dissolving forms, such as raw ground bone, may be more economically applied.

Applications. In the renovation of an apple orchard the following formula is suggested for the first year :

	POUNDS PER ACRE
Muriate or sulphate of potash	200
Acid phosphate	300
Raw ground bone	400

When the phosphoric acid in the raw bone becomes available, the amount of acid phosphate may be reduced one half the second season and omitted entirely the third and subsequent years. In view of the beneficial effect of lime on most soils, 400 pounds of

basic slag, which contains a large proportion of lime, may be substituted occasionally for the raw ground bone. Free lime, or fertilizers containing lime, like basic slag and wood ashes, should not be used with acid phosphate, for the reason that lime renders it insoluble. Good results in orchard renovation have followed the use of 200 pounds of muriate of potash and 400 pounds of basic slag per acre. The quantities of the various materials required for single, full-grown trees may be determined by dividing the given amounts by 30.

Commercial fertilizers are best applied after plowing, when they should be thoroughly worked into the soil by disking. It is important to get them into the soil just as growth is commencing in the spring.

Cover crops. From the standpoint of orchard renovation the use of cover crops is probably of greatest importance in utilizing the surplus plant food and moisture in the fall. This checks the growth of the trees, and thus sends them into the winter in a well-ripened condition; otherwise the stimulating effect of pruning, fertilizing, and cultivating may prolong the growth of the trees into the fall.

Some cover crops meet all the general requirements of the orchard,¹ but for the renovated orchard the legume group — vetches, clovers, cowpeas, and soy beans — are best. In some particular cases where these have failed or seem to be impracticable, rye, turnips, buckwheat, or the like, may be substituted.

These cover crops are generally plowed under in the spring, but if the trees, after a few years, are making satisfactory growth and if the crop is hardy, it may be well occasionally to allow it to remain during the summer. If this is done, it should be prevented from going to seed by mowing it regularly and leaving it where it falls, to form a mulch.

Orchards poorly situated. There are few orchards in which a thorough system of up-to-date management cannot be employed. Occasionally an orchard is found on comparatively heavy soil and so situated that if kept under cultivation the soil would probably wash badly. Washing may often be prevented by terracing, which consists in leaving a narrow strip of sod along the rows, or between the rows, and cultivating the rest of the ground.

¹ See Chapter XI.

While better results may usually be obtained from the tilled orchard, it is also possible to produce satisfactory results from some systems of sod treatment, and those orchards that cannot be conveniently cultivated may be made highly remunerative by liberal feeding and mulching. In such cases the feeding should be such as will produce a strong growth of herbage, which when cut will form an effective mulch and thus prevent the loss of moisture. The liberal application of stable manure, supplemented with muriate of potash and acid phosphate, would be a good start toward bringing a neglected orchard into a thrifty condition under sod treatment.

Spraying. Spraying is absolutely necessary for success. Where the San José scale is present or diseases are common, winter spraying should be given. Lime-sulphur or miscible oils should be used, according to the complete directions given in Chapter XX. It is a decided advantage to have the trees scraped and pruned before spraying. It saves labor, material, and makes better work possible. Thoroughness is the all-important watchword.

The summer spray should follow the winter work. The system spoken of in Chapter XX should be followed carefully. In the neglected orchard spraying will be less effectual the first season, the reason being that the trees are so thoroughly infested with various kinds of diseases and insects that one season's work cannot remedy them all. More careful and persistent work is therefore necessary.

Grafting. Probably in most orchards to be renovated there are trees of the variety which is of questionable value. If these trees are desirable in other respects they can be top-grafted to marketable sorts. Occasionally it is advantageous to top-graft some trees to insure proper pollination, this being especially true when there are solid blocks of sterile varieties or weak fertile varieties.

Cleft-grafting is the most common method, although some growers practice whip-grafting. The process of grafting is described in Chapter XXXII.

When to graft. Top-grafting is always done during the dormant season. The work may be commenced just before the buds swell in the spring and continue, if necessary, for four or five weeks. If the season must be prolonged, it is better to begin earlier rather than to continue later than the time mentioned.

What to graft. With trees that are extremely weak the whole top may be removed and grafted in one season. In most cases, however, it is better to remove only those branches required for grafting, or those that will form the new top. The remainder may be removed the following season. The chief objection to this practice is the danger of injuring the young grafts when the brush is eventually removed.

Care should be exercised in the distribution of the stubs to form a well-shaped tree. It should be remembered that the young grafts



FIG. 177. Top-grafting

An orchard at Clyde, New York, top-grafted

always grow upward, and for this reason one stub should not be located beneath another. Stubs between 1 and 2 inches in diameter are most suitable for grafting. Those larger than this seldom heal over completely.

The after-treatment. If the grafts make a very rank growth the first season, they should be pinched back to prevent injury from strong winds. If both grafts grow, one should be sawed off about the middle of the summer. In the following spring if the grafts have not been treated during the previous summer, they should be cut back about half their length to induce a spreading habit. The pruning of a graft will require some care and should not differ much from the pruning of a young tree. The limbs of the old

variety left from the previous season may be removed in March or April. In order to get them cut without injuring any of the grafts, it may be necessary to cut them up into several pieces. If there are more grafts than are necessary to produce a good top, as is likely to be the case, they may be removed at the same time as the brush.

Summary. The whole scheme of renovating may be summed up in a few words. Good business principles applied to a young or moderately old neglected orchard may result in profitable returns. A good system of orchard management thoroughly applied will develop wonders from neglected, sound apple trees.

Examples of successful renovation. Many examples of successful orchard renovation might be cited, but two or three will be sufficient to illustrate just how much may be done in certain cases. The factors just discussed, particularly the personal element, have influenced, to a marked degree, the success in each case.

Dr. F. H. Lattin, a practicing physician, has been very successful in his work of renovation. According to him the four great factors in the successful growing of apples are pruning, tilling, spraying, and fertilizing. The more attention is given to each of these, the better are the results.

In order to give weight to what he considers the proper management of orchards and to add assurance that his conclusions are not based on assumption, guesswork, or hypothesis, we give here results from several Orleans County (New York) orchards which have come under Dr. Lattin's care for a period of five years. These orchards, as a rule, had not previously been recognized as desirable ones, mainly because the owners were poor managers.

Orchard No. 1 contains 100 trees, set in 1876, of the following varieties: 30 Baldwin, 40 Hubbardston, 7 King, 12 fall varieties, and 11 assorted winter varieties. Dr. Lattin purchased this orchard in the spring of 1903. It had previously received fairly good care and was recognized locally as a good orchard. Pruning in previous years had been insufficiently but intelligently performed. The orchard had been cropped annually since planting. Annual applications of barnyard manure had been given it. Spraying had been neglected. The yield of fruit for the previous five

years had been about 100 barrels annually. Since 1903 the annual yield has been as follows :

YEAR	YIELD	YEAR	YIELD	YEAR	YIELD
1903	287 barrels	1906	323 barrels	1909	353 barrels
1904	460 barrels	1907	340 barrels	1910	235 barrels
1905	206 barrels	1908	335 barrels	1911	494 barrels

This gives a nine-year average of 337 barrels, and the annual receipts have averaged \$758.36. In 1907 the fruit on the 40 Hubbardston trees, a single acre, was sold from the orchard for \$800.00, and in 1911 the yield from the same trees exceeded 1000 bushels.

Orchard No. 2 contains 200 trees, about fifty years old, of the following varieties : 60 Baldwin, 60 Roxbury, 30 Rhode Island Greening, 10 Tompkins King, 10 Tolman, 5 Northern Spy, 15 fall varieties, and 10 assorted winter varieties. This orchard also came under Dr. Lattin's care in the spring of 1903, and had previously received fairly good care. The orchard was recognized locally as only a fair one ; the soil varied from a light sand to a clay loam ; at least 25 per cent of the original planting had been killed from lack of proper drainage. For several years previous the returns from this orchard had averaged about \$300.00 per annum ; that is, when fruit was cheap the crop was such that the gross returns were about that amount, and when fruit was high the returns were about the same. The fruit of this orchard harvested or marketed since coming into Dr. Lattin's possession has been as follows :

YEAR	YIELD	YEAR	YIELD	YEAR	YIELD
1903	451 barrels	1906	468 barrels	1909	552 barrels
1904	495 barrels	1907	493 barrels	1910	360 barrels
1905	477 barrels	1908	500 barrels	1911	711 barrels

Nine-year average, 488 barrels, and the annual gross receipts have averaged \$1102.93.

Orchard No. 3 contains 130 trees, perhaps sixty or more years old, of the following varieties : 25 Rhode Island Greening, 35 Baldwin, 35 Roxbury, 6 Northern Spy, 15 fall varieties, and 14 assorted winter varieties. The soil is sandy loam, the drainage good. In order to purchase this orchard, Dr. Lattin was forced to lease for a term of five years the farm on which this orchard was located. The prospect of ever reclaiming or renovating it so as to be profitable

was not at all promising. Indeed, it was questionable whether he could ever get any fruit from it. The orchard had practically been abandoned and its only recognized value locally was the amount of stove wood it contained. Before properly breaking up the soil, it was necessary to grub and bush-hook the entire orchard to rid it of the blackberry bushes, sumach, and other growth which completely covered the ground. In fact, there seemed to be more truth than poetry in the advice one of Dr. Lattin's neighbors gave at the time the ground was being cleared preparatory to plowing. "Well, doctor," he remarked, "it is none of my business what you do with your money; but take my advice — cut down the apple trees for firewood and raise blackberries. The financial returns will surely be greater." The number of large, old, broken-down limbs was so great that before the teams could be worked in the orchard, two strong, active men had to spend two days with a cross-cut saw dropping the branches to the ground so that they might be removed. This orchard was plowed in November, 1905, and was thoroughly and — according to the onlookers — recklessly pruned during the following winter. The pruning expense alone exceeded 50 cents a tree. The crop from this orchard during the previous five years had totaled less than 300 barrels. Dr. Lattin marketed fruit from this orchard as follows:

YEAR	YIELD	YEAR	YIELD	YEAR	YIELD
1906	369 barrels	1908	300 barrels	1910	275 barrels
1907	427 barrels	1909	507 barrels	1911	376 barrels

Six-year average, 376 barrels, and the annual returns have averaged \$996.52.

It may be of interest to state that the success in reclaiming this old orchard was a big prop to the faith with which some of the most unpromising Oswego County orchards were attacked.

The average annual yield an acre from all the Orleans County apple orchards has been 117 barrels; the average annual returns an acre for the series of years, \$326; the average annual returns per tree, \$8.15; and the average annual net profit per acre, in round numbers, approximately \$150.00. The average price per barrel realized from the sale (1910 included) was \$2.47, and the average price for culls 23 cents a bushel.

The annual average yield of these same orchards for the five years preceding their coming under Dr. Lattin's care was about 27 barrels per acre; the cash returns per acre, including culls, about \$60.00; and the average returns per tree, \$1.50.

A Vermont orchard. C. T. Holmes, of Charlotte, Vermont, has brought a small yielding orchard up to high standards by systematic, intelligent work. Just what he has done is given in his own words:

I was interested in this orchard before 1907, but not in such a way that I could give it the kind of care I knew it should have. The 100 acres had been in sod for years. The trees had been trimmed and sprayed thoroughly for several years, but the yield had never been up to the average of orchards in this section, although since spraying began, the quality had been good.

In the winter of 1907, fifty acres of Greenings were given a good mulch of barnyard manure as far as the branches extended. As soon as frost was out of the ground, I turned this mulch under about 3 inches — not deep enough to injure the roots. I don't believe in pruning a tree at both ends. One acre was given a dressing of air-slacked lime, about 200 pounds to each tree. This acre showed such marked superiority to the rest in color and size of foliage and in finish and texture of fruit that 70 acres more were limed that fall, and the remainder of the orchard will be limed this winter.

To go back to 1907, the plowed ground was thoroughly pulverized with a disk harrow and was gone over with a spring-tooth harrow about once every two weeks until the middle of July, when I sowed a bushel of buckwheat to the acre. Two weeks before apple-picking time, when the buckwheat was in full bloom, it was rolled with a low roller in order to break it down and at the same time provide a soft cushion for windfalls and keep them clean. That fall I picked 2500 barrels from the 50 acres I took care of, and 600 barrels from the rest.

In the spring of 1908, foolishly allowing myself to be influenced against my own judgment by the opinions of some of the "wise ones," who said the crop of the previous year was due to manure alone, I manured the entire orchard, but cultivated only 25 acres. Everybody knows what a dry season we had in 1908. I cultivated the 25 acres once every ten days until the middle of July, when I seeded it to Mammoth clover for a winter cover crop. The outcome of this experiment was that from the 25 acres cultivated two years in succession 600 barrels were picked; the 25 acres cultivated but one year yielded 200 barrels of a product much inferior in size; and from the other half of the whole orchard I got nothing.

I was now convinced that intensive cultivation was of the greatest importance, and the following year the whole orchard was under cultivation. From inquiries coming from all parts of the continent, it would seem that everyone had heard of the crop of apples which rewarded me in 1909. Of 4000 barrels, I

picked 3100 from the 50 acres cultivated two and three years, and of these I did not have 10 barrels of stung apples. The crop was packed as fancies, firsts, and seconds: 2200 barrels fancies (nothing smaller than $2\frac{3}{4}$ inches); 800 barrels firsts (nothing smaller than $2\frac{1}{4}$ inches); balance, windfalls (a trifle small, but free from worms).

The windfalls brought \$2.00 per barrel at the station. The others were placed in cold storage at Troy, New York, and were handled by a commission house in New York. Fancies have sold at \$7.00 and firsts at \$5.00. Seconds were sold on arrival at \$3.00.

The 1907 crop netted, after deducting costs of picking, freight, and commission	\$3044.50
The crop of 1908 netted	2000.00
In 1909 the net returns will go well beyond	10,000.00
[In 1912 Mr. Holmes estimated that it would go well beyond	20,000.00]

In spraying I use a two-and-a-third horse-power gasoline sprayer made by the Field Force Pump Company. Hand-power pumps are too laborious, and do not give force enough to produce the fine spray necessary to reach every part of fruit and foliage.

I spray before buds open for bud moth and cigar-case bearer with Bordeaux-lead-arsenate mixture, and again after the blossoms fall for codling moth with lead arsenate and lime. My experience is that this is the most important spray. The third spray comes just before the apple turns down, and is for blight, fungus, and the codling moth. Spraying at this time, if carefully done, fills the calyx with a first and last breakfast for the grub when he emerges from the egg. Our greatest pest is the codling moth, but this need not be feared if the spray nozzle is pointed in the right direction and held there long enough during the second spraying.

With good cultivation, thorough spraying, trimming, and fertilization we have nothing to fear from the great Northwest.

Last, but not least, pack true to mark.

Mr. Holmes has refused \$1000 an acre for his hundred acres of orchard.

CHAPTER XXXII

PROPAGATION

Seedlings. Orchardists may suit their own convenience as to whether they will raise or purchase their seedlings. To raise them, it is necessary to obtain plenty of seeds, which may be purchased from seed houses, from importers of nursery stock, or from the cider mill in the form of pomace. If seeds are purchased, they may be planted in the fall or in the spring, not deeper than 1 inch, in good sandy loam. When apple pomace is used, it should be strewn in furrows at a depth of from 2 to 4 inches and covered with soil. During the spring and summer the seeds will germinate and grow, and if they come up too thickly they may be thinned either by discarding some or by transplanting.

Seedlings may be purchased at little cost from the large nursery-importing houses, which receive the small trees directly from France and other foreign countries. They cost about \$8.00 to \$9.00 per thousand trees.

Seedlings generally will not produce fruit true to the variety of the tree upon which they were grown, and therefore must be grafted to produce the desired variety.

Budding. A method of grafting commonly practiced in the eastern United States is budding. This system consists of a simple operation. The yearling seedling is grasped by one hand of the operator about 6 or 9 inches from the ground. In the other hand is a sharp knife, preferably a budding knife. With this the operator makes in the bark a slit not more than $1\frac{1}{2}$ inches long the long way of the tree and about 2 or 3 inches from the level of the soil. Across the top of the slit, and at right angles to it, another cut is made, thus forming a T. The back of the knife or end of the handle may be used to loosen the bark at the cambium layer.

Scions from trees that are heavy bearers of desirable varieties should be at hand. Cut one of these about one fourth of an inch just below a bud. Cut out one bud and a small portion of bark just

below and above the bud. Be careful not to include much (if any) wood. Insert the bud in the T-slit; draw the side bark close about it and secure it with a small piece of raffia or twine just below and above the bud. Watch the bud and cut the raffia when it has united well. When it has developed to a length of one foot, cut the seedling limbs or top from the tree, making a cut quite near the bud and on a slant. The result is seedling roots and a grafted top.

Budding may be done in the spring, but is usually performed in August and September. The bark should slip slightly for the best work; it should slip easily at this time.



FIG. 178. Shield budding

Root-grafting. The West seems to prefer trees that are root-grafted, some sections preferring piece roots, others whole roots.

The seedlings which are to be grafted are treated in two ways. The more common way is to cut off the tops at the crown, and to cut each root into two or three pieces from 2 to 4 inches long, according to the diameter and length of the root. A scion is then grafted into each piece by the whip-grafting method. This is called a piece-root graft and the tree grown from it a piece-root tree. A second way is to put one scion into the crown of each seedling root, which is not cut except to shorten the side roots and the extreme tip. This is a whole-root graft, and will make a whole-root tree.

In order to determine the advantages of each system of root-grafting, experiments were carried out by many state experiment stations. These showed that in their early life whole-root trees do better than piece-root trees, but that later there is little difference.

Both whole-root and piece-root grafted trees are usually cut down to the ground at the end of the first year, and start out the following spring on equal terms as regards the size of the top. The piece-root graft has made many new roots during the first year, and a difference in growth between the two during the second

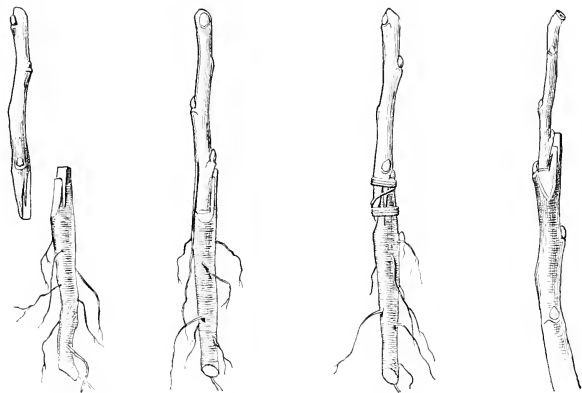


FIG. 179. Whip-grafting

year is seldom noticeable. The disparity between the two grows constantly less as the trees get older. After three or four years one can rarely detect the difference between them in vigor or size.

The length of the scion used in root-grafting is thought to make some difference; however, experiments carried on at the Kansas Station have clearly shown that for practical purposes the length of the scion is of minor importance, but that a length of from 6 to 9 inches is preferable.

Comparison of budding and root-grafting. Practice and experiments have fully demonstrated that, so far as the method of propagation is concerned, there is absolutely no difference in the

value of root-grafted and budded trees. It has been proved beyond any question that orchards of root-grafted trees are as uniformly vigorous, productive, and long-lived as orchards of budded trees. An unbiased examination of the older orchards of the East and West should convince one of this fact.

Whip-grafting. This process is to cut the tree on a slant or angle and not straight across. The scion is cut in a like manner. With a sharp knife the cut is made with one stroke. A tongue is made on each slanting cut of both stock and scion by slightly pushing the knife into the wood. The scion is then placed on the stock, cut surface against cut surface, and the tongues lapped so that they hold the scion in place.

It is important to have the cut of both scion and stock similar, and to have the cambium layer of the scion coincide with the corresponding layer on the stock either entirely, where the stock and scion are the same size, or partly, where the stock is larger than the scion. Sometimes it may help to tie the scion to the stock with raffia or twine, but this should be removed soon after a union is made.

Whip-grafting is sometimes used in top-working trees, as well as in root-grafting. The operation generally takes place in the spring.

Cleft-grafting. This method of grafting is the most common and the easiest to perform. A branch between 1 and 1½ inches in diameter is cut with a pruning saw, care being taken not to loosen or tear the bark on the stub. If the saw is coarse the stub may be dressed with a sharp knife, which will tend to hasten the callousing. A grafting tool may be made by any local blacksmith from an old file, and will be found more serviceable than the other forms now on the market. The important characteristics of this tool are the heavy, curved blade, sharpened on the inner side, and the wedge on the end, placed well away from the back of the blade. The curved blade prevents the unnecessary loosening of the bark in making the cleft, and therefore is better than a straight blade. The stub is split with this tool just enough to accommodate the scions. The cleft is then held open with the small wedge, and two trimmed scions are placed in the cleft. Each scion should contain about three buds, and the lower end of the scion should

be trimmed with a sharp knife to a wedge about 1 or $1\frac{1}{2}$ inches long, with the outer edge of the wedge thicker than the other. It is very important that the sides of this wedge be cut perfectly even, and since the union of the scion and stock takes place at the cambium layer or inner bark, it is also important that the inner bark of the scion come in contact with the inner bark of the stock. Hence the scion is left a little thicker on the outside edge to insure a pressure of the stock against the scion at this

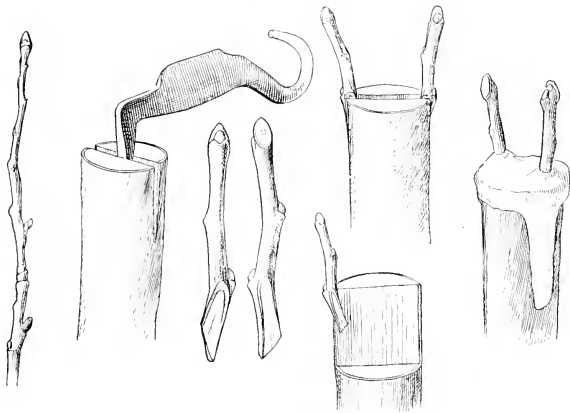


FIG. 180. Cleft-grafting

point. Frequently the scion is tipped slightly outward to bring the cambium layers into contact at one point at least. In preparing the scion it is also advisable to trim it in such a manner as to have a bud just above the wedge on the thicker side, so that when it is placed in the stock it will appear just above the cleft on the outside. After the scions are trimmed and placed in the stock, the wedged end of the grafting tool may be released from the cleft and the graft waxed.

If both the grafts grow, the weaker one should be cut out the following spring to prevent the formation of a crotch, and the stub, if not entirely healed, may be again covered with wax.

Time to graft. The trees may be grafted any time in the spring before the sap begins to flow. It is generally performed about the time the trees are pruned in the spring. If the trees are not grafted at this time and the scions are kept dormant in some cool place, such as an ice house, the grafting may be successfully done later in the spring when the cutting will not result in serious bleeding.

The most important factor in top-working large trees is the selection of the branches to form the top. Scions when grafted on horizontal branches, instead of continuing to grow in the direction of the original branch, always grow upward. This tends to produce a narrow, high-topped tree. Great care should be exercised, therefore, in selecting branches well away from the trunk and covering all the fruit-bearing surface of the tree. Scions seem to grow more successfully on branches which do not exceed $1\frac{1}{2}$ inches in diameter at the point of grafting. In top-working an old tree, about a third of the branches that are to be grafted should be worked each year, as the cutting of more in a single season would prove injurious to the tree. It will therefore take from three to five years to renew the entire top. Where the fruit-bearing surface is large, this will often necessitate the making of from 10 to 20 grafts each season for three successive years. All the important branches should be grafted, and it is safer to graft too many branches and be obliged to cut out a few in later years than not to graft enough.

Other forms of grafting. Many other forms of grafting apple trees are in use, but they are by no means as common as the foregoing. A mastery of the three systems described above is all that is necessary for successful and practical work.

Grafting wax. A good grafting wax is made from the following formula: 4 pounds resin, 2 pounds beeswax, 1 pound beef tallow.

Pulverize the resin and cut up the beeswax and tallow. Boil together slowly until all are entirely dissolved. Pour this into a pail of cold water, and after greasing the hands, squeeze all the water out of the wax and pull, as one would molasses candy, until the wax becomes light colored. If wrapped in oilpaper, this may be stored until needed. In cold weather, when the wax is hard to work, it should be slightly heated before using.

For cleft-grafts pull the wax out into wide ribbons, and cover first the sides of the cleft, then the entire upper surface of the stub, being especially careful to press the wax firmly around the scion to prevent the stock and scions from drying out. The tips of the scion may also be covered with wax.

Waxed string can be made by dropping a ball of darning cotton into the boiling wax and allowing it to cool or harden. The raffia used in tying grafts may be purchased from seed stores or nurserymen; it consists of ribbonlike strips of fiber from the palm tree.

Selection of scions. Scions are selected from bearing trees of the desired variety. They may be cut at any time before the buds swell in the spring, although the best time is late fall or early winter. Only wood from bearing branches of the past season's growth is selected, and after cutting this into lengths of from 8 to 12 inches, it is plainly labeled and tied into bunches of convenient size. These should then be packed in sand or sawdust, and stored in a cool cellar or some other suitable place to prevent them from starting into growth before grafting.

Relation between stock and scion. The variations reported to have been due to grafting are almost endless. Season, shape, color, taste, growth, and almost every quality possessed by tree fruit is alleged to have been changed in some degree. Yet trees are planted each year, propagated by the usual methods, and the expected results are obtained.

Definite experiments carried on by scientific men as to the effect of the stock on the scion have not shown that there is any perceptible differences in tree or fruit, but more thorough study should be undertaken along this line in the future. Of the effect of the scion on the stock very few concern themselves, for it is of no practical importance. There is, however, some definite relation between certain stocks and scions. This is particularly noticeable when a scion will not readily unite with the stock, or vice versa. Enough experiments along this line have not been made to enable us to state the relation of a particular stock to a particular scion, and further study is needed before practical advice can be given.

CHAPTER XXXIII

POLLINATION

Undoubtedly orchardists have observed apple trees which blossomed well but did not set a fair amount of fruit. Such a failure may be due to a number of causes :

1. Poorly nourished fruit buds.
2. Injury to the pistil during winter (not easily observed with the eye alone).
3. Injury to the blossoms by fungi.
4. Injury to the blossoms by rain.
5. Injury to the blossoms by strong or drying winds.
6. Injury by insects.
7. Lack of proper pollination (self-sterile and self-fertile trees).

Probably the most important factor is the last. Many times total failure in the setting of fruit is due to self-sterility. Properly speaking, a self-sterile tree is one which, to bear well, must have other varieties near it. But a tree is not self-sterile when it does not blossom.

Self-sterile trees. The following varieties are more or less self-sterile in New York State : Baldwin, Ben Davis, Fallwater, Oldenburg, Rhode Island Greening, Red Astrachan, Smith Cider.

A list from the West showing both self-sterile and self-fertile varieties is interesting :

VARIETY	POLLEN BEARERS
Arkansas	Abundant
Arkansas Black	Medium
Autumn Bough	Medium
Bailey Sweet	Medium
Baldwin	Medium
Ben Davis	Medium
Bietigheimer	Shy
Bough	Abundant
Canada Reinette	Abundant
Domine	Medium
Early Strawberry	Abundant

VARIETY	POLLEN BEARERS
Esopus	Medium
Fallawater	Medium
Gano	Abundant
Golden Sweet	Medium
Gravenstein	Shy
Grimes	Shy
Haas	Abundant
Hoover	Medium
Jewett Red	Medium
Jonathan	Medium
Limbirtwig	Medium
Longfellow	Abundant
Maiden Blush	Medium
Mann	Abundant
Melon	Medium
Missouri	Medium
Montreal (crab)	Medium
Oldenburg	Medium
Pewaukee	Medium
Ralls	Abundant
Rambo	Shy
Red Canada	Medium
Red Cheek Pippin	Abundant
Red Golden Pippin	Medium
Rhode Island Greening	Abundant
Rome Beauty	Abundant
Saint Lawrence	Abundant
Scott Winter	Abundant
Shiawassee	Shy
Stark	Abundant
Summer Pearmain	Shy
Tolman	Abundant
Tompkins King	Abundant
Transcendent Crab	Shy
Twenty Ounce	Abundant
Wagener	Abundant
Wealthy	Medium
White Pippin	Shy
Willow	Medium
Winesap	Shy
Yellow Bellflower	Medium
Yellow Newtown	Medium
Yellow Transparent	Shy
York Imperial	Abundant

The practical bearing of the self-sterility problem is this : There are certain varieties of fruit which we wish to grow for the general market, but we find that they are not productive when planted alone. They need the pollen of other varieties to make them fruitful. We must therefore do what some of our most intelligent fruit-growers have been doing for years — plant other varieties near them as pollenizers. Cross-pollination of varieties is no longer a theory ; it has become an established orchard practice.



FIG. 181. Ready for the bees

A very fine orchard in full bloom, at the right stage for pollinating

It would appear that the only thing to be done now is to find out what varieties are inclined to be self-sterile and what varieties are best adapted for fertilizing them. But as a matter of fact, cross-pollination gives better results with nearly all varieties, whether they are self-sterile or self-fertile. A variety may be able to bear good fruit when it is planted alone, but it will often bear better fruit if suitable varieties are near it. Mixed orchards are everywhere more productive than solid blocks. For example, in western New York it is a common report that Baldwins in mixed orchards are more uniformly productive than Baldwins in large blocks.

Furthermore, although a variety may be able to set an abundance of fruit with its own pollen, this fruit will often be smaller than if other pollen were supplied.

Pollen-carriers. The pollen of one variety is carried to the pistils of another in two natural ways — by the wind and by insects. There are many kinds of insects, such as bees, wasps, and flies, which aid in the cross-pollination of orchard fruits, and of these the wild bees of several species are probably the most important. But few of the wild bees can live in a large orchard, especially if it is well tilled; therefore, as the extent and thoroughness of cultivation increases, the number of these natural aids to cross-pollination decreases and it becomes necessary to keep domestic honey bees for this purpose.

Every large orchard where the trees are numbered by the thousands should have near by a bee yard of at least fifty swarms to help in thoroughly pollinating the blossoms and obtaining the best results. Bees will not be poisoned by the spraying of fruit trees with poisoned substances if the work is done at the right time, which is just after the blossoms fall. No sensible orchardist will spray his trees when in full bloom and thus poison one of his best friends — the bees.

Pollination by hand. In the West some attention has been given to pollinating the blossoms by hand. Large numbers of buds have been gathered from the trees and forced in either greenhouses or dwellings, and the pollen collected and later applied to the trees with camel's-hair brushes. The results have been quite satisfactory, particularly on trees that were more or less self-sterile.

CHAPTER XXXIV

BREEDING

The apple has been cultivated for many centuries, yet in studying the history of the three thousand or more varieties we find that practically all have come from chance seedlings and not from systematic breeding. In fact, the little breeding that has been done has been more conspicuous for its error and laxity than for its truth and exactness.

One reason for the lack of interest in the breeding of apples may be found in the fact that it is especially difficult to put the principles and methods of this science into practice. Other reasons may be found in the smallness of the pecuniary reward, the amount of money necessary to carry on the work, and the length of time one must wait for results. The discoveries of Mendel and his followers have enabled plant breeders to improve their methods greatly, but more experience in handling this material is necessary before much real good work can be accomplished.

The flower. The blossom of the apple which is hermaphrodite, that is, both male and female organs are found in the same flower, should be carefully studied before experiments are made in breeding. After thoroughly studying the construction of this blossom, the next step is to learn the operation of emasculation, the object of which is to prevent self-pollination. This consists in removing the anthers from the flower, rapidly, as well as efficiency, being necessary in work of this nature.

Methods of emasculation.¹ Grasp the blossom with the thumb and forefinger of one hand and the tips of the petals with the thumb and forefinger of the other hand; then by simply giving the wrist a quick upward or downward movement the petals can be easily detached from the blossom. Now with one or two quick movements with the scissors remove the anthers, and the pistils

¹ *Bulletin No. 104, Oregon Agricultural Experiment Station.*

are ready to receive the pollen. After the application of pollen is made the emasculated blossom



FIG. 182. The first step in pollinating a blossom

Holding petals ready for removing. (Oregon Agricultural Experiment Station)

the other parts of the flower. Several methods of emasculating the blossoms are used in different parts of the United States, one being to remove the corolla with the aid of a small, sharp pair of scissors, leaving the emasculated blossom. A sharp scalpel has also been fairly successful in performing the work. It has been found that in every case where the sepals were removed with the petals, a malformation of the apple resulted. It is evident that emasculating must be skillfully done, for the slightest mutilation causes a malformation of the calyx end of the apple. The percentage of emasculated blossoms that set fruit is larger when the sepals of the flower are not injured in any way.

is inclosed within a bag and allowed to remain until fecundation has taken place and all danger from the action of foreign pollen is over. After every pollination, label each bag in such a way that there will be no question as to what variety of pollen has been used. As the apples approach maturity they should be inclosed in cheesecloth bags. This protects the fruits from being picked accidentally.

The object in removing the petals is to tell just where to make the cuts without injuring



FIG. 183. The first step completed
Removal of the petals. (Oregon Agricultural Experiment Station)

Gathering pollen. An adequate supply of pollen must be secured; and in regions where many of the leading varieties

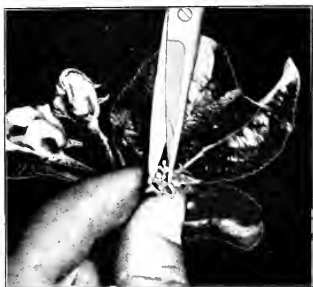


FIG. 184. The next step in pollinating. Removing the stamens by the aid of scissors. (Oregon Agricultural Experiment Station)

blossom together, it must be gathered in sufficient quantities beforehand. One of the simplest ways of procuring pollen is to cover with paper sacks branches that are nearly in flower, the ripened anthers of these blossoms furnishing the necessary pollen. Another method, used in many cases of emergency, is to put in a warm room unripe anthers from flowers about to open.

In a few hours the anthers will dehisce. Perhaps the

most popular way of collecting pollen is to pick off the unopened buds, remove the anthers, and leave them to dehisce.

Another method practiced in some sections is to select small twigs having from three to six clusters of flower buds. These twigs are placed in a forcing house or in a south window of the home a week or two before the trees come into blossom. If the weather is good the blossoms will open in three or four days. If it is desired to obtain quicker results, warm water may be used in place of cold and the stems of the twigs may be split. A gain of from one to two days can be realized by the use of warm water and the splitting of stems, a very important factor if pollen is desired at a

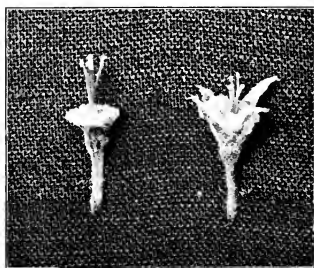


FIG. 185. Pistils after removal of the stamens

At left improperly emasculated; at right properly emasculated, sepals intact. (Oregon Agricultural Experiment Station)

certain time.

After the anthers dehisce and the pollen becomes ripe a small vial, properly labeled, is used to collect the pollen. By removing the hoods the pollen can be easily dusted into the vials by the aid of small camel's-hair brushes. If sufficiently dried, the pollen will keep in these vials until ready for use; if it is not dried enough, fermentation is likely to set in. Very gratifying results have been obtained by collecting in this manner.

It is not known just how long pollen can be kept before it loses its viability. Good results have been had from pollen that was gathered three weeks before.

If pollen is taken from blossoms when on the tree, accuracy is safeguarded by taking it from a flower which has been protected by a paper bag.

How to apply pollen. It has been found that the quickest and most effective way of applying the pollen to the pistils is by the use of a small, pointed camel's-hair brush having a handle from 6 to 8 inches in length. While more or less pollen



FIG. 186. The most interesting step
Applying pollen to the pistils. (Oregon Agricultural Experiment Station)

is wasted in making the application, the disadvantages are greatly offset by the advantages. Brush pollination is the most practicable method, when many thousands of blossoms must be pollinated. The simplest way to apply pollen is to touch the stigma with a dehisced anther; another way is to dip the thumb or forefinger in the pollen and carry it to the stigma of the pistil.

When using a camel's-hair brush, too much care cannot be exercised in making the application. Enough pollen should be placed on the stigma so that it can be readily seen. In all cases each kind of pollen for each variety pollinated must have its own brush if scientific results are to be obtained. Fingers and tools used in pollination must be sterilized; this can probably be best accomplished by the use of alcohol before each operation.

When to make application. There appears to be considerable controversy as to the best time of applying the pollen to the pistils. The indications are that the receptivity of the pistil depends much upon the maturity of the bud at the time of emasculation. This receptivity is also influenced by such factors as climatic conditions, vigor and age of tree, variety, condition of soil, and general care of the orchard reduced.

The paramount question is whether better results can be obtained by applying the pollen at the time of emasculation or waiting until the pistil is receptive. Excellent results have been obtained by



FIG. 187. Bagging

A good method of bagging and labeling a specially pollinated flower. (Oregon Agricultural Experiment Station)

applying the pollen to the pistil as soon as the blossom is emasculated, but this success may have been due to the fact that the blossoms treated were such as would, under normal conditions, open the day following the operation. It is evident, from experiments made, that in a great many varieties the pistils are receptive before the blossoms open. This tends to demonstrate that nature encourages cross-pollination rather

than self-pollination. One of the greatest advantages of pollinating at the time of emasculation is the saving of time, as the bags will not have to be removed. Many plant breeders, however, do not make the application until two or three days after the blossoms have opened, and their results have been satisfactory.

The treated flower is inclosed in a paper bag to protect it from other pollen until seeds have set. After a week or two the paper bag is removed, and one of cheesecloth or mosquito netting is substituted, to remain as protection for the fruit until harvested.

Pollinating should be done on bright, sunny days, and is generally accomplished with much greater ease and assurity on calm still days.

Planting. After the fruit is harvested and, therefore, well ripened, the seeds may be removed and planted in the soil or packed in moist sand. Great care is necessary in handling the seeds to prevent mistakes and to guard against injury.

The seedling trees may be left in the nursery row the first year, but it is important to give them more room for thorough development after the second or third year. A space 8×8 ft. is large enough until the seedlings are tested as to desirability.

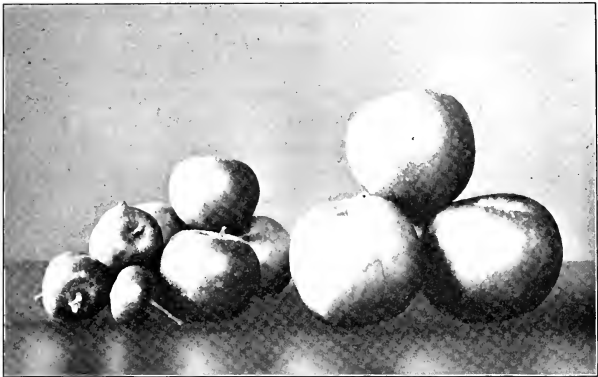


FIG. 188. Results of special pollination

At the left, self-pollinated Newtowns, at least one third of the apples undersized; at the right, Yellow Newtowns pollinated with Grimes Golden, no small apples. (Oregon Agricultural Experiment Station)

Crosses. The breeding of apples on a considerable scale has been carried on by several experiment stations and by individuals. The Geneva Experiment Station (New York) has recently published a report of some of its work along these lines. A careful study of this bulletin resulted in selecting some of the crosses which have given good results. They are the following:

1. Ben Davis crossed with Green Newtown produced the Clinton, an apple very attractive in appearance and of good quality. The size, shape, and quality resembled the Green Newtown, but the color is a handsome red.

2. Ben Davis crossed with McIntosh produced the Cortland, an apple closely resembling the McIntosh in color, shape, and flesh. It gives promise of being a valuable commercial apple of the McIntosh type.

3. Esopus crossed with Ben Davis produced the Nassau. The Nassau is much superior to the Ben Davis in quality, but is hardly equal to the Esopus. The color is more like that of the Ben Davis, and its contrasting red and yellow is most attractive.

4. Sutton crossed with Northern Spy produced the Oswego. This resembles the Northern Spy, though it is larger, more conical, and brighter in color. The flesh resembles that of the Spy in color and texture, but the flavor is different, although equally good.

5. Ben Davis crossed with Mother produced the Rockland. The fruit of this cross is most pleasing in appearance, although small, resembling the Mother in size, shape, color, texture, flavor, and quality. This ought to be especially valuable as a dessert fruit.

6. Ben Davis crossed with Mother produced the Schenectady. This new variety is remarkably attractive, its size, shape, and color all being most pleasing. It is not quite high enough in quality to be called a first-class dessert fruit, but it is much better than the Ben Davis and is a splendid apple.

7. Ralls crossed with Northern Spy produced the Schoharie, which is of proper size but somewhat dull in color. Its flavor is such as to make it desirable both as a cooking apple and as a dessert apple. It is of the type of the Northern Spy in shape and color, and its flesh, while more yellow than that of the Northern Spy, has the same delicious flavor and aroma.

Aim in breeding. The aim in breeding is to produce varieties which have the greatest number of desirable characters and the fewest undesirable ones. Mendel has shown that characters are transmitted as units, which segregate in accordance with a definite formula. It remains, then, for the breeder to take certain characters from one parent, others from another, and make as many combinations as possible and select the best from these. The first task is to determine how characters are inherited, after which they can be associated or disassociated somewhat as the breeder wishes.

The determination of the factors by which the various characters are transmitted will prove a difficult task. If all were simple

characters depending upon a single factor, the work would be greatly simplified, but it is likely that some of the most important characters of apples depend upon the simultaneous presence of several distinct factors. Thus, in the crosses given, there are indications that shape, size, and color of fruit may depend on the presence or absence of several factors.

Another difficulty is that characters, if recessive, may not appear in the F_1 generation.¹ This skipping of a generation will greatly delay and complicate the breeding of plants that are propagated vegetatively, for if the desired characters do not appear in the intermediate generation, propagation cannot proceed at once.

In the case of certain plants it has been found that some characters are linked together and are so transmitted, while others repel one another and refuse to be transmitted together. This phenomenon of coupling and repulsion is not yet understood, and if it appears in apples will tend to complicate breeding processes. Then, too, the bringing together of complementary factors, which somehow in the past breeding of the fruit had become separated, may result in reversions and thus produce unexpected characters.

A breeder cannot obtain wholly new characters in apples by making Mendelian combinations; nor can he augment existing characters, with the possible exception of size and vigor, by crossing.

To perpetuate all the many characters of a species it is necessary to work with large numbers of plants, which in the case of apples is difficult and time-consuming. It is probable that disappointments will most often come from the attempt to perpetuate variations which are fluctuations dependent upon environment and not upon the constitution of the gametes.

There is likely to be some confusion, at least until we have more knowledge on the subject, between what are known as "simple Mendelian characters" and "blending characters," or those which may be complex in composition, in which the offspring are seemingly intermediate between the parents.

Bud-selection.² It is held by many orchardists and experimenters that such qualities as productiveness, vigor, and hardiness can be reproduced by taking scions, or buds, from the plants possessing

¹ The intermediate generation.

² After Professor U. P. Hedrick, Geneva Experiment Station.

these qualities ; but a study of the varieties of apples now grown gives no evidence that any one of them has come into existence by continuous selection or that any variety has improved or degenerated through the cumulative action of natural or artificial selection. No precise experimental evidence has been offered to prove that varieties of fruit can be changed in the least by continuous bud-selection. Scientific research seems wholly to disprove of the theory of the transmission of acquired characters, and of continuous selection as a process for improving or changing plants grown from seeds.

The differences to be found in all varieties of the apple are due to changing environment — if we except the rare bud-mutations, the causes of which are not known. Environmental changes produce manifold modifications in many of the characters of individual apple trees, but there is nothing to show that such changes have any effect on varietal characters. These variations appear when individuals of a variety have different environments ; with a return to the original environment, they disappear. A Baldwin taken from New York to Virginia produces an apple different from the New York Baldwin ; when taken to Missouri or to Oregon the results are still different. If trees are brought back from these states to New York, they again become New York Baldwins.

Appearance of the fruit. In connection with the mutual affinity of varieties which are selected for cross-pollination, there comes the question of the immediate influence of pollen. For instance, if McIntosh pollen is put on Ben Davis pistils, will it impart the McIntosh flavor, color, and characteristic shape to the resulting fruit? Of course the characters of both may be united in the seeds, and the trees which come from these seeds may be expected to be intermediate, but is the flesh of the fruit ever changed by foreign pollen?

The increase in size which often follows crossing cannot be called a true immediate influence, for the foreign pollen generally stimulates the fruit to a better growth because it is more acceptable to the pistils, not because it carries over the size-character of the variety from which it came. Hyslop Crab pistils, when fertilized with pollen from the large Tompkins King, grew into fruits of the usual crab size. An immediate influence in size may be possible, for the size of the fruit is nearly as constant a varietal character as

is the shape ; but most of the increased size in crosses of orchard fruits probably arises from the fact that the pollen is acceptable.

Setting aside the consideration of size resulting from crossing, we still wish to know whether changes in shape, color, quality, and season of ripening of the fruit will result from crossing by pollen. A few instances of such changes have been noticed in the case of some plants in which the seed is the principal part of the fruit ; for example, corn, peas, and beans. With fruits in which the seed is surrounded by a fleshy pulp, as in the apple, it is still a matter of dispute whether the pulp is at all changed. Most men have formed their theories about the immediate influence of pollen from observation rather than from experimentation. It does not necessarily follow that "sweet and sour" apples are due to cross-pollination, nor that the russet on Greening apples that grew on the side of the tree next a Roxbury was produced by the influence of the Roxbury pollen.

Most of the changes in fruit which are attributed to the influence of cross-pollination are due to variation. Every bud on a tree is different in some way from every other bud on that tree, and may develop unusual characters according to the conditions under which it grows.

CHAPTER XXXV

EXHIBITS, SCORING, JUDGING, DESCRIBING

Exhibits. The educational value of national, state, and county fairs to fruit-growers has sometimes been overlooked. Whether the grower exhibits the product of his orchard at these fairs or at those held by horticultural societies, granges, and similar organizations, or simply attends as an onlooker, he cannot help receiving much benefit from them.

The advantages of fruit exhibits consist in informing the grower of the methods and results obtained by other orchardists, and in giving him an opportunity to meet and talk with men who have been more successful than he. Then, too, the consumer is educated as to the varieties and their uses in such a way as to make him a more intelligent purchaser. It is unfortunate, however, that some of the effects of exhibiting at fairs and meetings have proved discouraging to the grower. If he is a beginner, there is danger that he will feel incapable of ever producing such results as he sees on all sides of him. Or perhaps a grower has been induced to exhibit his fruit and through a lack of fairness or an error in judgment has lost a prize that seemed justly his. Such occurrences are apt to prevent the diffident grower from getting all the help possible out of displaying his product. In addition to these discouragements, there must be considered the large amount of disagreeable work that an exhibit involves. Often the time spent seems out of all proportion to the good accomplished.

Preparing fruit for exhibition. No definite rules can be laid down for the preparation of apples for exhibition. Some growers simply select their best fruit and give no special thought to it except to exercise care in handling. Others not only select the best fruit, but coat it with such preparations as beeswax, shellac, etc., which have a tendency to keep the fruit in good condition for a long period. Some fairs, however, do not permit the use of these preparations.

What fruit to show. Only the very best fruit should be taken to a fair or placed on exhibition. No insect-infested or diseased specimens should be considered. Apples should be true to type as to shape, size, color markings, calyx, stem, bloom, and so on, all the specimens resembling each other closely in these characteristics. A plate of five apples that are alike in every particular will be most satisfactory.

How to show fruit. If the apples are to be placed in plates of five specimens each, see that the plates are clean. A dark-green paper mat in the plate will set off yellow or red varieties, while a fairly deep-red paper mat will tend to improve the looks of green fruit. If these mats are not allowed, then see that the plate is a good, new, white one. Place the apples stems up, four on the plate and one on top of the four.

If barrel or box packing is shown, be careful to have each apple in its proper place and the barrel or box new and fresh looking. A white paper-lace collar or strip will add much to the attractiveness of the packed fruit.

Apple prize list of the New York State Fair. A list of the various apples and prizes given in one of the large Eastern fairs will serve to illustrate the interest shown in apples as a whole and certain varieties in particular.

COLLECTION EXHIBITS

For the largest and best collection of fruits grown in any county in the state of New York, collected and exhibited by any county organization: \$250.00, \$200.00, \$150.00.

For the largest and best collection of fruits grown in the state of New York, collected and exhibited by any subordinate grange in the state: \$150.00, \$100.00, \$75.00.

COMMERCIAL EXHIBITS

APPLES

Best display of three packed barrels, not less than three varieties	\$75.00	\$50.00	\$25.00
Best-packed barrel of Baldwins	25.00	15.00	10.00
Best-packed barrel of Greenings	25.00	15.00	10.00
Best-packed barrel of Kings or Twenty Ounce	25.00	15.00	10.00

APPLES (Continued)

Best display of three packed boxes, not less than three varieties	\$50.00	\$30.00	\$20.00
Best-packed box of Baldwins	15.00	7.50	5.00
Best-packed box of Kings	15.00	7.50	5.00
Best-packed box of Spitzenbergs	15.00	7.50	5.00

BOYS' APPLE-PACKING CONTEST

Best-packed standard box, \$25.00, \$15.00, \$10.00.

Contestants to furnish apples. The Commission will furnish standard boxes. The contest will take place in the fruit department on ——— at 10 o'clock. Each contestant will be allowed twenty minutes. Quality of fruit, as well as pack, will be considered.

SPECIAL AMATEUR COLLECTION

For the best arranged and most extensive, perfect, and varied exhibit of orchard products (fresh fruits) grown by any amateur exhibitor, \$30.00, \$20.00, \$10.00.

(This is a premium offered to encourage the exhibition of a "fruit farm" collection. It includes apples, pears, cherries, peaches, grapes, and all other fruits.)

BOYS' AND GIRLS' COLLECTION

For the best-arranged and most extensive, perfect, and varied display of orchard products (fresh fruits) collected and exhibited by any boys' and girls' club or rural school, \$20.00, \$10.00, \$5.00.

For the best display of fruit collected and exhibited by any boy or girl, \$10.00, \$5.00, \$2.50.

APPLES

Largest and best collection of 5 specimens of each variety (no duplicates), \$50.00, \$25.00, \$12.50.

Collection of 10 varieties, 5 specimens of each, \$30.00, \$15.00, \$7.50.

Collection of 5 varieties, 5 specimens of each, \$15.00, \$7.50, \$3.75.

OPEN TO THE WORLD

Collection of 10 varieties, 5 specimens of each, \$20.00, \$10.00, \$5.00.

Collection of 5 varieties, 5 specimens of each, \$15.00, \$7.50, \$3.75.

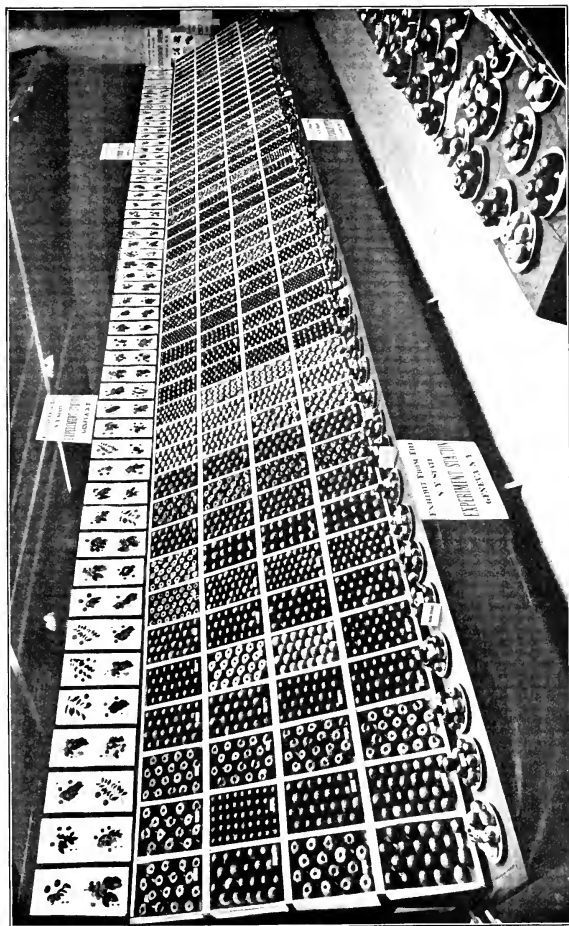


FIG. 189. A fine exhibit of fruit
Display of Geneva Experiment Station at the New York State Fair, Syracuse. (Courtesy of Professor C. P. Hedrick)

FRUITS — SINGLE PLATES

APPLES

(Five specimens of each)

Alexander	\$15.00	\$5.00	\$2.50
Baldwin	50.00	10.00	5.00
Banana	2.00	1.00	.50
Ben Davis	5.00	1.00	.50
Benoni	2.00	1.00	.50
Bietighcimer	2.00	1.00	.50
Bismark	2.00	1.00	.50
Black Gilliflower	2.00	1.00	.50
Boiken	2.00	1.00	.50
Bough	2.00	1.00	.50
Chenango	2.00	1.00	.50
Cooper Market	2.00	1.00	.50
Delicious	2.00	1.00	.50
Detroit Red	2.00	1.00	.50
Early Strawberry	2.00	1.00	.50
Esopus	10.00	5.00	2.50
Fall Pippin	5.00	1.00	.50
Fallowater	2.00	1.00	.50
Fameuse	10.00	5.00	2.50
Fanny	2.00	1.00	.50
Gano	2.00	1.00	.50
Garden Royal	2.00	1.00	.50
Golden Russet	2.00	1.00	.50
Golden Sweet	2.00	1.00	.50
Gravenstein	5.00	1.00	.50
Grimes	2.00	1.00	.50
Hubbardston	10.00	5.00	2.50
Jonathan	5.00	1.00	.50
Lady	2.00	1.00	.50
Lady Sweet	2.00	1.00	.50
Late Strawberry	2.00	1.00	.50
Lowell (Greasy Pippin)	2.00	1.00	.50
McIntosh	15.00	5.00	2.50
Maiden Blush	5.00	1.00	.50
Mother	2.00	1.00	.50
Northern Spy	20.00	10.00	5.00
Northwestern	2.00	1.00	.50
Oldenburg (Duchess)	5.00	1.00	.50
Opalescent	2.00	1.00	.50
Porter	2.00	1.00	.50

APPLES (Continued)

Primate	\$2.00	\$1.00	\$.50
Pumpkin Sweet (Pound Sweet)	10.00	5.00	2.50
Red Astrachan	2.00	1.00	.50
Red Canada	10.00	5.00	2.50
Rhode Island Greening	50.00	10.00	5.00
Rome Beauty	10.00	5.00	2.50
Roxbury	10.00	5.00	2.50
Saint Lawrence	2.00	1.00	.50
Smokehouse	2.00	1.00	.50
Stark	2.00	1.00	.50
Stayman Winesap	2.00	1.00	.50
Stump	2.00	1.00	.50
Sutton	2.00	1.00	.50
Swaar	2.00	1.00	.50
Sweet Winesap (Hendrick)	2.00	1.00	.50
Tolman	2.00	1.00	.50
Tompkins King	20.00	10.00	5.00
Twenty Ounce	15.00	5.00	2.50
Wagener	5.00	1.00	.50
Washington Strawberry	2.00	1.00	.50
Wealthy	15.00	5.00	2.50
Westfield (Seek-no-further)	2.00	1.00	.50
Williams (Williams Favorite)	2.00	1.00	.50
Winesap	2.00	1.00	.50
Wolf River	5.00	1.00	.50
Yellow Bellflower	2.00	1.00	.50
Yellow Newtown	2.00	1.00	.50
Yellow Transparent	2.00	1.00	.50
York Imperial	2.00	1.00	.50

Scoring. As already pointed out, we need a better understanding of the growing, breeding, and marketing of fruit, but we also need to study more the minute characters of each fruit. Such a minute study is called systematic pomology. When we come to be more critical with regard to the fine points of differences between one variety and another or between two samples of the same variety, we realize the need of some reliable method of comparison. In this study much may be learned from the best breeders of live stock. Seldom do competent judges decide offhand between the merits of two animals. They submit each animal to the score-card test.

A score card for fruit testing is devised to give the different characters of the fruit under examination their correct relative values. It requires long experience to determine what these relative values should be, and in the end an absolute agreement between experts cannot be reached. Nevertheless, a great deal can be done, and disagreements are not in most cases so serious as to discredit the system. What we need is more practical experience in the use of the score card.

Score cards. A very good general score card has been adopted by the Massachusetts State Board of Agriculture. This, however, is used for judging all kinds of fruit.

MASSACHUSETTS SCORE CARD

ALL FRUIT

	NUMBER OF POINTS	SCORE
Quality	20	.....
Form	15	.....
Color	15	.....
Size	10	.....
Uniformity in size	20	.....
Freedom from imperfections	<u>20</u>	.....
Perfection	100	.....

As we become more and more intensive in our methods, we shall demand a card that gives more emphasis to the one fruit—apples. The Ontario Fruit-Growers have designed a very good score card for apples:

ONTARIO SCORE CARD

APPLES

	VALUE OF POINTS	SCORE
Form	10	.....
Size	10	.....
Color	10	.....
Freedom from blemishes	20	.....
Uniformity	20	.....
Quality	<u>30</u>	.....
Perfection	100	.....

Professor F. A. Waugh of the Massachusetts Agricultural College has a personal score card of some merit :

SCORE CARD FOR APPLES

	NUMBER OF POINTS	SCORE
Form	15	
Size	10	
Color	20	
Uniformity	10	
Quality	15	
Freedom from blemishes	20	
Total	100	
Variety		
Grown by		
Scored by		Date

Another scale of points used in some sections by old experienced men and easily remembered is as follows :

SCORE CARD FOR APPLES

	NUMBER OF POINTS
Form	5
The specimens should have the normal character of the variety, and should be nearly uniform	
Color	5
Should be bright, clear, and clean, and typical of the variety	
Size	5
Good size is a sign of high cultivation	
Freedom from imperfections	10
Should not show wormholes, spots, bruises, or blemishes; the stem should be intact, and the bloom undisturbed	
Total points	25

A perfect score card would require even greater nicety than has yet been suggested. In a perfectly ideal method of judging it would not be sufficient to have a separate score card for apples, peaches, plums, etc.; there would have to be several different cards for apples, each variety requiring a card of its own. The qualities

which constitute a perfect Ben Davis are not the same which make a perfect Williams Favorite. Mann is notable for its keeping quality, and two samples of this variety in competition would be judged chiefly on that point. Maiden Blush is remarkable for its beauty, and two competing samples would be judged chiefly on this quality. Mother is cultivated principally on account of its high flavor, and with this variety all other considerations ought to be secondary.

SCORE CARD FOR MANN

	NUMBER OF POINTS
Form	10
Size	10
Color	5
Freedom from blemishes	10
Uniformity	15
Keeping quality	50

SCORE CARD FOR MAIDEN BLUSH

	NUMBER OF POINTS
Form	10
Size	10
Color or beauty	40
Freedom from blemishes	20
Uniformity	10
Quality	10

SCORE CARD FOR MOTHER

	NUMBER OF POINTS
Form	10
Size	5
Color	15
Freedom from blemishes	10
Uniformity	10
Quality of flavor	50

There ought to be a score card for cold-storage varieties, another for summer-market varieties, and still another for home-use varieties. It is evident that when a variety is intended for cold storage it must be judged on a different basis from that used when it is to be sold for immediate table use.

Essentials for judging. Each judge should have a good knowledge of the varieties of apples, especially of the characteristics of each variety, such as its shape, size, color, and quality. Often the apples entered in competition are not classed properly, therefore experience in systematic pomology is quite essential for competent judging. In judging, each entry should be closely inspected and the poorest eliminated. Later the score cards should be used for the two or three leading plates or specimens. They may also serve as a record of the decision which can be easily referred to, if necessary.

Describing fruit. In order to classify specimens properly they must be fully described. The description may then be compared with authoritative books and the variety established in that way. A farmer or grower who had an unknown variety could readily make out a sheet such as is used by Cornell University and forward it to his state experiment station, where comparisons could be made, and if the description was accurately given the variety could probably be found and named.

A good form of description is used by the Massachusetts Agricultural College at Amherst and another by the pomological department of the New York State College of Agriculture at Cornell.

FRUIT DESCRIPTIVE BLANK¹

APPLE

FRUIT, form	size
cavity	stem
basin	calyx
color	
dots	bloom
skin	flesh
core	flavor
quality	season
TREE	
GENERAL NOTES	
SPECIMENS RECEIVED FROM	described by
	date

¹ Used by the Massachusetts Agricultural College.

FRUIT DESCRIPTIVE BLANK¹*Apple*

DIAGRAM

NAME

SYNONYMS

SIZE

r

d

UNIFORMITY

FORM

SKIN, texture

surface

color

dots

bloom

CAVITY, form

markings

STEM,

BASIN, form

markings

CALYX, tube

lobes

FLESH, color

texture

flavor

quality

CORE, position

lines

seeds

SEASON

use

GENERAL NOTES

SPECIMENS RECEIVED FROM

date

DESCRIBED BY

¹ Used by Cornell University.

CHAPTER XXXVI

COLOR

Many factors seem to have some influence on the increase or decrease in the amount of color in different varieties of apples. Experimental work has been carried on to determine just how much influence some of these factors have.

Influence of fertilizers. Many prominent fruit-growers and fertilizer experts have maintained that potash is the element needed by the trees to produce more color. In tests carried on for several years by the Geneva Experiment Station an attempt was made to find out the effect of potash in the form of wood ashes and also whether phosphoric acid has a decidedly beneficial effect on the color of apples. Since the experiments of the Station in this matter are of some general interest, they are described below.

Experiments with wood ashes. Wood ashes were applied to the four treated plats at the rate of 100 pounds per tree annually, with the exception of two years, 1901 and 1902, when the applications were omitted. As there are 48 trees per acre, 4800 pounds were applied per acre. The ashes were thoroughly mixed, weighed separately for each tree, and applied broadcast to a line midway between adjacent rows. Applications were made in the spring and were well worked into the ground. No other fertilizer was applied to any part of the orchard during the first five years of the experiment. The following cover crops were plowed under :

1893, oats and peas	1899, crimson clover
1894, crop not stated	1900, rye
1895, crop not stated	1901, oats
1896, sweet clover	1902, barley
1897, mammoth clover	1903, crimson clover
1898, crimson clover	1904, mammoth clover

Acid phosphate was added to the treated plats during the last seven years of the experiment.

Analyses were made of each application of ashes to determine the percentage of potash, with the following results:

YEAR	PER CENT	YEAR	PER CENT
First	4.13	Seventh	3.24
Second	3.89	Eighth	4.39
Third	5.71	Ninth	—
Fourth	5.71	Tenth	—
Fifth	1.38	Eleventh	5.06
Sixth	4.01	Twelfth	4.79

Since 100 pounds of ashes were applied to each tree annually, these figures show the number of pounds of actual potash per tree each season. Thus, during the twelve years 42.31 pounds were applied per tree and 2031 pounds per acre—an average of 169 pounds per acre for the twelve years. The amount of potash applied was much greater than is generally used in orchard practice, from 50 to 100 pounds per acre for apples being the common allowance.

Unfortunately the amounts of phosphoric acid and lime in the ashes used were not determined, but since the amount of phosphoric acid found in ashes varies from 1 to 2 per cent, 1½ per cent being a fair average, we can assume that 1½ pounds of phosphoric acid were applied per tree each year, or 72 pounds per acre. The average analysis of commercial wood ashes shows them to contain 32 per cent of lime, so that there was probably added about 32 pounds of lime per tree annually, or 1536 pounds per acre. These amounts are in excess of those commonly thought to be necessary per acre for apples, and therefore this experiment has to do with phosphoric acid and lime as well as potash. It is true that phosphoric acid in ashes becomes available slowly, but its effects should be seen in twelve years, especially since the cultivation and the plowing under of cover crops were favorable for its becoming available.

It is held by some that the apple does best on a slightly acid soil, and it may be claimed that in this experiment lime has hindered the action of the other ingredients. However, no data could be found to show that an alkaline condition of the soil brought about by lime hinders any specific function of potash or

phosphoric acid in growing apple trees, nor that the lime accompaniment could in any way nullify or obscure the action of these nutrients as to the yield or color of apples. In this connection it is worth noting that some of the best apple regions in the United States have limestone soils. Many fruit-growers use lime in moderate quantities as a fertilizer for apples. From these considerations it may be assumed that lime in the quantities added did not have a deleterious effect on the yield or color of the apple in this experiment; on the contrary it might be suspected that the lime was in part responsible for such beneficial effects as were noted.

While no tests to determine the acidity of the soil were made, it may be inferred, since all leguminous cover crops grew readily in the untreated plats, that the soil of the orchard is not strongly acid, for the clovers in particular do not thrive in an acid soil.

Acid phosphate was applied to the treated plats at the rate of $8\frac{1}{2}$ pounds per tree during the last seven years of the experiment. With 48 trees per acre there were, therefore, 408 pounds of the acid phosphate applied to each acre. The fertilizer was guaranteed to contain 14 per cent of phosphoric acid (analysis proved it to contain approximately that much), and the amount of available phosphoric acid per tree each season was 1.19 pounds, or 8.33 pounds per tree in the seven years. This is equivalent to 399.84 pounds per acre, an average of 57 pounds per acre annually. The amount of phosphoric acid recommended for apples ranges from 30 to 60 pounds per acre. Adding to the above amount the phosphoric acid to be found in the wood ashes, approximately 72 pounds per acre, the total quantity is about 129 pounds per acre — a great abundance.

In the Station orchard apples did not color well, and it was thought that if the addition of these fertilizers would heighten color, their use might be desirable, even though there was no great gain in yield. As a rule apples take on their brightest colors on sandy soils, while on clay they run to duller hues. Because of their influence on color, potash and phosphoric acid are thought to be especially valuable on clay soils. The clay soil of the Station orchard was therefore a very favorable one on which to try these substances to influence color.

The records for the twelve years were as follows :

1893. Slight improvement was noted in the color of all the varieties on the treated sections. Even the Roxbury was smoother and more highly colored on the treated than on the untreated section.

1894. Fall Pippins were smoother and fairer on the treated plats. Baldwins showed but little difference and that in favor of the untreated trees. Rhode Island Greenings had a riper appearance, more yellow, and a tinge of red on the treated plats. No difference discernible with the Northern Spy and the Roxbury. The results for this year were not at all uniform.

1895. Effects were not more noticeable in this season than in the previous one, Rhode Island Greenings and Northern Spies showing the best color in the untreated plats, and Baldwins and Roxburys the highest color in the treated plats. No difference was noted between the plats of Fall Pippins.

1896. Colors developed as well on the untreated plats as on the treated.

1897. The crop was comparatively small and poorly colored on both the treated and the untreated plats, without noticeable difference.

1898. Effects were not at all uniform, the product of the trees in the same plats differing as much as the products from the different plats.

1899. Slight improvement was shown in the color of Baldwins and Northern Spies (the red sorts), but no difference in Rhode Island Greenings, Fall Pippins, and Roxburys (the green varieties).

1900. No differences could be noted.

1901. A small crop of undersized fruit, all poorly colored and showing no difference in favor of either set of plats.

1902. All the treated plats showed more brilliant colors, though the differences could scarcely be noted in the green varieties.

1903. No crop.

1904. The differences were slight and variable and not to be counted in favor of either the treated or the untreated trees.

Taken as a whole the results were disappointing. They lacked uniformity, and were not decided enough in a sufficient number of the twelve seasons to enable the Geneva Station to state that the addition of the substances applied heightened the color of apples under the conditions of this experiment. Not only did the results vary from season to season, but varieties varied greatly in the same season, and in some cases the same variety colored differently in plats receiving the same treatment. When we consider the number of factors which are known to influence color in fruit we cannot assume with any degree of certainty that the results described above show that the addition of these fertilizers changed the color of the fruit in any season. Since exposure to

light, the intensity of the light, the amount of foliage on the tree, the healthiness of the foliage, the amount of stored food in the plant, the soil heat, the texture of the soil, all have an influence on the color of the fruit, it is clear that it is an intricate task, and an almost impossible one, to determine in an experiment like this what were the most potent factors.

A comparison of the color data with meteorological data for the twelve-year period shows that the treatment seemed to have an influence in coloring fruit only in those years when the apple did not develop well, as in 1893 and 1902; and that in other seasons, as in 1896, 1900, and 1904, when climatic conditions were favorable to the development of fruit and foliage, the coloring was as nearly perfect on the untreated as on the treated plats.

Experiment with basic-slag meal. From a very reliable source we have an interesting account of an increase in the color of apples by the application of basic-slag meal, an exclusively phosphatic fertilizer. About 20 pounds of the slag was spread around the trees, most of it between 1 and 2 feet beyond the spread of the branches. This was thoroughly worked into the soil.

The fruit set was light, so far as yield is concerned, but the increased size and the higher color of the fruit on the trees treated in this way made the experiment a wise and profitable one.

Experiments with nitrogen. From experiments carried on at the Pennsylvania State College it has been found that nitrogen has the effect of reducing the color of apples.

Influence of cultivation on color. With apples, as with other crops, probably the chief function of cultural methods is the proper control of soil moisture. Other functions, such as promoting nitrification and killing weeds, are important, sometimes more so than moisture control, but the latter is usually the chief consideration. This is especially true of fruit trees, the moisture demand of which is large, both for use in transpiration and as a constituent of the fruit and vegetative parts. Hence a shortage in water supply may occur frequently in an orchard, at least for limited periods during the season. This to a great extent reduces or nullifies the effect of all other operations in the orchard.

An experiment made along this line has shown that in an orchard that was allowed to remain in sod, the color of the apples

scored an average of 85 per cent out of a possible 100 per cent. In an orchard in which sod mulch was used the color averaged about 82.5 per cent. Clean-tillage fruit averaged $75\frac{1}{3}$ per cent, and orchards treated by tillage and cover crops showed about 75 per cent.

These experiments seem to bear out the observations of practical growers that there is an increase in the color of fruit grown in sod orchards and a decrease as the cultivation of the soil is intensified.

Influence of light on color. In apples there are but two colors to be considered — yellow and red. Physiologically, yellow is connected with colored bodies in the superficial layers of cells. It develops independently of light, and its intensity depends merely upon the degree of maturity or ripeness. Red, however, is a constituent of the cell sap. It is capable of being influenced by a number of agencies, and its intensity depends primarily upon the amount of light received during the later stages of maturity.

A test of the effect of light upon apples after they were picked was made by the Pennsylvania Experiment Station. In this test some 200 York Imperial apples were separated into four lots of equal size, each lot containing approximately the same amount of color at the beginning of the test. Two of these lots were arranged to test the effect of sunlight and two the effect of electric light, one of the lots in each case being darkened and all other factors being kept essentially uniform.

The results of the test, in brief, are that the lot exposed to sunlight increased in redness by about 35 per cent, while in no other case was any definite increase observable. In some instances an apparent increase in the brightness, though not in the extent, of the redness was observed, but this seemed to be due essentially to the coming up of the yellow colors, thus increasing the contrast. This test shows first the importance of sunlight, especially in connection with maturity, and, second, that color is apparently independent of anything contributed by the cell sap, at least after normal size is reached.

To obtain high color, however, it is desirable to maintain connection with the tree as long as possible because of the unfavorable effects upon keeping quality that result from any considerable exposure of the fruit after it is picked.

The chief influence on color. Apples matured on the tree in an abundance of sunlight show the highest color; therefore, anything that tends to hasten maturity or to increase the amount of sunlight, such as proper pruning of the branches, thinning of the fruit, and selection of site, will promote color, while factors tending to retard the one or decrease the other will lessen the color.

The relation of this fact to certain others is interesting. Manure and nitrogen applications, heavy soils, and excessive cultivation, all tend to decrease color; while light soils, sod or sod-mulch, and possibly phosphate and potash applications tend to improve it. These differences are all readily accounted for on the basis of their relation to maturity, though some of them also indirectly affect the amount of light. The first group of factors evidently tends to retard maturity, while the second group hastens it. We also know that dense tree tops, heavy foliage, and early picking of fruit give us reduced color, while the reverse conditions favor it. These effects are evidently due to modifications in the amount of light, and in one case also to the different degree of maturity.

Our conclusions, then, are that the yellow colors in apples are independent of light and of nearly all other environmental conditions. The red colors, however, are primarily dependent on sunlight, and especially on the amount received during the later stages of maturity. Maturity in sunlight is therefore the dominant environmental influence in the production of color in apples. Hence, anything that tends to hasten maturity or to increase the amount of sunlight received will favor color, while the reverse conditions will injure it.

Exposure of apples to sunlight after they are harvested has increased their redness by 35 per cent, while those kept in the dark or exposed to electric light showed no definite increase.

Effect of iron on color. The idea that iron in the soil or applications of iron have some definite relation to color in apples has long existed. In the experiments that have been conducted, better coloring was reported on both the fruit and the foliage of trees receiving the applications, but the leaves and peelings contained less iron than those of the checks.

Heredity and variation as affecting color. The environmental factors influencing the color of apples have been discussed, but other influences must be considered. The influence of internal factors is obvious in such varieties as the Yellow Transparent, Yellow Newtown, and Rhode Island Greening, or in other varieties, as the Jonathan, McIntosh, and Baldwin. The difference in color in these varieties doubtless comes from variations in the seed. There is evidence, however, that at least some of the differences are due to

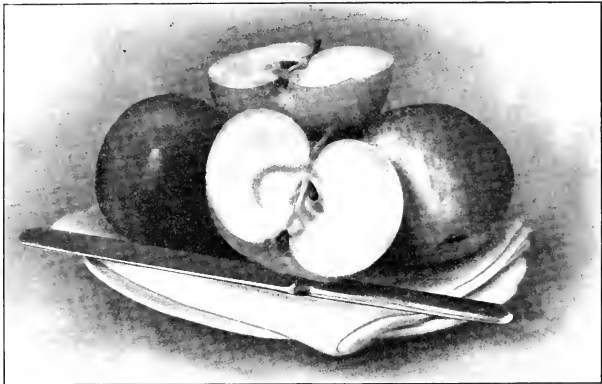


FIG. 190. The king of fruits

What is more inviting or more pleasing than a plate of extra-choice apples?

variations in buds or branches—even on the same tree. This is true of the Banks and Collamer apples, which have been developed from the Gravenstein and Twenty Ounce varieties, respectively, by variations in single branches of their parent trees. The narrow red stripes of the parent apples have been broadened so as to cover the fruit much more completely. In two other cases these stripes are further broadened into practically solid-red colors. These are the Hitchings, and the Red Gravenstein reported by Beach from an island in Puget Sound. The origin of Gano which has been obtained from the Ben Davis may also be a case emphasizing the particular fruit.

In some of these cases the color is also heritable. This is true of the Banks, which is reported to have been widely propagated in Nova Scotia, and to have come satisfactorily true to type in most cases. The genuine Gano is known to be practically constant in its solid-red colors, at least within its proper habitat. The rather striking and apparently heritable differences in color, some of which have certainly originated by vegetative variation, seem more nearly to prove the existence of genuine bud-mutations and the possibility of their utilization in apple improvement along various lines than any other evidence we have.

Conclusions. A study of the subject as a whole leads to the following general conclusions:

Color in the pome fruits is not influenced directly in the immediate cross.

New characters cannot be added by the pollen, except in the seed itself, in the immediate cross.

The manifestation of color is dependent on many environmental factors.

Color, as usually found, is composed of a number of unit characters.

Somatic segregation may occur, and by this means the several factors may appear as bands more or less parallel or a band of but one color surrounded by the normal color.

Similar segregation may extend to any group of unit characters of which the plant is composed.

Segregation may extend to either fruit or leaf buds, if such variations may be propagated asexually.

Red in apples may consist of either a single character or a complex unit of characters — at least three reds are recognizable.

Somatic segregation may be of service to plant breeders as indicating the unit characters that are likely to exhibit themselves when a plant is propagated sexually.

Segregation generally extends to the flower bud only in apples, while in pears the shoot is frequently affected.

CHAPTER XXXVII

FRUIT-GROWING IN VARIOUS SECTIONS OF NORTH AMERICA

The Piedmont and Blue Ridge regions. The Piedmont and Blue Ridge regions comprise parts of the following states: Virginia, West Virginia, North and South Carolina, Tennessee, and Kentucky. Until ten years ago practically no commercial apple production was to be found in this section. Apples were raised in some abundance, but nearly all were used for cider, apple juice, or some other by-product. Lately the development of this region has been very rapid, probably more than a million young trees being planted in the last few years.

According to available figures the production of this region in 1911 amounted to 5,400,000 barrels — about 15.1 per cent of the total. In 1912 the production probably exceeded 6,000,000 barrels. The Virginias alone, in 1909, produced 10,329,000 bushels of apples valued at \$5,591,000.00. This gives an average of 54 cents a bushel, and compares favorably with the average value of 52 cents a bushel in New York State, 50 cents in Pennsylvania, and 48 cents in Michigan.

This region is a land of mountains, valleys, hills, and plateaus, and has been found to be a natural apple belt. The soil is rich, and largely made up of débris of the peculiar rotten-granite rocks of the mountains — a soil very deep and very retentive of moisture. The soil types are numerous and variable. In Virginia the Bureau of Soils has surveyed two areas, the largest parts of which have been found to contain the best possible fruit-growing soils. The Cecil series, the Porter series, and the Merrill series are the areas described in the report of the survey.

In the elevated sections of this region the climate is cool, with plenty of rain and sunshine, and the growing season is long. Where the land is level or slightly rolling the orchards are usually given

thorough cultivation until the middle or last of July. Crimson clover or cowpeas are sowed for a cover crop at this time.

In the mountain orchards, where the land is rough and irregular and the rows are not straight, cultivation is difficult and sometimes impossible. Many times, even when cultivation could be given, it is not advisable to do so because of the resulting loss by erosion. Sometimes the odd and even rows are given culture in alternate years, care being taken to cultivate along the contour lines. Mulches are used where cultivation is impracticable or impossible.

The young orchards are headed low, from 2 to 3 feet being the average height. The method of pruning differs from that in the North — the closed-center or central-leader system being used almost entirely in order to prevent sunscald.

Many insects and diseases are found in this region, the worst insect being the round-headed apple-tree borer, while cedar rust and bitter rot seem to be the most troublesome diseases. Spraying is becoming more common, and power sprayers are in evidence where the size of the orchard warrants. Low-power outfits of the lightest weight are used on the hills.

Some of the most modern orchardists use commercial fertilizer, while others do not regard it of great value.

Cheap labor is abundant. The mountain valleys are well supplied with people of primitive ways of living, who are good, willing workers, easily taught, and are content with low wages.

The box is not common, although certain growers prefer it to other packs. The barrel is the most common carrier for the apples. Transportation facilities are very good in this region, some parts being nearer the large cities of the East than western New York, while small markets, such as mining towns, lumber camps, and small manufacturing centers, are near at hand. For export trade the region is very well situated, being near important tidewater ports.

There seem to be ample facilities for the storage of the best apples, and the near-by large cities offer cold-storage room. The pressing need is for some means of utilizing profitably the drops and bulk fruit. Very few evaporators or canning factories are now available, but there are good opportunities for investment along these two lines.

A large amount of Northern capital has been invested in the cheap orchards and orchard lands of this territory. Some of these newly purchased farms have set out between 2000 and 3000 trees, the plan being to carry on the work under the most scientific methods. Where older orchards have been systematized, the product has doubled in a year.

The varieties differ from those of the North. The York Imperial with its characteristic lopsided and irregular form is the leading variety. It is very productive, well colored, and in good demand. Its irregularity is a market asset, giving even the most uninformed person a sure means of identifying it. The Limbertwig is another variety of importance in a certain part of this region. It has a good reputation as a hardy variety and heavy producer, and yields a large amount of juice for cider and applejack. It is a fine, medium-sized apple, with a rich-red skin. The trees are low-headed, the branches often touching the ground. The Ben Davis, Arkansas, Grimes, Jonathan, Northwestern, Stayman Winesap, Winesap, Yellow Newtown, and Rome Beauty are grown successfully in this region. Many other valuable varieties are found in the older orchards.

The Pacific Northwest. So much attention has been attracted to the wonders of the fruit grown in the Pacific Northwest that a brief description of the limitation and desirable characteristics may be of interest. This district, which embraces Oregon, Washington, and lower British Columbia, may be divided into three great apple-producing regions: the Coast Region, which is west of the Cascade Mountains and has a heavy annual rainfall and an even temperature throughout the year; the Inland Valleys, east of the Cascade Mountains, which has an altitude of from 300 to 1000 feet and a rainfall of from 4 to 10 inches, so that irrigation is usually necessary for crop production; the Inland Uplands, east of the Cascade Mountains, which has an altitude of from 1000 to 3000 feet and a rainfall of from 12 to 25 inches, and is not irrigated. These sections are again divided into countries, such as the Palouse country, the Big Bend country, the Puget Sound country, and the Hood River country. A "country" is a district having almost uniform climatic and soil conditions. Some of these countries are very large, while others are only narrow river valleys.

The main characteristics of orchard methods in these various apple-producing regions may be summed up as follows :

1. *Tillage.* In the Coast Region, where the rainfall is heavy and the soils usually rich in humus, there is less need of tillage to conserve moisture than in the drier inland sections. However, even under these conditions, which are especially favorable for the neglect of tillage, it is usually found that tilled orchards are far more profitable than sod orchards, especially when the latter are pastured. In some sections of the Coast Region, however, there is an increasing tendency to adopt the mulching system. It is believed that this will become a standard system in the lowlands. Some advocate seeding the orchard to clover, which is cut two or three years before the sod is plowed under, and the orchard then tilled one or two seasons before being again seeded to clover. There are many orchard soils in the Coast Region which need thorough tillage as much as any in the East, but it

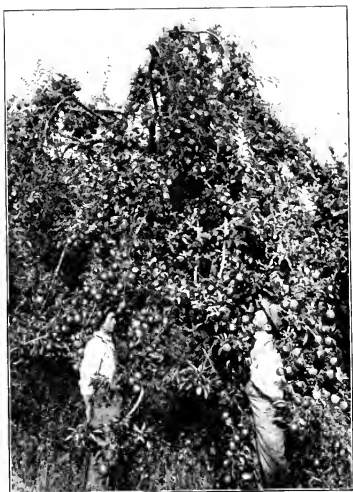


FIG. 191. Eastern results with Western fruit

A magnificent showing of Spitzenburg apples in New York State, said to be not the environment for the Spitzenburg. Fruit farm of Glenn H. Timpleloug, Sodus, New York. (*Tribune Farmer*)

seems that some modification of the mulching system will often be found satisfactory with apples, pears, and sweet cherries.

Almost all of the irrigated orchards in the inland valleys have clean tillage. In the early days it was thought that tillage could be neglected if the trees were irrigated often enough, but this was soon found to be a great mistake. There is a growing tendency to reduce the number of irrigations and to increase the number of

cultivations. Over-irrigation gives soft, watery, poorly flavored and poorly colored fruit which does not keep or carry well. Some of the best orchardists in the Inland Valleys, who used to irrigate four or five times a year, now irrigate but once or twice, and keep up cultivation the rest of the summer.

2. *Pruning.* The methods of pruning orchards in the Coast Region are just the opposite of those prevailing in the inland regions. The climatic and soil conditions of the Coast Region tend to produce a rapid growth of wood, and as a result fruit trees come into bearing several years later than those in the interior. They are often made unfruitful by this luxuriant growth, and have to be checked in order to throw them into bearing. It is advisable to winter-prune some orchards on the heavier soils, but a large proportion of Coast Region orchards, especially apple orchards on the lowlands, should be pruned in summer or spring. Many orchards are pruned when in full blossom, sometimes as much as half the tree being pruned off at that time. The effect of this treatment is to check the exuberant growth and induce fruitfulness. Root-pruning is also practiced to a limited extent.

On the other hand, in the drier inland regions fruit trees come into bearing very early and run to fruit instead of to wood. They often bear themselves to death unless properly managed. The aim of the inland orchardist is not to reduce wood growth by summer pruning, but to increase it by winter pruning. Practically all the pruning in this region is done in winter or early spring.

There is a similar difference of practice in the training of fruit trees on the two sides of the Cascades. On the western side, fruit trees are headed 4 or 5 feet high, as in the old fruit sections of the Eastern seaboard. Every effort is made to elevate the tree into the air and to keep its top well thinned so that the fruit will color and ripen well. In western British Columbia the fruit-growers do not cut back the leader at the time of planting, or at any other time. Some claim that the ideal apple tree for that climate is one which does not have a spreading top, but instead has a tall, strong, central leader reaching high into the air, with many small limbs distributed evenly along it.

On the eastern side of the Cascades, fruit trees are headed low because of the high winds prevailing in that region and because of

the danger of injury from sunscald. The two extremes are 1 foot and $2\frac{1}{2}$ feet, the latter being the most common height for apple trees. The tops of the inland trees are kept much thicker than those in the Coast Region and in the Atlantic States. A very diffuse and spreading habit of growth is desired from the beginning. Every effort is made to keep the trees close to the ground and to shade the trunks. The greater difficulty in tilling orchards of such low-headed trees is considered not at all commensurate with the advantages gained in freedom from sunscald, in the lessened danger of injury from high winds, and in the increased facility of harvesting and spraying. It is rare that one can find within a few hundred miles of each other such utterly dissimilar methods of horticultural practice as are to be seen in Northwestern fruit-growing.

3. *Cover crops.* In both the Inland Uplands and the Inland Valleys the question of cover crops for orchards is now attracting attention. Almost all the orchard soils in both



FIG. 192. Ingram apples in the Ozarks

regions are deficient in humus, and constant clean tillage during the hot, dry summers tends to burn out of the soils what little humus they have naturally. In the Inland Valley orchards the cover-crop problem is not so difficult as in the upland orchards, because moisture for the germination of cover-crop seeds can be supplied at any time by irrigation. On the uplands, however, practically no rain falls between the first of July and the first of October. It is absolutely essential that the orchard be tilled early in the season; therefore no cover crop can be sown over all the ground in spring. When tillage has ceased in late July or August the soil is so dry

that even field peas will not germinate unless drilled in deeply. Other seeds simply lie in the soil without germinating until the fall rains come in October. There are two ways of getting a cover crop in the orchards of the Inland Uplands. Some crop must be found that can be sown in early fall and will make growth enough before winter to protect the ground. For this purpose no more satisfactory crop than field peas has yet been found. Another way would be alternate strips of cultivated land and spring-sown cover crops; reverse from tillage to cover crops the next season or from cover crops to tillage.

4. *Insects and diseases.* The Northwest was at first quite free from serious insect pests and diseases. On the strength of this experience many of the early fruit-growers based the hopeful prediction that fruit pests would never be a serious problem in this region, and called to the aid of the argument certain peculiarities of climate which were supposed to be unfavorable to their development. Stringent laws which aim to exclude all diseased and infested nursery stock and fruit have been passed. All nursery stock grown there and all that is shipped into this section is supposed to be carefully inspected for injurious insects and diseases before being planted. In spite of these precautions practically all the common insects and diseases of Eastern orchards are now found in the Northwest. Laws have failed to keep them out, and the responsibility for their control now falls on the shoulders of individual growers.

The humid climate of the Coast Region is favorable for the growth of fungous diseases. Apple scab, bitter rot, and brown rot are serious. Careful spraying keeps these diseases in check, but the frequent rains in the early part of the season make spraying less efficient and more expensive than in inland orchards. The russetting of fruit from spraying is also very common in this wet climate. The New York apple canker and a somewhat similar disease, called the dead-spot apple canker and known only in the Northwest, are found in neglected orchards. This canker appears as small sunken areas of dead bark, from 1 to 2 inches in diameter, which are often so numerous as to girdle the trunks or scaffold limbs of young trees. Painting with Bordeaux mixture, wrapping the trunks with building paper or burlap, and top-working on

the more resistant varieties are the most satisfactory methods of controlling the ravages of the canker.

The prevalence of fungous diseases will always be a serious hindrance to commercial orcharding west of the Cascade Mountains, but this region is not seriously infested with insects. The codling moth is easily controlled. The San José scale is common, but is easily kept down with the lime-sulphur-salt spray.

The Inland Valley fruit-growers have practically no trouble with fungous diseases, because of their very dry climate, but are grievously tormented with insects, especially the codling moth. At least 90 per cent of the orchards in this region have codling moth in them. There are several broods each season, and the broods overlap, so that it is a continuous fight from the fall of the blossoms until the last of August. In the Northwest the codling moth is a far more serious orchard pest than the San José scale. Some of the best growers are able to save from 80 to 90 per cent of their crop by giving from five to six sprayings each season, at intervals of from two to three weeks, the first spraying being given immediately after the blossoms have fallen, as in the East. This one spraying is not sufficient, however, for it is the later broods which do the most damage. Arsenite of soda, in several formulas, is the material most commonly used. Spraying is usually supplemented by banding the trees. One large grower reports that he has trapped 4000 codling moths in one season under the bands of 750 trees.

Many growers now thin their apples, so that no two fruits touch each other. The thinning of apples is coming to be recognized as a profitable orchard practice in the Northwest, and it is one which many Eastern growers might follow to advantage.

The orchards of the Inland Uplands are favored with comparative freedom from injurious insects and diseases, except that apple scab, codling moth, and San José scale are present to a limited extent. The dry summers are not favorable for the growth of fungous diseases, and the cool nights and short seasons are supposed to limit insect development. Although the upland orchardists cannot expect complete immunity from insects and diseases, as many have hopefully predicted, it is quite certain that they will not be as seriously troubled with them as the fruit-growers in other sections of the Northwest.

5. *Marketing.* The cities of Portland, Seattle, Tacoma, Spokane, Vancouver, and Victoria are all excellent and growing markets, but they cannot consume a fiftieth part of the fruit raised in the Northwest. The chief markets for this fruit at present are the mining camps of Washington, Oregon, British Columbia, Montana, and the cities of the Dakotas and Minnesota. It is well known that mining camps are much better markets for fruits and vegetables, in proportion to the population, than manufacturing towns. Butte, Montana, is the center of an extensive mining district and is one of the largest distributing centers for Northwestern fruit; but Montana now has a million fruit trees coming into bearing, and these will soon claim a share of this trade.

The local towns and mining camps of the Northwest will always be important markets for the fruit of this section, but one is convinced that the great opportunity of Northwestern fruit-growers is in developing a market in Alaska and the Orient. The Northwest occupies a strategic position with reference to oriental trade. Through the wonderful inland harbor of Puget Sound will pour most of the vast volume of trade which is bound to pass between the United States and Japan, China, the Philippines, and other Asiatic countries. That there has long been a waiting market in the Orient for the fresh and preserved fruits of other countries is shown by the fact that in 1899 the exportations of fruit from various sources, chiefly American, to oriental markets were valued at about \$700,000.00. The white population of these countries almost entirely depend upon the imported fruits to supply their tables. The tinned fruits found in the Orient come mostly from America, and the preserved fruits from Europe. Within the past few years a good market for Northwestern apples has been opened up in Siberia, and each year many apples are shipped to Australia, the Winesap being a special favorite for this trade. Several thousand boxes of apples, principally the Ben Davis, are annually shipped to China and invariably reach there in good condition.

In 1900 about 150,000 boxes of Pacific coast apples were exported to Europe via New York. The freight tariff on carload lots of apples from Pacific Ocean terminals and intermediate points to the Atlantic seaboard cities was \$1.00 per hundred pounds for apples in boxes. The railroad men explain this high rate in

various ways, but most unbiased persons agree that as a rule the freight rates on Northwestern fruits are exorbitant.

The apple barrel of the East is almost entirely replaced here with the bushel box. The standard box is $18 \times 11 \times 10\frac{1}{2}$ in. To accommodate certain sizes of fruit, there is a special apple box, which is $20 \times 11 \times 10\frac{1}{4}$ in. These are inside measurements, with end pieces $\frac{7}{8}$ inch thick. The boxes cost about \$9.00 per hundred knocked down. All filled boxes are supposed to weigh 50 pounds and contain 1 bushel of fruit. The choicest apples, particularly the yellow-skinned varieties, are commonly wrapped before being packed. The packing of fruit in tiers in these boxes gives a uniformity which it is almost impossible to secure in barrel packing. Barrels are sometimes used for shipping apples across the sea, as the salt air injures certain varieties when packed in boxes, but these constitute a very small proportion of the fruit marketed.

6. *Organization.* The Northwest country realizes that its future lies in thorough organization. The men are enthusiastic for it, and being so aggressive they generally get what they want. Meetings of the men in horticultural organizations are full of vim and snap, and teem with the "get there" spirit of this progressive country.

Apple-growing in western New York. The western New York apple-growing belt embraces territory about 125 miles long and from 10 to 20 miles in width. It includes parts of eleven counties — Niagara, Orleans, Monroe, Genesee, Livingston, Wayne, Cayuga, Oswego, Ontario, Seneca, and Yates. From 10 to 15 per cent of the total area of these counties is planted to apple trees of various kinds, and in 1909, according to the last census, they contained 40 per cent of the apple trees and produced 53 per cent of all the apples grown in the state of New York.

Practically all the young orchards are being set with fillers, peach trees being used extensively and with great success in the peach-growing sections. The distance apart is not over 20 feet, and usually it is 18. The rectangular method of planting is followed, with every other tree in one row a permanent tree and the others fillers, and in the next row all fillers. Out of four trees three are peach and one is apple. In other sections the system most often employed is to use other varieties of the apple for fillers, especially the so-called early-bearing varieties. At the

present time Wealthy and McIntosh are probably the leading fillers, although several years ago Duchess was heavily planted and in some sections still holds its own. Kings are employed frequently, chiefly because of the small size of an old tree.

If apples are used for fillers, the plantings are seldom closer than 20×20 ft. More frequently the distance is 25×25 ft., in which case the diagonal system of planting is used, especially in all cases where the trees are of medium or small size. Half the trees under this system will ultimately be cut out, solid rows being cut diagonally across the field. This system gives a distance between



FIG. 193. An orchard in western New York

General view of the orchard of E. W. Catchpole at North Rose, New York
(*Tribune Farmer*)

the permanent trees of between 35 and 36 feet. Another point in favor of this system of planting which carries weight with the New York farmer is that it is necessary to determine which of two varieties planted together will ultimately be left. This gives the owner an opportunity of planting one of the old-time varieties and also one of the newer varieties, but it does not require him to determine in advance which he will keep for his permanent orchard.

More two-year-old trees have been set than one-year-old. The younger tree is, however, gaining in favor. The trees are headed fairly low, about 30 inches being the average height, although high-headed trees are common in some sections, particularly near

Rose, New York. Both roots and tops are generally trimmed at the time of setting. Little pruning is required before the tree begins to bear. Branches which cross are removed and possibly a few of the limbs growing back into the tree are pruned out, but very little of the new growth is cut back. After fruiting, pruning is given more attention and the tree is kept more open and free from obstructing limbs and dead wood.

The best growers are believers in thorough cultivation, although there are a few notable exceptions, some of whom have good grounds for their belief in the sod-mulch practice. We cultivate for the purpose of conserving moisture in the soil and of preparing the soil for root activity. In Monroe County practically a third of all the apple orchards are cultivated every year. Almost another third is cultivated at least three years out of five. Some of the best growers practice fall plowing, especially when no cover crop occupies the ground. This aids materially in reducing the spring work, for when the orchard has been plowed before winter a disk harrow can be used as early in the spring as possible. Thorough cultivation is then practiced until midsummer. The spring-tooth harrow is used extensively, and when the soil is very fine and the rains are not heavy a spike-tooth drag or even a weeder may be used. All the ground is plowed and cultivated, even up to the tree trunks, the soil around which is hoed.

After cultivation stops, many orchardists allow the weeds to grow, forming a cover crop; others plant such crops as buckwheat or rye. Legumes are not planted much because of the failure to get a good stand when sown in July. Some have sown legumes in May or early June, and have had a good crop, which was plowed under early the following spring. When the cover crop is sown late in the summer, it is not plowed under until late the following spring, or it may be left over the whole summer. A cover crop made up of cowhorn turnips, oats, and clover or vetch is coming into favor.

Where orchards have been placed on light or poor soils a new method of cover cropping is used. The ground is plowed in the spring and kept thoroughly cultivated until late spring, when corn is drilled in. A coating of manure may be used to produce a good stand of corn. In the late summer, when the corn has reached a rank growth but before it shows any signs of ripening, it is plowed

under, — a heavy chain being needed to pull the corn under, — and a cover crop is sown immediately. This may be rye or turnips, or some of the mixtures recommended where a leguminous plant is included.

Commercial fertilizers are being used somewhat, but many good growers are meeting with success without any. Stable manure is always used when available. A good many cars of this are shipped into this section each year from Buffalo. It is difficult to secure, and has to be ordered a long time in advance.

Intercropping for a few years is generally practiced — potatoes, beans, cabbage, peas, carrots, and other vegetables being used — and the tree rows are kept thoroughly cultivated. It is unusual to see a young orchard kept for any time in the sod.

A few of our better growers are beginning to practice summer thinning, which is done in July and August. The entire tree is gone over, and such varieties as Northern Spy and Twenty Ounce are thinned to one apple in a cluster. Not more than two apples of any variety are ever left in a cluster, and all poor apples, whatever the fault, are removed.

Most growers in this section are not enthusiastic over top-working young trees, for there have been many failures. Budding high on the trunk is practiced in some parts, while whip-grafting is more commonly practiced, and seems to be more successful.

Spraying is done thoroughly by many orchardists with gasoline-power outfits. The San José scale is scattered over the whole state; this necessitates the dormant spray, consisting of lime-sulphur 1 to 9 or 10, either a commercial brand or a homemade mixture being used. The second spraying comes just before blossoming and should be finished as the cluster buds are beginning to break apart. The lime-sulphur solution is applied in about the proportion of 1 to 30. Growers differ somewhat in their practice at the third application. Some employ the poison spray, using enough to cover the closing buds thoroughly; others add the lime-sulphur in the proportion of 1 to 35 or 40, or even 50, and try to spray light enough so that the leaves will not drip at any time. A fourth spraying is given when the apples are about the size of hickory nuts, and many orchardists make a fifth application. Some growers are still using Bordeaux mixture, but lime-sulphur has come

to be quite generally adopted. Arsenate of lead is used for the insecticide, taking from $2\frac{1}{2}$ to 4 pounds for each 50 gallons. This at greater or less strength is used at each spraying.

Harvesting labor is of the transient variety, called "hobo." Some growers pay 12 or 15 cents a barrel; others pay by the day, from \$1.50 to \$2.00 or more, with board, many orchardists being equipped with cheap boarding or lodging houses.

Some grading of the fruit is practiced, but all qualities can be found throughout this section. A No. 1 apple should be $2\frac{1}{2}$ inches



FIG. 194. Dunn Farm, Chazy, Clinton County, New York
(Photograph by F. E. Welch)

in diameter and reasonably free from worms, scab, and blemishes of any kind. In packing, the fruit is taken by hand from the sorting table, and the top of the barrel is tailed off. The barrel is taken down about 3 inches below the top, and the apples are placed checks up, beginning on the outside, making a complete circle. The fruit is brought up just level with the top of the barrel, and is then properly tacked and taken away. The best growers pack this way, although there are other methods in use.

The fruit is packed immediately after picking, generally in the orchard, although some growers have a central packing house. When the fruit is packed, it is drawn to the cold-storage house or to the railroad; in general, the pack of one day is in storage the following day.

Provided competition is good and prices strong the fruit-grower sells much of the fruit before harvesting, the sales being based either on a packed barrel or on a barrel of tree-run fruit. Under the first method the grower packs his own fruit; under the second, the grower picks the fruit and puts it on the sorting table, but the buyer does the work of sorting and packing. This last method has grown in favor during recent years. In some sections fruit is still sold in bulk on the trees. Other growers dispose of their apples at so much per hundred pounds.

Buyers have been too plentiful and competition too keen to stimulate any movement looking toward coöperation. As a result, all kinds and grades of packing will be found.

The Baldwin apple leads all others, with the Rhode Island Greening ranking next. Probably these two varieties supply over half the apples grown for market. The Northern Spy ranks third, with King, Hubbardston, Esopus, Twenty Ounce, Duchess, Wagener, and several others following, but probably not in the order named.

In recent years the desire to obtain quick returns from young orchards has been of prime importance; hence large numbers of early-bearing varieties have been put out. The Duchess, Alexander, Wagener, and Hubbardston have all been planted extensively, and in some sections the Twenty Ounce has more than held its own. The Rhode Island Greening has also been used largely, but comparatively few Kings have been set. The tendency is more and more toward using these old-time, money-making varieties rather than the newer, untried ones. The Baldwin is to-day being set very extensively, and many of the Spy trees, originally set out with the intention of top-working, will probably be left as they are, or possibly grafted to Baldwin or King. McIntosh is another apple which is demanding considerable attention at the present time.

The Ozark region. This is a much larger region than is ordinarily supposed, its approximate boundaries being the Missouri and Osage rivers on the north and northwest, the St. Francis River on the east, and the Arkansas on the south. It is then an irregular oval running southwest from the center of Missouri, covering parts of Missouri, Arkansas, and Oklahoma, the whole area being practically equal to the state of Missouri.

The geological history of the country is interesting, for representatives of every geological age from the Archæan to the Carboniferous inclusive have been found here. Limestone varying in character from the disintegrating form to the flinty shale is the predominating rock formation. Broken shale, sandstone, and here and there granitic formations are found.

The designation Ozark Mountains gives the impression of a prominently elevated region, but the country is not truly mountainous. One of the distinctive features of this interesting country is the surprising and spontaneous way in which streams break forth from the limestone strata; in southern Missouri and northern Arkansas these occurrences are numerous and noteworthy. The elevations may be thrown into two groups — the lower levels, following the stream valleys, and the upper levels, the side hills and plateaus, which the orchardists are climbing in setting trees.

Measured by years the commercial fruit-growing of the Ozarks is less than a quarter of a century old. Apples and peaches have been successfully cultivated for many years, but the commercial plantings have practically all occurred within the last twenty-five years, and the heavy development of the country within the last fifteen years.

Apples and peaches are the staple crops. Other fruits are grown to a somewhat limited extent in certain sections, but the crop of the country is the apple. In the middle elevations of Arkansas the peach industry leads.

The fruit-grower from the East is struck by the following important features in the apple orchards of this region. (1) The trees are planted from 20 to 30 feet apart, with 60 to 70 trees per acre. (2) Very little pruning is done. (3) Comparatively little tilling is done. In fact, the ground is so stony in many places that surface tillage would seem impossible to the man accustomed to sandy or loamy conditions. The surface of many orchards in the side-hill region is covered with loose, shaly stone. (4) The trees come into bearing early. (5) They appear to age young.

The king of the region is the Ben Davis. The following varieties are those held in greatest popularity by the heavy planters — first choice: Ben Davis, Gano, York Imperial, Jonathan, Grimes, Ingram; second choice: Huntsman, Willow, Pippin, Winesap, Ralls.

The great cities of the Middle West are the consumers of the big red apple of the Ozarks. Chicago, Omaha, St. Louis, and other river towns appreciate perhaps more fully the qualities of the apple and peach products of this region than do the cities of the East. It is certain that for apples that require warm soil, fervent day heat, and relatively cool nights the conditions in this region are most favorable, and the Ben Davis of the Ozarks is a different creation from the Ben Davis of New York or New England, and a better one.

The region is being rapidly developed, but it does not follow that because apple trees are being planted there by the hundreds of thousands it is going to dominate the apple-producing sections of the United States. Drawbacks are found here as elsewhere. Cold rains and unfavorable spring conditions have blasted fruit prospects for three consecutive years. Present fruit-growing methods will probably need modification as time goes on.

It is worth noting that on account of the small stature of the trees and the hilly and irregular surface of the ground, many of the Ozark fruit-growers have adopted the dust or dry-spray method of combating insects and other plant parasites.

The fruit-growers of the region are energetic, hospitable people, and visitors are welcomed and entertained with true Western heartiness.

The Nova Scotia section. Much English capital has been invested in the growing of apples in Nova Scotia, the center of the industry being in the beautiful Annapolis valley. The varieties of apples which have proved most generally successful in the coldest sections of Nova Scotia are as follows: Yellow Transparent, Wealthy, Ribston, Baxter, McIntosh, Stark. The ten most popular and largely grown sorts for the Annapolis valley and other more favorable sections are probably the Gravenstein, Ribston, Blenheim, Northern Spy, Baldwin, King, Nonpareil, Fallwater, Golden Russet, and Stark.

The general tendency of the planters in this region is to hold to the better quality of varieties. However, considerable plantings have recently been made of Ben Davis and Gano. The apples are generally exported to England, principally to the Liverpool market, the annual export being from 250,000 to 400,000 barrels.

The methods of marketing have changed very slowly so far as the package is concerned. There is probably a very slight increase in the quantity of apples shipped in boxes, but for the most part the barrel is used, since it has proved satisfactory to the English market. Barrels are manufactured especially for the Nova Scotia apple trade, the flat-hooped barrel being the one most desired because of its better appearance. The size of the barrel in Nova Scotia is 96 quarts, while in Ontario it is 112 quarts, but there will undoubtedly be some law passed requiring a uniform size.



FIG. 195. A Rhode Island orchard

A portion of a 1000-tree orchard in Rhode Island. (Courtesy of A. E. Stene)

Owing largely to the Fruit Marks Act the honesty and care with which apples are packed have materially improved. This improvement has, in a measure, been the result of the fear of detection on the part of fraudulent packers, but it is chiefly the result of the educational effect of the law, through demonstrations of the proper way to pack apples and the arousing of a general interest in the matter.

There has been a gradual increase in the percentage of orchards which are thoroughly cultivated; in fact, it may be said that as a rule cultivation is more common than any other method of management. Clean culture is practiced up to about July 1, when some

cover crop is sown. The most popular plants are clovers (medium and mammoth), buckwheat, and vetch. In some special cases alfalfa has proved very satisfactory.

The San José scale to date has not caused great trouble in this section. This is indeed remarkable, because large quantities of stock are imported each year from regions where the scale is known to exist. The most serious pests continue to be the codling moth, bud moth, cankerworm, tent caterpillar, oyster-shell scale, apple scab, and some other diseases. In spite of the most careful spraying, these pests take their large annual tolls.

Cold storage is very little practiced in Nova Scotia. There are a few growers who have small iced compartments in their packing houses where fruit may be held, but for the most part the frost-proof warehouses are found sufficient, as they are cool even during the warm days.

CHAPTER XXXVIII

VARIETIES

It is highly important that the apple-grower have a fairly definite idea of the varieties that are worth while. An alphabetical list of apples with a short description of each may serve as a guide in suggesting possible varieties. It is not intended, however, to give a complete list, but one that will show the most common varieties.

Akin. Originated in Illinois. Form conical. Color yellowish-red. Flavor subacid. Quality very good. Size medium large. Season late. Use: dessert and general market apple.

Alexander. Originated in Russia. Form roundish-conical. Color greenish-yellow with many red stripes. Flavor acid. Quality good. Size very large. Season medium. Use: cooking. Good shipper.

Arkansas (Mammoth Black Twig). Originated in Arkansas. Form oblong-conical. Color yellowish-red. Flavor medium subacid. Quality good. Size large. Season late. Use: cooking. Good shipper.

Arkansas Black. Originated in Arkansas. Form roundish-conical. Color dark red. Flavor subacid. Quality good. Size medium large. Season late. Use: market and cooking. Good shipper.

Autumn Bough. Origin unknown, but probably America. Form roundish-conical. Color greenish-yellow. Flavor sweet. Quality very good. Size medium. Season medium early. Use: dessert.

Bailey Sweet. Originated in New York. Form roundish-oblong-conical. Color yellow with red stripes. Flavor very sweet. Quality very good. Size large. Season medium. Use: dessert, cooking, and market.

Baldwin. Originated in Massachusetts. Form roundish-conical. Color yellow with many red stripes. Flavor subacid. Quality very good. Size medium large to large. Season late. Use: dessert, cooking, and market. Good shipper.

Banana. Originated in Indiana. Form oblate. Color yellow-blushed. Flavor medium subacid. Quality very good. Size medium to large. Season late. Use: dessert.

Ben Davis (Carolina, New York Pippin). Form roundish-oblong-conical. Color yellow striped with red. Flavor subacid. Quality good. Size medium to large. Season late. Use: market.

Benoni. Originated in Massachusetts. Form roundish-oblate-conical. Color yellow striped with red. Flavor mild to subacid. Quality very good. Size medium to large. Season medium early. Use: dessert.

Bethel (Vermont). Originated in Vermont. Form round. Color yellow striped. Quality very good. Size medium to large. Season late. Use: market.

Bietigheimer (Red Bietigheimer). Originated in Germany. Form oblate-conical. Color whitish-yellow striped with red. Flavor subacid. Quality good. Size very large. Season medium early. Use: cooking and market.

Black Gilliflower (Red Gilliflower). Form oblong-conical. Color dark red. Flavor subacid. Quality good. Size medium. Season medium late. Use: cooking and market.

Blenheim (Blenheim Orange). Originated in England. Form roundish-oblate. Color yellowish russet. Flavor subacid. Quality very good. Size large. Season late. Use: dessert and cooking.

Blue Pearmain. Form roundish-conical. Color dark-red striped. Flavor subacid. Quality very good. Size very large. Season late. Use: dessert and market.

Boiken (Boikenapfel). Originated in Russia. Quality good. Size medium to large. Season medium.

Bough (Sweet Bough). Originated in America. Form oblong-conical. Color greenish-yellow. Flavor sweet. Quality very good. Size medium to large. Season early. Use: dessert and cooking.

Buckingham (Fall Queen, Byers' Red). Probably originated in Virginia. Form oblate-conical. Color greenish-yellow striped with red. Flavor subacid. Quality very good. Size medium to large. Season medium late. Use: dessert, cooking, and market.

Canada Baldwin. Originated in Quebec. Form oblate. Flavor subacid. Size medium. Season very late. Use: dessert, cooking, and market.

Canada Reinette (Canada Pippin). Probably originated in Europe. Form oblate-conical. Color greenish-yellow. Flavor subacid. Quality very good. Size very large. Season late. Use: dessert and market.

Chenango (Chenango Strawberry). Originated in New York. Form oblong-conical. Color white striped with red. Flavor subacid. Quality very good. Size medium. Season medium early. Use: dessert and market.

Delicious. Originated in Iowa. Form oblong-conical. Color yellow striped with red. Flavor mild to acid. Quality very good. Size medium to large. Season late. Use: dessert and market.

Domine (American Nonpareil). Form oblate. Color greenish-yellow striped with red. Flavor subacid. Quality good. Size medium. Season late. Use: dessert, cooking, and market.

Early Harvest (Prince's Harvest). Originated in America. Form roundish-oblate. Color pale yellow. Flavor subacid. Quality very good to best. Size medium. Season very early. Use: dessert and cooking.

Esopus (Esopus Spitzenburg). Originated in New York. Form roundish-oblong-conical. Color yellowish-red. Flavor subacid. Quality very good to best. Size large. Season medium to late. Use: dessert, cooking, and market.

Fallwater (Tulpehocken). Originated in Pennsylvania. Form roundish-conical. Color yellowish-green blushed. Flavor pleasant, mild subacid. Quality good. Size very large. Season medium late. Use: cooking and market.

Fall Pippin (Pound Pippin). Originated in America. Form roundish-oblong-oblate. Color yellowish-green. Flavor pleasant subacid. Quality good to very good. Size very large. Season medium. Use: dessert, cooking, and market.

Fancuse (Snow, Snow Apple). Probably originated in Canada. Form roundish-oblate. Color greenish-yellow to red or crimson. Flavor subacid. Quality very good to best. Size medium to small. Season medium early. Use: dessert, cooking, and market.

Gano (Black Ben). Form roundish-oblate. Color dark yellowish-red. Flavor mild subacid. Quality good. Size large. Season late. Use: market.

Golden Russet (New York) (English Golden Russet). Probably originated in England. Form roundish-oblate. Color greenish-yellow to russet. Flavor acid. Quality good to best. Size medium. Season late. Use: dessert, cooking, and market.

Golden Sweet (Orange Sweeting). Originated in Connecticut. Form round. Color pale yellow. Flavor rich and sweet. Quality good to very good. Size large. Season medium early. Use: cooking and market.

Gravenstein (Early Congress). Originated in Germany. Form roundish-oblate. Color yellow striped with red. Flavor subacid. Quality very good. Size large. Season medium. Use: cooking and market.

Grimes (Grimes Golden). Originated in West Virginia. Form roundish-oblate. Color yellow. Flavor rich subacid. Quality very good to best. Size medium. Season medium late. Use: dessert, cooking, and market.

Haas (Fall Queen, Gros Premier). Originated in Missouri. Form oblate-conical. Color greenish-yellow striped with red. Flavor subacid. Quality good to very good. Size medium to large. Season medium. Use: cooking and market.

Hubbardston (Hubbardston Nonsuch). Originated in Massachusetts. Form roundish-oblate. Color yellow striped with red. Flavor subacid. Quality very good. Size large. Season medium late. Use: dessert and cooking.

Ingram (Ingram's Seedling). Originated in Missouri. Form roundish-oblate-conical. Color yellow striped with red. Flavor mild subacid. Quality very good. Size medium. Season very late. Use: dessert, cooking, and market.

Jefferis (Everbearing, Grantham). Originated in Pennsylvania. Form oblate-conical. Color yellowish-red with crimson stripes. Flavor rich, mild, subacid. Quality very good to best. Size medium. Season medium early. Use: dessert and market.

Jewett Red (Nodhead). Originated in New Hampshire. Form roundish-oblate. Color greenish-white and red striped with crimson. Flavor pleasant, mild subacid. Quality good to very good. Size medium. Season medium to late.

Jonathan (New Spitzenburg). Originated in New York. Form roundish-oblong-conical. Color yellowish striped and blushed with red. Flavor mild subacid. Quality very good to best. Size medium. Season medium to late. Use: dessert, cooking, and market.

Lady (Lady Apple, Pomme d'Api). Originated in France. Form oblate. Color pale-yellow blushed. Flavor subacid. Quality very good. Size very small. Season late. Use: dessert.

Limbertain (Red Limbertwig). Probably originated in North Carolina. Form roundish-oblate-conical. Color greenish-yellow to red and crimson. Flavor acid. Quality good. Size medium. Season very late. Use: dessert and cooking.

Lowland Raspberry (Lowland Raspberry). Originated in Russia. Form oblong-conical. Color yellow striped with red. Flavor mild subacid. Quality very good. Size medium. Season medium early. Use: dessert and market.

Longfield (Good Peasant). Originated in Russia. Form roundish-oblong. Color yellow blushed. Flavor subacid. Quality good. Size medium to large. Season medium. Use: cooking and market.

McIntosh (McIntosh Red). Originated in Ontario. Form roundish-oblate. Color whitish-yellow to red and crimson. Flavor subacid. Quality good to very good. Size medium to large. Season medium late. Use: dessert, market, and cooking.

Magog (Magog Red Streak). Originated in Vermont. Form roundish-oblong. Color yellowish-red striped. Flavor subacid. Quality good. Size medium. Season late.

Maiden Blush (Maiden's Blush). Originated in New Jersey. Form roundish-oblate. Color pale-yellow blushed. Flavor subacid. Quality good. Size medium. Season medium. Use: dessert, cooking, and market.

Mann (Diltz). Originated in New York. Form roundish-oblate. Color greenish-yellow. Flavor subacid. Quality good. Size medium to large. Season very late. Use: cooking and market.

Minkler (Mumper Vandevere). Probably originated in Pennsylvania. Form roundish-oblate-conical. Color greenish-yellow striped with red. Flavor subacid. Quality good. Size medium. Season late. Use: dessert and cooking.

Missouri (Missouri Pippin). Originated in Missouri. Form roundish-oblate. Color whitish-yellow striped with red. Flavor brisk subacid. Quality good. Size medium to large. Season late. Use: cooking and market.

Monmouth (Red Cheek Pippin). Originated in New Jersey. Form oblate-conical. Color pale-yellow blushed. Flavor brisk subacid. Quality very good to best. Size large. Season medium late. Use: dessert and cooking.

Mother (Gardener's Apple). Originated in Massachusetts. Form roundish-conical. Color yellow striped with red. Flavor rich subacid. Quality best. Size medium. Season medium late. Use: dessert.

Newtown Spitzenburg (New York Vandevere). Originated in New York. Form roundish-oblate-conical. Color yellow striped with red. Flavor rich, mild subacid. Quality very good to best. Size medium to large. Season medium late. Use: dessert and cooking.

Northern Spy (Spy). Originated in New York. Form roundish-oblate-conical. Color greenish-yellow striped with red. Flavor subacid. Quality very good to best. Size large. Season late. Use: dessert, cooking, and market.

Northwestern (Northwestern Greening). Originated in Wisconsin. Form round. Color yellowish-green. Flavor subacid. Quality good. Size large. Season medium late. Use: market.

Oldenburg (Duchess of Oldenburg). Originated in Russia. Form roundish-oblate. Color whitish-yellow striped with red. Flavor brisk acid. Quality good. Size medium. Season medium early. Use: cooking and market.

Pewaukee. Originated in Wisconsin. Form roundish-oblate. Color yellow striped with red. Flavor brisk acid. Quality good. Size medium to large. Season late. Use: cooking.

Porter (Yellow Summer Pearmain). Originated in Massachusetts. Form oblong-conical. Color yellow. Flavor subacid. Quality very good to best. Size medium to large. Season medium early. Use: dessert, cooking, and market.

Primate (Sour Harvest). Probably originated in New York. Form roundish-oblate-conical. Color greenish-white blushed. Flavor subacid. Quality very good to best. Size medium. Season medium early. Use: dessert.

Ralls (Janet, Rawle's Genet). Probably originated in Virginia. Form oblate-conical. Color yellowish-red striped with crimson. Flavor pleasant, subacid. Quality good to very good. Size medium. Season very late. Use: dessert, cooking, and market.

Rambo (Bread and Cheese). Originated in Pennsylvania. Form roundish-oblate. Color yellowish-white striped with red. Flavor rich, mild subacid. Quality very good. Size medium. Season medium. Use: dessert and cooking.

Red Astrachan (Abe Lincoln). Originated in Russia. Form roundish-conical. Color greenish-yellow to red and crimson. Flavor acid. Quality good to very good. Size medium to large. Season early. Use: dessert, cooking, and market.

Red Canada (Canada Red, Steele's Red). Probably originated in Connecticut. Form oblate-conical. Color yellowish-red striped with crimson. Flavor brisk subacid. Quality very good. Size medium. Season very late. Use: dessert and market.

Red June (Carolina Red June). Probably originated in North Carolina. Form oblong-conical. Color yellowish-red to crimson. Flavor mild subacid. Quality good to very good. Size medium to small. Season early. Use: dessert and market.

Rhode Island Greening (Greening). Originated in Rhode Island. Form roundish-oblate-conical. Color pale yellowish-green. Flavor brisk acid. Quality very good. Size large. Season medium late. Use: dessert, cooking, and market.

Ribston (Ribston Pippin). Originated in England. Form roundish-conical. Color yellow blushed with russet. Flavor acid. Quality very good. Size medium to large. Season late. Use: dessert.

Rome Beauty (Gillett's Seedling). Originated in Ohio. Form roundish-oblate-conical. Color yellow striped with red. Flavor pleasant subacid. Quality very good. Size large. Season medium late. Use: dessert and market.

Roxbury (Roxbury Russet). Originated in Massachusetts. Form roundish-oblate. Color yellowish-russet. Flavor rich acid. Quality good to very good. Size medium to large. Season very late. Use: cooking and market.

Scott Winter (Scott's Winter). Originated in Vermont. Form roundish-conical. Color red striped. Flavor acid. Quality good. Size medium. Season very late. Use: market and cooking.

Shiawassee (Michigan Beauty). Originated in Michigan. Form roundish-oblato. Color whitish-red striped with crimson. Flavor brisk subacid. Quality very good. Size medium. Season medium late. Use: dessert and market.

Smith Cider (Smith's Cider). Originated in Pennsylvania. Form roundish-oblato-conical. Color yellow striped with red. Flavor pleasant, mild subacid. Quality good. Size medium to large. Season medium late. Use: market.

Sops of Wine (Sops in Wine). Originated in Europe. Form round. Color yellow striped with red. Flavor pleasant subacid. Quality good. Size medium. Season medium early. Use: dessert.

Stark (Robinson, Yeats). Originated in Ohio. Form roundish-conical. Color greenish-yellow striped with red. Flavor mild subacid. Quality good. Size large. Season late. Use: cooking and market.

Stayman Winesap (Stayman). Originated in Kansas. Form oblato-conical. Color greenish-yellow striped with red. Flavor rich, mild acid. Quality very good. Size medium to large. Season late. Use: dessert and market.

Sutton (Sutton's Beauty). Originated in Massachusetts. Form roundish-oblato-conical. Color pale yellowish-red striped with crimson. Flavor subacid. Quality very good. Size medium to large. Season medium late. Use: dessert, cooking, and market.

Swaar (Hardwick). Originated in New York. Form roundish-oblato. Color greenish-yellow. Flavor rich subacid. Quality very good to best. Size large. Season medium late. Use: dessert and cooking.

Tetofski (Tetofsky). Originated in Russia. Form roundish-oblato-conical. Color yellow striped with red. Flavor acid. Quality good. Size medium to small. Season medium early. Use: cooking and market.

Tolman (Tolman Sweet). Originated in Rhode Island. Form roundish-conical. Color whitish-yellow blushed. Flavor sweet. Quality very good. Size medium. Season very late. Use: dessert and cooking.

Tompkins King (King of Tompkins County). Probably originated in New York. Form oblato-roundish-conical. Color yellow striped with red. Flavor subacid. Quality very good. Size large. Season late. Use: dessert and market.

Twenty Ounce (Cayuga Red Streak). Originated in Connecticut. Form roundish-conical. Color greenish-yellow striped with red. Flavor pleasant, subacid. Quality good to very good. Size very large. Season medium late.

Wagener (Wagener). Originated in New York. Form roundish-oblato. Color yellowish-red striped with crimson. Flavor brisk subacid. Quality very good to best. Size medium to large. Season late. Use: dessert, cooking, and market.

Wealthy. Originated in Minnesota. Form roundish-oblato. Color whitish-red striped with crimson. Flavor brisk subacid. Quality very good. Size medium. Season medium. Use: dessert and market.

Westfield (Westfield Seek-no-further). Originated in Connecticut. Form roundish-conical. Color greenish-red striped with russet. Flavor rich subacid.

Quality very good to best. Size large. Season medium late. Use: dessert, cooking, and market.

Williams (Williams' Favorite). Originated in Massachusetts. Form roundish-oblong-conical. Color dark red. Flavor subacid. Quality very good. Size medium to large. Season medium early. Use: market.

Winesap (Winter Winesap). Originated in New Jersey. Form roundish-oblong-conical. Color dark-red striped. Flavor mild subacid. Quality very good. Size medium. Season very late. Use: dessert, market, and cider.

Wolf River. Originated in Wisconsin. Form roundish-oblate-conical. Color greenish-yellow striped with red. Flavor subacid. Quality good. Size very large. Season medium late. Use: cooking and market.

Yellow Newtown (Albemarle, Newtown Pippin). Originated in New York. Form roundish-oblong. Color greenish-yellow. Flavor brisk acid. Quality very good to best. Size medium to large. Season very late. Use: dessert, cooking, and market.

Yellow Transparent (White Transparent). Originated in Russia. Form roundish-oblate-conical. Color pale yellow. Flavor subacid. Quality good to very good. Size medium. Season medium early. Use: dessert, cooking, and market.

York Imperial (Johnson's Fine Winter). Originated in Pennsylvania. Form roundish-oblate. Color white striped with crimson. Flavor subacid. Quality good to very good. Size medium to large. Season medium late. Use: cooking and market.

The best varieties for the small home lot. The most suitable varieties for planting in the small home orchard are not the same for all parts of the country. The following is a list of the six best varieties for this purpose, grouped by sections. In each case the first two varieties in the first column of each group are the best.

For southern Canada and the colder parts of eastern United States:

McIntosh	Yellow Transparent
Spy	Duchess
King	Gravenstein

For New England:

Gravenstein	Yellow Transparent
Baldwin	Rhode Island Greening
Red Astrachan	Roxbury Russet

For the central Atlantic district:

Bough	Maiden Blush
York Imperial	Red Astrachan
Grimes	Stayman Winesap

For the Middle West :

Jonathan	Red Astrachan
Mammoth Black Twig	Winesap
Rome Beauty	Yellow Transparent

For the Far West :

Banana	Wagener
Esopus	Winesap
Rome Beauty	Yellow Newtown

The best varieties for the farm or commercial orchard. A large number of varieties are suitable for farm and commercial purposes. It is better, however, to make a selection from varieties that have been tested in the locality and have proved profitable. For commercial planting it may be best to select only a few varieties, although where fillers are used the number of varieties will be increased.

For southern Canada and the colder parts of the United States :

Alexander	Longfield
Baldwin	McIntosh
Blenheim	Northwestern
Blue Pearmain	Porter
Duchess	Red Astrachan
Fameuse	Rhode Island Greening
Gano	Spy
Gravenstein	Tetofski
Grimes	Tolman
Hubbardston	Wealthy
King	Wolf River
Livland Raspberry	Yellow Transparent

For New England, New York, and other similar locations :

Alexander	Fameuse
Baldwin	Gano
Ben Davis	Grimes
Bethel	Hubbardston
Black Gilliflower	Jonathan
Blue Pearmain	King
Chenango	Lady
Duchess	McIntosh
Early Harvest	Maiden Blush
Esopus	Mann
Fall Pippin	Peck

Red Astrachan	Wagener
Red Canada	Wealthy
Rhode Island Greening	Wolf River
Rome	Yellow Bellflower
Roxbury Russet	Yellow Newtown
Spy	Yellow Transparent
Swaar	And some others in particular
Twenty Ounce	locations.

The leaders of the above varieties are :

Baldwin	Twenty Ounce
King	Rhode Island Greening
McIntosh	Spy

For the Central Atlantic States :

Arkansas	Limbirtwig
Ben Davis	Maiden Blush
Benoni	Missouri
Bough	Oldenburg
Buckingham	Ralls
Buncombe	Rambo
Chenango	Red Astrachan
Early Harvest	Red June
Gano	Rome Beauty
Golden Sweet	Stayman Winesap
Gravenstein	Wealthy
Grimes	Winesap
Ingram	Yellow Transparent
Jefferis	York Imperial
Jonathan	

For the Middle West :

Arkansas	Jonathan
Bailey Sweet	McIntosh
Ben Davis	Maiden Blush
Benoni	Minkler
Chenango	Missouri
Delicious	Northern Spy
Domine	Northwestern
Fameuse	Oldenburg
Gano	Stayman Winesap
Golden Sweet	Wealthy
Grimes	Winesap
Ingram	Yellow Transparent
Jefferis	York Imperial

For the Far West :

Akin	Longfield
Alexander	McIntosh
Arkansas	Maiden Blush
Baldwin	Mammoth
Benoni	Mother
Ben Davis	Northern Spy
Delicious	Oldenburg
Early Harvest	Red Astrachan
Esopus	Rhode Island Greening
Fall Pippin	Rome Beauty
Fameuse	Stayman Winesap
Gano	Wagener
Gravenstein	Wealthy
Grimes	Winesap
Jefferis	Yellow Newtown
Jonathan	Yellow Transparent
King	

Varieties for the local market. Many more varieties in each of the sections mentioned may be used in local-market sales, for consumers can be educated to buy almost any good variety.

Varieties for the general market. As a rule, it is far better to raise only a few varieties for the general market. A man known for his Spies is much more certain of success in raising only these than in handling many varieties. Many dealers who have an established trade in one or two kinds of apples buy no others.

Varieties for permanent trees. For permanent trees select varieties that are long-lived, hardy, sturdy growers, and of a standard sort. For the northeastern states such varieties as Baldwin, Rhode Island Greening, and Spy are suitable. Farther south Ben Davis, Gano, Grimes, Missouri, and York Imperial are the kinds that will prove satisfactory. In the Middle West the grower may choose Arkansas, Ben Davis, Delicious, Grimes, Jonathan, and others, and in the Far West he may take Akin, Banana, Jonathan, Rome Beauty, Wagener, and Yellow Newtown.

Fillers. For fillers always select varieties that are known to produce fruit when very young and that are good market sorts. The following list contains many that are desirable but are given only as suggestions. Each locality must work out for itself a list of varieties suitable for this purpose.

For cold climates :

Duchess	Wealthy
Fameuse	Wolf River
McIntosh	

For New England, New York, and similar localities :

Duchess	Red Astrachan
Early Harvest	Wealthy
Fall Pippin	Yellow Transparent
McIntosh	

For the Central Atlantic States :

Bough	Oldenburg
Chenango	Red Astrachan
Early Harvest	Red June (and others)

For the Middle West :

Bailey Sweet	Fameuse
Chenango	Golden Sweet (and others)

For the Far West :

Early Harvest	Mother
Fall Pippin	Red Astrachan
Gravenstein	(and others)

Box trade. Only apples that are free from blemishes, of good color, of fair to good size, and of good shape should be placed in boxes. Probably the best varieties in the five apple sections of the country are as follows :

For Canada and the colder parts of New England :

Blue Pearmain	McIntosh
Fameuse	Wealthy
King	Yellow Transparent

For New England, New York, etc. :

Baldwin	Red Astrachan
Blue Pearmain	Twenty Ounce
McIntosh	Wealthy
Maiden Blush	Yellow Transparent
Northern Spy	

For the Central Atlantic States :

Gravenstein	Red Astrachan
Grimes	Stayman Winesap
Jonathan	York Imperial

For the Middle West :

Arkansas	Jonathan
Delicious	Maiden Blush
Fameuse	Stayman Winesap

For the Far West :

Arkansas	Jonathan
Banana	Maiden Blush
Delicious	Stayman Winesap
Fall Pippin	Wagener
Grimes	Yellow Newtown

The individual dessert trade. For fruit that is to be placed individually in small paper cartons or twelve specimens to a box, these varieties are to be recommended :

For Canada, New England, and New York :

Fameuse
McIntosh
Yellow Transparent

For the Central Atlantic States :

Golden Sweet
Red Astrachan
Yellow Transparent

For the Middle West :

Bailey Sweet	Golden Sweet
Delicious	Maiden Blush

For the Far West :

Banana	Rome Beauty
Esopus	Yellow Newtown
Mother	

Export trade. Almost all the hardy apples are suitable for export trade, but the varieties most used for this purpose throughout the country are the Baldwin, Northern Spy, Rhode Island Greening, and Ben Davis.

Lately some of the Western varieties, such as Grimes, Jonathan, Rome Beauty, Winesap, Wagener, and Yellow Newtown, have been demanded in different foreign countries. As this export trade increases, others will be introduced and a demand created for them.

The larger part of the export trade is shipped in barrels, but recently boxes have been used, and fruit men are now waiting for the general approval of this package.

Varieties for storage. In the following list the date indicates the time up to which the fruit can be safely kept in storage.

Baldwin, May 15.

Ben Davis, July 1.

Delicious.

Fallowater, April 1.

Gano (like the Ben Davis, a good long-keeping apple).

Grimes Golden, February 1 latest.

Golden Russet, June 1.

Jonathan (an excellent storage variety).

King, May 1.

Lady Sweet, May 1.

Limbertwig, July 1.

Mammoth Black Twig, February 15 latest.

Mann, excellent July 1.

Minkler (an excellent variety for cold-storage purposes; does not scald badly or shrivel).

Northern Spy, April 15.

Northwest Greening (requires care in handling).

Pewaukee, May 15.

Red Canada, May 1.

Rhode Island Greening, April 1.

Rome Beauty, May 1.

Roxbury Russet, June 15.

Scott Winter, April 1.

Stark, July 1.

Stayman Winesap (a valuable storage variety if well colored; market March 17).

Swaar, May 1.

Wealthy (if properly ripened, carefully handled, and immediately stored, can be kept in good condition until May).

Winesap (when properly matured a valuable apple, whether intended for cold storage or common storage).

Yellow Newtown, May 1.

Varieties for cider. Almost any juicy variety, such as the Roxbury Russet, Smith Cider, Baldwin, McIntosh, Wealthy, Red Canada, Winesap, is good for cider making. However, early varieties do not make as good cider as late ones, and yellow apples do not give as good color to the cider as red or colored varieties.

Varieties for drying. For drying, the variety should be a hard-fleshed, firm apple — fall apples or soft, mushy fruit are not desirable. Baldwins, Rhode Island Greenings, and all that are listed above under "Varieties for storage" are satisfactory for this purpose.

Strongly colored varieties. The following are among the sorts most distinctly and solidly colored :

Most popular red apples :

Early: Red Astrachan
 Midseason: McIntosh
 Late: Baldwin

Most popular green apples :

Early: Bough
 Midseason: Fall Pippin
 Late: Rhode Island Greening

Most popular yellow apples :

Early: Yellow Transparent
 Midseason: Grimes
 Late: Yellow Newtown

Some good combinations of colors :

Early: Red Astrachan
 Midseason: Fall Pippin
 Late: Yellow Newtown

Early: Yellow Transparent
 Midseason: McIntosh
 Late: Rhode Island Greening

Early: Bough
 Midseason: Grimes
 Late: Baldwin

Older varieties. Many old varieties are of great value to the home growers and probably to the local trade. Wherever these older varieties are growing, it is highly important that they be tested out for desirability.

Newer varieties. Experiment stations and the government, as well as some private individuals, are working to secure new varieties of merit. Probably the Geneva Experiment Station has produced as many new varieties as any other source. A new variety should possess some special merit before being considered worth cultivating. It should be especially desirable because of size, shape, color, quality, or some other characteristic, or a combination of these.

APPENDIX

TABLE I. AVERAGE PRICES OF VARIETIES BY MONTHS¹

VARIETY	1893-1894 TO 1902-1903											
	August	September	October	November	December	January	February	March	April	May	June	
Alexander	\$2.13	\$2.39	\$2.77	\$2.75								
Fall Pippin	1.56	1.89	2.09	1.98								
Fameuse			2.47	2.92	\$3.47							
Gravenstein	1.82	2.16	2.03									
Maiden Blush	1.64	1.86	2.08									
McIntosh												
Oldenburg	1.99	2.01	1.62									
Pound Sweet		2.75	2.00	1.50	1.25							
Twenty Ounce	1.83	1.93	2.05	2.64								
Baldwin		1.75	1.85	2.30	2.61	\$2.75	\$3.03	\$3.15	\$3.45	\$3.56	\$3.57	
Ben Davis			2.44	2.46	2.65	2.67	2.88	3.27	3.53	3.56	3.42	
Esopus Spitzenburg			2.91	3.03	3.34	3.13	3.61	3.68	3.60	3.29		
Northern Spy		1.89	2.32	2.47	2.72	3.00	3.06	3.73	3.49		3.05	
Rhode Island	1.99	2.01	2.43	2.75	2.91	3.12	3.30	3.76	3.34			
Russet							2.98	2.83				
Tompkins King		2.31	2.48	2.99	2.99	2.96	3.38	3.03	1.84	3.07	3.10	
	1903-1904 TO 1912-1913											
Alexander	3.08	3.18	3.18	3.30								
Fall Pippin	2.43	2.43	2.52	2.87								
Fameuse			2.82	3.01	2.56							
Gravenstein	2.48	2.62	2.64									
Maiden Blush	2.23	2.41	2.42									
McIntosh		2.93	3.58	3.64	3.70							
Oldenburg	2.63	2.72	2.91									
Pound Sweet		1.68	2.02	2.34	2.37							
Twenty Ounce	2.46	2.57	2.66	2.96								
Baldwin		2.68	2.16	2.39	2.54	2.80	3.19	3.40	3.61	4.07	4.93	
Ben Davis			2.44	2.41	2.29	2.47	2.71	3.21	3.25	3.80	3.94	
Esopus Spitzenburg			2.44	2.79	2.87	2.97	3.57	3.57	3.52	4.02		
Northern Spy			2.17	2.69	2.77	2.87	3.44	3.60	3.85	4.33	4.51	
Rhode Island		2.99	2.31	2.69	2.96	3.09	3.24	3.47	3.99	4.08		
Russet								2.79	2.79	3.29	3.44	
Tompkins King		2.61	2.79	2.99	3.13	3.27	3.58	3.44	3.30			

¹ After H. B. Knapp, Ithaca, N.Y.

TABLE II. AVERAGE PRICES PER BARREL OF APPLES IN NEW YORK BY MONTHS FOR TWENTY YEARS¹

	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
1893-1894	\$2.18	\$2.45	\$2.65	\$3.10	\$3.88	\$4.56	\$5.10	\$4.37	\$5.00	\$4.98	
1894-1895	1.83	1.95	2.17	2.34	2.58	3.00	3.84	3.66	4.00	3.52	
1895-1896	1.56	1.59	1.99	2.13	2.28	2.40	2.64	2.95	3.19	3.16	\$3.25
1896-1897	1.49	1.32	1.31	1.20	1.20	1.30	1.53	1.56	2.22	2.00	2.89
1897-1898	1.98	2.11	2.22	2.54	2.99	3.27	3.23	3.16	3.08	3.26	3.47
1898-1899	2.13	2.43	2.27	3.48	3.93	4.12	4.00	4.61	4.33	3.92	4.14
1899-1900	1.69	1.81	1.78	2.05	2.51	2.61	2.91	3.38	4.19	4.07	3.37
1900-1901	1.63	1.84	1.87	2.32	2.70	2.74	3.11	3.23	3.36	3.52	4.31
1901-1902	3.08	3.23	3.80	4.45	4.10	2.59	3.21	3.68	3.87	3.99	3.37
1902-1903	2.00	1.72	1.99	1.77	1.76	2.56	2.35	2.37	2.37	2.50	2.56
1903-1904	2.38	2.02	2.18	2.42	2.36	2.40	2.85	2.67	2.60	2.66	2.55
1904-1905	2.15	1.85	1.75	1.95	2.19	2.22	2.34	2.41	2.20	2.72	3.31
1905-1906	2.54	2.56	2.90	3.32	3.53	3.50	4.51	4.77	5.10	5.21	5.48
1906-1907	2.67	2.48	2.34	2.38	2.19	2.26	2.80	3.82	3.94	5.23	5.64
1907-1908	2.91	2.94	2.94	3.06	2.95	3.08	3.71	3.04	3.33	3.95	1.93
1908-1909	2.93	2.59	2.75	3.00	3.58	4.11	4.33	4.29	4.29	4.00	4.93
1909-1910	3.15	3.31	3.04	3.27	3.20	3.00	3.23	3.10	3.14	3.28	3.88
1910-1911	3.17	3.27	3.28	3.40	3.37	3.77	4.19	4.48	4.85	4.81	4.33
1911-1912	2.34	2.22	2.51	2.63	2.59	2.87	2.66	3.03	3.44	3.66	3.11
1912-1913	2.66	2.66	2.48	2.40	2.38	2.53	2.69	2.44	2.60	4.01	4.09
Yearly average for twenty years	\$2.27	\$2.32	\$2.41	\$2.66	\$2.81	\$2.94	\$3.26	\$3.35	\$3.56	\$3.74	\$3.70
Yearly average 1893 to 1903	1.96	2.05	2.20	2.54	2.79	2.91	3.40	3.30	3.56	3.52	3.42
Yearly average 1903 to 1913	2.67	2.59	2.62	2.78	2.83	2.97	3.33	3.40	3.56	3.96	3.92

NOTE: Sixteen varieties are considered in this table—all that were quoted consistently enough to be worthy of consideration. They are Alexander, Fall Pippin, Fameuse, Gravenstein, Maiden Blush, McIntosh, Oldenburg, Twenty Ounce, Baldwin, Ben Davis, Esopus, Spitzenburg, Northern Spy, Rhode Island, Russet, Tompkins King, Pound Sweet. In the statement of receipts the number of barrels of each variety is not given. Each variety has equal weight for the months for which it is quoted. This allows for some error, but is the most nearly accurate way of figuring.

¹After H. B. Knapp, Ithaca, N. Y.

TABLE IV. SHOWING THE HIGH, THE LOW, AND THE AVERAGE PRICES BY MONTHS OF WINTER APPLES IN THE NEW YORK MARKET COVERING TWENTY YEARS¹

VARIETY	For ten years, from 1893-1894 to 1902-1903										For ten years, from 1903-1904 to 1912-1913											
	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY
Baldwin	High	\$2.02	\$2.15	\$2.73	\$3.09	\$3.21	\$3.54	\$3.55	\$3.90	\$3.96	\$4.06	\$3.50	\$2.58	\$2.66	\$2.97	\$3.41	\$3.88	\$4.07	\$4.31	\$4.79	\$4.62	\$4.81
	Low	1.48	1.56	1.88	2.14	3.29	2.52	2.76	3.00	3.16	3.41	2.50	4.58	1.97	1.82	1.97	2.19	2.51	2.74	2.97	3.45	3.44
	Avg.	1.75	1.85	2.30	2.61	2.75	3.03	3.15	3.45	3.56	3.57	3.00	2.68	2.16	2.39	2.54	2.80	3.19	3.40	3.64	4.07	4.03
Ben Davis	High	1.25	6.83	7.29	7.13	6.33	6.51	7.33	4.00	4.69	7.39	3.00	—	72.96	2.93	2.81	3.68	3.26	3.76	3.82	4.37	4.48
	Low	1.50	1.69	2.01	2.16	2.04	2.25	2.72	3.07	3.03	2.96	2.50	—	1.99	1.69	1.77	1.89	2.17	2.66	2.69	3.23	3.40
	Avg.	1.88	2.41	2.46	2.65	2.67	2.88	3.27	3.53	3.56	3.42	2.75	—	2.44	2.41	2.29	2.47	2.71	3.21	3.25	3.80	3.94
Northern Spy	High	—	2.25	2.75	2.97	3.22	3.50	3.62	4.35	3.92	3.96	4.00	3.00	5.27	3.33	3.44	3.54	4.19	4.36	4.69	5.22	5.36
	Low	—	1.54	1.89	1.97	2.23	2.51	2.51	3.11	2.89	2.45	3.00	2.00	1.77	2.06	2.11	2.21	2.69	2.84	3.02	3.45	3.67
	Avg.	—	1.89	2.32	2.47	2.72	3.00	3.06	3.73	3.40	3.05	3.50	2.50	2.17	2.69	2.77	2.87	3.44	3.60	3.85	4.33	4.51
Rhode Island	High	2.15	2.36	2.68	3.33	3.45	3.76	3.99	4.52	4.81	4.00	—	8.250	2.91	3.55	3.94	3.91	4.06	4.32	4.81	5.12	4.73
	Low	1.65	1.66	1.88	2.17	2.37	2.48	2.62	3.00	2.87	3.00	—	1.69	1.71	1.84	1.98	2.27	2.42	2.73	3.09	3.05	3.37
	Avg.	1.90	2.01	2.43	2.75	2.91	3.12	3.30	3.76	3.34	3.50	—	2.09	2.31	2.69	2.96	3.09	3.24	3.47	3.90	4.08	4.05
Spitzenburg	High	—	3.58	3.66	4.13	4.06	4.61	4.75	6.71	3.50	—	23.25	5.99	3.66	3.68	3.78	4.45	4.39	4.38	5.62	5.60	—
	Low	—	2.25	2.41	2.50	2.20	2.61	2.62	3.10	3.08	—	2.00	1.99	1.99	2.07	2.17	2.70	2.76	2.67	3.02	4.00	—
	Avg.	—	2.91	3.03	3.34	3.13	3.61	3.68	3.90	3.29	—	2.62	2.44	2.79	2.87	2.97	3.57	3.57	3.52	4.02	4.50	—
Tompkins King	High	2.63	2.99	3.58	3.55	4.09	3.75	2.31	1.50	—	—	6.322	3.49	3.82	3.93	4.03	4.42	4.23	4.66	4.78	16.50	—
	Low	1.99	1.98	2.40	2.44	2.38	2.67	2.32	1.37	1.75	—	2.00	2.09	2.17	2.33	2.51	2.75	2.90	2.55	3.10	5.50	—
	Avg.	2.31	2.48	2.99	2.99	2.96	3.38	3.03	1.84	2.12	—	2.61	2.79	2.99	3.13	3.27	3.58	3.44	3.30	3.94	6.00	—
Russet	High	—	—	—	—	—	53.29	3.30	3.50	3.64	1.50	—	—	—	—	—	—	—	—	—	4.34	—
	Low	—	—	—	—	—	2.67	3.37	2.56	2.57	2.50	—	—	—	—	—	—	—	—	—	2.86	4.00
	Avg.	—	—	—	—	—	2.98	2.83	3.07	3.10	3.00	—	—	—	—	—	—	—	—	—	3.44	4.17

NOTE. Superior figures indicate number of years that quotations appear for each of the ten-year periods.

¹ Alter H. B. Knapp, Ithaca, N. Y.

TABLE V. MONTHLY AND YEARLY RECEIPTS OF APPLES IN NEW YORK CITY (IN BARRELS), 1893-1913¹

	August	September	October	November	December	January	February	March	April	May	June	July	Total
1893-1894	4,632	20,461	57,068	69,166	25,678	18,662	15,462	12,451	8,845	5,414	971	1,430	237,204
1894-1895	17,046	33,800	125,000	159,527	58,419	33,632	27,942	36,522	24,668	10,442	2,193	20,177	548,768
1895-1896	33,510	75,394	152,419	104,463	110,638	50,327	58,782	45,293	30,209	13,955	1,497	12,017	748,594
1896-1897	51,047	188,135	293,491	273,052	105,494	115,096	134,113	125,945	74,936	24,054	9,683	19,813	1,446,359
1897-1898	38,713	71,433	203,538	166,477	81,095	70,949	62,500	71,913	47,521	25,532	7,046	5,366	882,475
1898-1899	36,428	76,867	161,879	117,068	80,251	46,578	37,323	36,732	33,148	10,368	1,547	11,276	661,692
1899-1900	47,918	102,955	206,216	185,785	113,277	75,164	72,156	60,201	38,468	16,528	2,800	3,517	625,105
1900-1901	23,116	82,426	176,411	136,652	101,193	96,087	69,548	69,917	55,282	25,050	3,507	5,443	601,410
1901-1902	18,379	53,611	127,101	106,371	57,021	51,597	36,013	36,671	43,463	18,328	5,471	10,576	594,392
1902-1903	68,007	154,475	287,936	255,042	166,071	130,626	122,687	160,567	66,626	62,503	33,665	23,721	1,503,726
Yearly average for ten years	33,370	85,950	176,115	171,491	96,694	66,385	63,659	65,632	45,314	21,068	6,814	11,337	847,696
1903-1904	95,142	246,684	435,959	399,130	193,206	144,919	165,102	166,698	168,761	56,203	31,811	8,016	2,051,622
1904-1905	85,332	284,112	309,135	337,336	168,721	143,071	122,505	103,460	139,397	70,023	20,437	22,239	1,887,695
1905-1906	143,952	252,056	367,638	281,482	152,045	110,369	82,084	80,466	49,034	27,802	10,688	7,688	1,574,543
1906-1907	174,657	255,600	478,323	413,566	223,554	223,496	145,847	173,133	87,412	39,442	12,594	1,017	2,229,494
1907-1908	60,488	137,720	350,529	394,490	171,099	168,649	117,038	160,210	168,194	75,719	33,162	13,839	1,702,046
1908-1909	121,641	310,289	447,895	337,586	217,601	137,683	92,688	87,168	61,486	32,399	11,857	5,470	1,803,737
1909-1910	64,395	183,892	393,288	406,772	248,797	131,769	138,119	162,011	68,704	51,693	16,548	6,493	1,694,671
1910-1911	78,078	166,597	538,630	416,374	208,496	127,015	115,654	105,385	74,391	48,107	23,030	5,550	1,937,883
1911-1912	75,022	199,039	320,569	314,330	301,257	176,639	171,219	138,045	102,727	52,757	22,604	5,335	1,880,503
1912-1913	41,335	171,798	636,626	464,450	223,096	201,454	193,840	217,240	191,250	93,069	45,177	16,769	2,466,647
Yearly average for ten years	94,953	223,780	427,858	373,551	210,877	157,392	134,506	148,385	101,236	54,835	23,125	6,317	1,688,884

NOTE. Boxes have been reduced to barrels, three boxes to a barrel.

¹ After H. B. Knapp, Ithaca, N. Y.

TABLE VI. AVERAGE PRICE OF APPLES IN NEW YORK FOR TWENTY YEARS¹

	Total receipts (barrels)	Total value	Average price per barrel
1893-1894	2,31,863	8805,873	\$3.43
1894-1895	520,338	1,368,710	2.60
1895-1896	736,487	1,627,007	2.21
1896-1897	1,426,546	2,018,411	1.41
1897-1898	877,077	2,336,034	2.66
1898-1899	650,686	2,116,021	3.25
1899-1900	921,648	2,147,728	2.33
1900-1901	805,967	2,238,004	2.50
1901-1902	553,816	2,057,679	3.72
1902-1903	1,540,005	3,196,294	2.08
1903-1904	2,043,606	4,880,324	2.39
1904-1905	1,895,459	3,895,384	2.00
1905-1906	1,566,855	5,176,749	3.30
1906-1907	2,227,577	5,880,810	2.64
1907-1908	1,687,719	5,150,687	3.05
1908-1909	1,858,207	5,902,356	3.22
1909-1910	1,868,268	6,045,390	3.18
1910-1911	1,932,327	6,904,624	3.57
1911-1912	1,875,168	5,028,725	2.68
1912-1913	2,438,606	6,320,766	2.59

TABLE VII. STATEMENT OF CARLOADS OF APPLES SHIPPED ON NEW YORK CENTRAL AND HUDSON RIVER RAILROAD FROM THE WESTERN NEW YORK STATE FRUIT BELT IN 1909

Shipments from the stations named below at which there are no storage facilities, consequently there is no doubt that the shipments originated at the stations named.

Barker	573 cars
Middleport	298 cars
Brockport	295 cars
Appleton	237 cars
Holley	230 cars
Spencerport	193 cars
Ransomville	187 cars
Kendall	181 cars
Greece	144 cars
Adam's Basin	144 cars
Morton	136 cars
South Greece	65 cars
Total	2683 cars

Figuring 175 barrels to the car, this produces a total of 469,525 barrels.

It was not possible to obtain statistics which would indicate what proportion of the apples shipped from stations at which storage houses are located originated in the vicinity of such stations and were teamed to the storage warehouses, and the proportion shipped from near-by stations to the storage points; and consequently, if the figures for this latter table were used, they would include an unknown percentage of apples which may have been shipped from some one of the stations shown in the first table to the storage points.

The total for the twenty-four stations is 7,193 cars, or approximately 1,311,275 barrels.

Below is a statement of the number of cars shipped during the year 1909 from stations at which storage warehouses are located.

Albion	763 cars
Lockport	728 cars
Hilton	593 cars
Medina	551 cars
Burt	541 cars
Gasport	455 cars
Carlton	222 cars
Lyndonville	216 cars
Hamilton	204 cars
Ashwood	198 cars
Le Roy	196 cars
Waterport	173 cars
Total	4810 cars

Figuring on the basis of 175 barrels per car, this produces 841,750 barrels.

¹The total value for the year is obtained by multiplying the receipts for each month (Table V) by the average price for that month (Table II). The total value divided by the total receipts gives the average price. This is the most nearly accurate method of determining the price with the figures available. No price was obtained for July, therefore the receipts for July were omitted. This was necessary also for June, 1893-1894; June, 1894-1895; August, 1907-1908; and August, 1912-1913.

TABLE VIII. CHART SHOWING THE PREFERENCES OF DIFFERENT UNITED STATES MARKETS FOR VARIOUS APPLE VARIETIES.

APPLES	BALDWIN	GREENING	Say	HERRINGTON	WAGENER	KING	GILFLO	HEALTHY	BEN DAVIS	NEWTOWN	ROBERT	GOLDEN	TEERNO	LEATHER	JONATHAN	YELLOW	DECESS	WEALTHY	ALEXANDER	MADISON	TWENTY	POND	TOLMAN	HOLLAND	YORK POTTIN	SNOW	MCINTOSH	GREEN	RED	ASTRACHAN									
BALTIMORE	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex								
BOSTON	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex								
BUFFALO	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex							
CHICAGO	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex						
CINCINNATI	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex					
CLEVELAND	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex				
COLUMBUS	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex				
DENVER	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g				
DETROIT	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex			
INDIANAPOLIS	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex			
KANSAS CITY	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex		
LOUISVILLE	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	
LOUISVILLE	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	
MEMPHIS	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	
MILWAUKEE	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
MOBILE	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
NEW ORLEANS	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
NEW YORK	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
NEW YORK	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
NORFOLK	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
NORFOLK	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
OMAHA	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
PEORIA	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
PHILADELPHIA	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
PITTSBURGH	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
PITTSBURGH	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
RICHMOND	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
RICHMOND	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
ST. LOUIS	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
ST. LOUIS	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
ST. PAUL	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
ST. PAUL	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
TOLLEDO	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
TOLLEDO	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex
WASHINGTON	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex	ex

KEY (in descending order of merit). Ex = "excellent"; and so reported by every one; v.g. = "very good"; g = "good"; and so reported; f.g. = "fairly good"; and so reported; f = "fair"; p = "poor"; un* = "unknown"; n.g. = "no good"; l = "late"; f = "few wanted"; f = "fanning"; § = "best sweet"; || = "to January 1"; anything reported "excellent" or "v.g." = "a very good demand." When any other term is used before "ex" or "v.g." as f to ex, it indicates that some of the trade in that market has an excellent demand for the variety, and some of it has but a fair demand. Any market reporting poor or fair for a variety might be taken as a safe indication that the variety is either in poor favor or little known.

1 By Samuel Fraser, Geneseo, N.Y.

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