3-1915

Making Old Orchards Profitable

Laurenz Greene

Iowa State College

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Making Old Orchards Profitable

Abstract
In many sections of Iowa apples can be grown successfully and profitably in a large way, provided the industry is carefully studied and its problems are dealt with correctly.

To furnish a basis for study, to get at the difficulties of orcharding in the state, and to help growers meet them successfully and put the industry on a more permanent and profitable basis, the Iowa Agricultural Experiment Station, in the summers of 1911 and 1912, made a survey of the orchards of Mills county. This county was chosen because it ranked first in apple production and in the percentage of tillable soil devoted to this crop, although Pottawattamie county had a larger total area of apple orchards. In the survey every phase of orcharding was investigated and the results are reported in this bulletin, with suggestions for meeting the various problems that arise in the industry, and particularly for saving and restoring old orchards to profitable production.

While this report is made up of recommendations for the orchards of Mills county it will apply to orchards in all parts of the state. Iowa's rank as a fruit producing state, and the importance of the Missouri loess as an apple producing soil appear in these tables.

Keywords
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Disciplines
Agricultural Science | Agriculture | Fruit Science | Horticulture
Making Old Orchards Profitable

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IOWA STATE COLLEGE OF AGRICULTURE
AND THE MECHANIC ARTS

Pomology Section

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MAKING OLD ORCHARDS PROFITABLE

By LAURENZ GREENE

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While this report is made up of recommendations for the orchards of Mills county it will apply to orchards in all parts of the state.

Iowa's rank as a fruit producing state, and the importance of the Missouri loess as an apple producing soil appear in these tables.

ORCHARD AREA IN MILLS COUNTY

Table III gives the number of apple trees in Mills county for 1909 as 242,466. Estimating the average number of trees per acre as 80, the acreage in both commercial and home orchards was about 3,000 acres. There was a loss of about 50,000 trees in the 10 years

TABLE I. TEN HIGHEST APPLE PRODUCING STATES
(Crop of 1909 according to 1910 census)
### TABLE II. AVERAGE ANNUAL PRODUCTION (By States, 1899 to 1910)*

<table>
<thead>
<tr>
<th>Rank</th>
<th>State</th>
<th>AVERAGE ANNUAL PRODUCTION</th>
<th>In Barrels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New York</td>
<td>5,122,250</td>
<td>943,666</td>
</tr>
<tr>
<td>2</td>
<td>Pennsylvania</td>
<td>3,414,186</td>
<td>782,416</td>
</tr>
<tr>
<td>3</td>
<td>Ohio</td>
<td>2,516,416</td>
<td>703,083</td>
</tr>
<tr>
<td>4</td>
<td>Michigan</td>
<td>2,608,500</td>
<td>694,500</td>
</tr>
<tr>
<td>5</td>
<td>Illinois</td>
<td>1,273,333</td>
<td>685,583</td>
</tr>
<tr>
<td>6</td>
<td>Missouri</td>
<td>1,130,916</td>
<td>597,583</td>
</tr>
<tr>
<td>7</td>
<td>Indiana</td>
<td>1,088,583</td>
<td>518,333</td>
</tr>
<tr>
<td>8</td>
<td>California</td>
<td>1,031,418</td>
<td>502,606</td>
</tr>
<tr>
<td>9</td>
<td>Maine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Iowa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Arkansas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>New Hampshire</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE III. LEADING APPLE PRODUCING COUNTIES IN IOWA (From the 1910 Census)

<table>
<thead>
<tr>
<th>Rank</th>
<th>County</th>
<th>Trees reported April 15, 1910</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mills</td>
<td>1,096</td>
</tr>
<tr>
<td>2</td>
<td>Pottawattamie</td>
<td>2,751</td>
</tr>
<tr>
<td>3</td>
<td>Fremont</td>
<td>1,452</td>
</tr>
<tr>
<td>4</td>
<td>Page</td>
<td>1,986</td>
</tr>
<tr>
<td>5</td>
<td>Harrison</td>
<td>1,560</td>
</tr>
<tr>
<td>6</td>
<td>Ringgold</td>
<td>1,791</td>
</tr>
<tr>
<td>7</td>
<td>Decatur</td>
<td>1,088</td>
</tr>
<tr>
<td>8</td>
<td>Appanoose</td>
<td>1,844</td>
</tr>
<tr>
<td>9</td>
<td>Warren</td>
<td>2,167</td>
</tr>
<tr>
<td>10</td>
<td>Davis</td>
<td>1,984</td>
</tr>
<tr>
<td>11</td>
<td>Wayne</td>
<td>1,867</td>
</tr>
<tr>
<td>12</td>
<td>Cass</td>
<td>1,749</td>
</tr>
<tr>
<td>13</td>
<td>Montgomery</td>
<td>1,418</td>
</tr>
<tr>
<td>14</td>
<td>Van Buren</td>
<td>1,864</td>
</tr>
<tr>
<td>15</td>
<td>Madison</td>
<td>1,913</td>
</tr>
<tr>
<td>16</td>
<td>Monroe</td>
<td>1,260</td>
</tr>
<tr>
<td>17</td>
<td>Lucas</td>
<td>1,442</td>
</tr>
</tbody>
</table>

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<td>1,452</td>
</tr>
<tr>
<td>4</td>
<td>Page</td>
<td>1,986</td>
</tr>
<tr>
<td>5</td>
<td>Harrison</td>
<td>1,560</td>
</tr>
<tr>
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<td>1,791</td>
</tr>
<tr>
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<td>Decatur</td>
<td>1,088</td>
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<tr>
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<td>1,844</td>
</tr>
<tr>
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<td>2,167</td>
</tr>
<tr>
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</tr>
<tr>
<td>16</td>
<td>Monroe</td>
<td>1,260</td>
</tr>
<tr>
<td>17</td>
<td>Lucas</td>
<td>1,442</td>
</tr>
</tbody>
</table>

*Statistics from Better Fruit, Hood River, Oregon, Oct., 1911.

### TABLE IV. NUMBER OF COMMERCIAL ORCHARDS AND AREA PLANTED IN MILLS COUNTY, 1883 TO 1912

<table>
<thead>
<tr>
<th>Year planted</th>
<th>No of Orchards</th>
<th>Area, Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1883</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>1884</td>
<td>7</td>
<td>120</td>
</tr>
<tr>
<td>1885</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>1886</td>
<td>2</td>
<td>53</td>
</tr>
<tr>
<td>1887</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>1888</td>
<td>4</td>
<td>88</td>
</tr>
<tr>
<td>1889</td>
<td>10</td>
<td>168</td>
</tr>
<tr>
<td>1891</td>
<td>30</td>
<td>620</td>
</tr>
</tbody>
</table>
preceding, making approximately 625 acres less orchards in the county in 1909 than in 1899. Evidently, practically no new orchards are coming into bearing to take the places of those which are being lost. With a total area of 440 square miles, or 281,600 acres, Mills county has an orchard acreage only a little over one per cent of the whole. But Glenwood township shows an orchard acreage of over 1,000, or nearly 10 per cent of its total area.

VARIETIES FOUND IN MILLS COUNTY

While many varieties of apple trees are found in the county, comparatively few are grown commercially. The Jonathan and Ben Davis far outnumber any other varieties. In number of trees planted, Ben Davis probably leads, while Jonathan is a close second.

Each grower was asked to recommend a list of varieties for commercial planting. Table V shows these recommendations. Nearly all name the Jonathan, while some of the other varieties were recommended to be planted with it.

**TABLE V. SHOWING VARIETIES RECOMMENDED BY MILLS COUNTY GROWERS**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jonathan</td>
<td>31</td>
</tr>
<tr>
<td>Ben Davis</td>
<td>24</td>
</tr>
<tr>
<td>Grimes Golden</td>
<td>14</td>
</tr>
<tr>
<td>Duchess of Oldenburg</td>
<td>13</td>
</tr>
<tr>
<td>Wealthy</td>
<td>12</td>
</tr>
<tr>
<td>Winesap</td>
<td>4</td>
</tr>
<tr>
<td>Ralls</td>
<td>4</td>
</tr>
<tr>
<td>Missouri Pippin</td>
<td>1</td>
</tr>
<tr>
<td>Gano</td>
<td>2</td>
</tr>
<tr>
<td>Delicious</td>
<td>2</td>
</tr>
<tr>
<td>Willow Twig</td>
<td>1</td>
</tr>
<tr>
<td>Reynold's Sweet</td>
<td>1</td>
</tr>
<tr>
<td>Benoni</td>
<td>1</td>
</tr>
<tr>
<td>Black Ben Davis</td>
<td>1</td>
</tr>
<tr>
<td>Missouri Pippin</td>
<td>1</td>
</tr>
</tbody>
</table>

The western Iowa soil grows Jonathan and Grimes Golden to such perfection that it would seem desirable to make these two varieties the leading ones in future plantings. Grimes Golden, however, has one objectionable feature which makes it undesirable to grow on its own roots. In dry seasons the roots evidently do not furnish sufficient moisture, so that the tree is weakened. If these dry seasons are followed by severe winters, the bark will rot away near the surface of the ground, thus killing the tree. Numerous specimens of this variety were found to be in dying condition. Were the tree topworked on a hardier stock like Hibernal or Virginia crab it is believed this trouble would be overcome.

PLANTING PLANS

By far the greater proportion of the Mills county orchards were planted on the square plan as shown in fig. 1. A few were planted on the hexagonal system, fig. 2, and some on the quincunx, fig. 3. Some of the orchards were originally planted as far apart as 36 ft. x 36 ft., but many were planted as close as 16 ft. x 16 ft., 12 ft. x 24 ft., 15 ft. x 30 ft., etc. The average distance for 1,828 acres was 22 ft. x 22 ft., or 87 trees per acre. In all probability the close planting was made with the idea of taking out the trees before they began to crowd, but this has been done in only a few instances. It is rare that a man will cut out fillers and unless he has the courage
to do so, the planting of permanent trees closer than 33 ft. x 33 ft. is objectionable.

Accurate figures as to yield from plantings at these different distances could not be secured, but the health and vigor of the trees was quite noticeably better where the trees were given sufficient space for development.

---

Fig. 1 Rectangular: Original

Properly Thinned.

Fig. 2 Hexagonal: Original

Properly Thinned.

Fig. 3 Quincunx: Original

Properly Thinned.
Trees should not be allowed to crowd and thinning should begin before the branches of neighboring trees interlock.

TABLE VI. YIELD IN BUSHELS, GROSS INCOME AND NET INCOME PER ACRE UNDER DIFFERENT METHODS OF SOIL MANAGEMENT IN MILLS COUNTY

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1909</th>
<th>1911</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Orchards</td>
<td>Yield in Bushels</td>
</tr>
<tr>
<td>Sod</td>
<td>17</td>
<td>165</td>
</tr>
<tr>
<td>Sod and Manure</td>
<td>4</td>
<td>270</td>
</tr>
<tr>
<td>Partial Tillage</td>
<td>2</td>
<td>198</td>
</tr>
<tr>
<td>Partial Tillage and Manure</td>
<td>2</td>
<td>219</td>
</tr>
<tr>
<td>Sod Mulch</td>
<td>1</td>
<td>189</td>
</tr>
</tbody>
</table>

* No reports.

TABLE VII. AVERAGE YIELD IN BUSHELS, GROSS INCOME AND NET INCOME PER ACRE FOR 1909 AND 1911, UNDER DIFFERENT SOIL MANAGEMENT IN MILLS COUNTY

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1909</th>
<th>1911</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Orchards</td>
<td>Yield in Bushels</td>
</tr>
<tr>
<td>Sod</td>
<td>10</td>
<td>162.9</td>
</tr>
<tr>
<td>Sod and Manure</td>
<td>2</td>
<td>320.75</td>
</tr>
<tr>
<td>Sod Mulch</td>
<td>1</td>
<td>102.75</td>
</tr>
<tr>
<td>Partial Tillage</td>
<td>2</td>
<td>231.75</td>
</tr>
</tbody>
</table>

* Different treatments represented in the same orchard.

TABLE VIII. HOW OFTEN 110 ORCHARD MEN PRUNE THEIR TREES IN MILLS COUNTY

<table>
<thead>
<tr>
<th>Pruning Schedule</th>
<th>No. of Orchards</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annually</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>Not Pruned Annually</td>
<td>59</td>
<td>80.6</td>
</tr>
<tr>
<td>Each 2nd year</td>
<td>6</td>
<td>5.4</td>
</tr>
<tr>
<td>Each 3rd year</td>
<td>7</td>
<td>6.3</td>
</tr>
<tr>
<td>Each 5th year</td>
<td>2</td>
<td>2.7</td>
</tr>
<tr>
<td>At indefinite periods</td>
<td>31</td>
<td>25.1</td>
</tr>
<tr>
<td>No pruning</td>
<td>42</td>
<td>38.1</td>
</tr>
</tbody>
</table>
TABLE IX. YIELD IN BUSHELS PER ACRE UNDER VARIOUS METHODS OF PRUNING IN MILLS COUNTY

<table>
<thead>
<tr>
<th>Pruned</th>
<th>1909</th>
<th>1911</th>
<th>1909 and 1911</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Orchards</td>
<td>Yield</td>
<td>No. of Orchards</td>
</tr>
<tr>
<td>Annually</td>
<td>8</td>
<td>240</td>
<td>10</td>
</tr>
<tr>
<td>Not pruned annually</td>
<td>20</td>
<td>106,9</td>
<td>28</td>
</tr>
<tr>
<td>Each 2nd year</td>
<td>3</td>
<td>131</td>
<td>22</td>
</tr>
<tr>
<td>Each 3rd year</td>
<td>1</td>
<td>105</td>
<td>19</td>
</tr>
<tr>
<td>Each 5th year</td>
<td>5</td>
<td>120</td>
<td>7</td>
</tr>
<tr>
<td>At indefinite periods</td>
<td>9</td>
<td>163</td>
<td>13</td>
</tr>
</tbody>
</table>

TABLE X. GROSS INCOME PER ACRE UNDER DIFFERENT METHODS OF PRUNING IN MILLS COUNTY ORCHARDS

<table>
<thead>
<tr>
<th>Pruned</th>
<th>1909</th>
<th>1911</th>
<th>1909 and 1911</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Orchards</td>
<td>Gross Income</td>
<td>No. of Orchards</td>
</tr>
<tr>
<td>Annually</td>
<td>8</td>
<td>92.5</td>
<td>5</td>
</tr>
<tr>
<td>Not pruned annually</td>
<td>15</td>
<td>70.57</td>
<td>22</td>
</tr>
<tr>
<td>Each 2nd year</td>
<td>2</td>
<td>47.61</td>
<td>2</td>
</tr>
<tr>
<td>Each 3rd year</td>
<td>5</td>
<td>75.53</td>
<td>3</td>
</tr>
<tr>
<td>Each 5th year</td>
<td>4</td>
<td>53.60</td>
<td>5</td>
</tr>
<tr>
<td>At indefinite periods</td>
<td>6</td>
<td>57.68</td>
<td>11</td>
</tr>
</tbody>
</table>

TABLE XI. NET INCOME PER ACRE UNDER DIFFERENT METHODS OF PRUNING IN MILLS COUNTY ORCHARDS

<table>
<thead>
<tr>
<th>Pruned</th>
<th>1909</th>
<th>1911</th>
<th>1909 and 1911</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Orchards</td>
<td>Net Income</td>
<td>No. of Orchards</td>
</tr>
<tr>
<td>Annually</td>
<td>3</td>
<td>128.89</td>
<td>6</td>
</tr>
<tr>
<td>Not pruned annually</td>
<td>4</td>
<td>54.16</td>
<td>15</td>
</tr>
<tr>
<td>Each 2nd year</td>
<td>1</td>
<td>69.00</td>
<td>1</td>
</tr>
<tr>
<td>Each 3rd year</td>
<td>3</td>
<td>40.19</td>
<td>3</td>
</tr>
<tr>
<td>Each 5th year</td>
<td>1</td>
<td>83.00</td>
<td>1</td>
</tr>
<tr>
<td>At indefinite periods</td>
<td>5</td>
<td>59.28</td>
<td>6</td>
</tr>
<tr>
<td>No pruning</td>
<td>3</td>
<td>50.00</td>
<td>6</td>
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</table>
COST OF PRUNING

The cost of pruning as reported by these growers varied from 3 to 20 cents per tree. Very few had kept accurate figures as to orchard costs, doing the work at seasons when they were not busy at other things and often working only a few hours at a time. The average cost as reported by these growers was approximately 10 cents per tree. One grower in renovating a twenty-year-old orchard gave his cost as 15 to 20 cents per tree. The orchard had not been pruned before for several years. Another grower, in the case of an orchard of about the same age, gave his cost as 10 cents per tree. Those who made annual pruning a practice gave their costs at from 3 to 6 cents per tree. There are many old orchards that would cost 30 to 50 cents per tree to put into profitable bearing.

The growers who had used sprayers were unanimous in agreeing to their value, although one or two who had tried them, had but poor results. Many growers who did not care to go to the trouble of spraying in their own orchards were of the opinion that to make orcharding a success spraying would have to be adopted. Others questioned the value of spraying, and a few objected to the use of poisons in their pastures.

ORCHARD RENOVATION

It matters but little whether there is one tree or several thousand in old orchards. They should be made to pay or be removed and the ground put to other uses. Many farmers have already tired of the unsightly old trees and have removed them. They should be commended for this if they are not going to give them a chance to produce profitable crops.

| TABLE XII. GROSS INCOME FROM SPRAYED AND UNSPRAYED ORCHARDS IN MILLS COUNTY IN 1909 |
|----------------------------------------|---------------------------------|------------------|
| Sprayed                                | No. of Orchards | Income per Acre |
| ................................. | 2                | $111.36         |
| Not Sprayed                           | 20               | $77.89          |

<table>
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<tr>
<th>TABLE XIII. YIELD, GROSS, AND NET INCOME PER ACRE IN SPRAYED AND UNSPRAYED ORCHARDS IN MILLS COUNTY IN 1911</th>
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<tr>
<td>Yield</td>
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<td>No. of Orchards</td>
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<td>Sprayed ..........</td>
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<td>Not Sprayed ......</td>
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The most probable reasons for this decline in orchards are a failure to use proper methods of management and a lack of interest in this line of agriculture. The principal agricultural industries in Iowa are grain and stock farming. The orchards were set out at a time when orchard planting was popular, but the trees failed to produce for a few years and the growers became tired of the orchard business. Greater diversification of agriculture is desirable under present conditions and orchards offer opportunity for enlarging the farm income if they are properly handled.

It is not impossible to make orchards bear profitable crops even though they are in a badly run-down condition. Many accounts have been written in recent years of successful orchard renovation, or rejuvenation as it has been called, and some of these read like fiction. In all probability most of them are true, however, for these old trees that have lived and thrived under neglect will well repay all careful work that is put upon them.

The question naturally arises as to what orchards it will pay to renovate. Several considerations must be taken into account before deciding whether it will pay to care for the old, run-down apple orchard.

Of most importance is the attitude of the man who plans to care for the orchard. If he attempts this renovation as an immediate means of increasing his income and does not expect to care for the trees after the initial work is completed, he will undoubtedly fail at it. It will in most instances require two or three years to put the orchard in condition to pay more than expenses, although many orchards have paid profits at once. But the care that follows the thinning out and pruning of the trees is of so much importance that nothing short of a determination to give persistent attention to the old orchard year after year will make it profitable to commence the work. Usually the owner who has not taken care of the trees in the past will not care for them in the future. Therefore, the greatest opportunity is open to the new owners and the younger men who have a liking for fruit growing and will give the trees the attention they need. However, if the present owner can bring himself to believe thoroughly in his orchard and give it the same care and attention that he does stock and grain farming, he can make a profit from the orchard.

WHEN RENOVATION PAYS

If there is a 50 per cent stand of trees in good healthly condition, and if there is a small percentage in addition that can be brought back into bearing by pruning and by the removal of disease, it will pay to undertake the work of orchard renovation. Where thinning is necessary, as is usually the case, the vacancies will tend to reduce
the cost. But if there should be less than 50 per cent of a stand after all thinning is completed, it would pay better to start with a new planting.

WHEN RENOVATION DOES NOT PAY

When trees have been repeatedly defoliated by the canker worms, or by other insects and diseases they lack in vigor and health and it is a question whether they can be successfully invigorated and made profitable. If, however, they are recovering satisfactorily from this loss of leaf surface, then the work may be undertaken with promise of success.

It will not pay to work with trees in the commercial orchard if there is a large mixture of worthless varieties. If the orchard is for home use, a large number of varieties will not be objectionable if they are good ones. If the orchard is for commercial purposes, it will not pay to work with fruit that does not sell readily on the market. Too large a percentage of summer apples is to be avoided unless a good market can be provided. The ideal commercial orchard comprises not more than three or four standard varieties, one summer, one fall, one medium late, and one late winter variety. This is the ideal plan, and the commercial orchardist, whether working with a young orchard or working with an old run-down orchard, should labor to this end. If there are a comparatively few trees of undesirable varieties these may be topworked to standard sorts as suggested in section on topworking.

The location of the orchard will have a bearing upon its possibilities for renewing. If it is far from market, the cost of transportation to the market will be great. The supply of labor should be considered also for the lack of it often means the difference between a large profit and a loss.

A good site for an orchard has good air drainage. Slopes of land that are higher than the surrounding country are desirable. While there is little choice of the exposures, some prefer an eastern slope. In all probability the eastern and northern slopes are cooler, and will retain their moisture longer than the southern and western exposures. It will pay best, therefore, to work with those old orchards that are planted where these conditions can be found. However, unless the orchard is in a "pocket" where frosts are apt to catch the blossoms, it will pay the owner to renovate it, providing the other conditions above mentioned are met.

HOW TO RENOVATE THE OLD ORCHARD

If the orchard is likely to be profitable when renovated, these various steps must be taken in the renovation. First, the trees must be stimulated; second, they must be fed; and third, they must be protected.

In some old orchards the trees are planted far too closely togeth-
er, some not more than 16 feet apart each way. These trees should be systematically thinned properly before any other steps are taken. If the trees are 18 to 25 years old, they should not stand less than 30 feet apart, while a greater distance is better. Where planted as close as 16 feet, three of every four trees should be taken out, leaving the trees 32x32 feet.

Before beginning this thinning out process, the grower should know what varieties are in the orchard. If he does not, he will be unable to tell which he can leave with the most profit. It is therefore best to start renovation in the fall while there are a few apples on the trees so that they can be identified. One of the simplest plans to follow in thinning to proper distance is to plat the orchard on paper, marking the variety of each tree thereon. In determining the vacancies when the thinning is completed the present vacancies should be included when possible. In selecting the trees which are to be left standing, the most profitable varieties should be chosen first, and then those that are most healthy, next.

**THINNING**

Fig. 4 represents an orchard of 160 trees, 42, or 26 per cent, of which are either missing, weak or undesirable varieties. The dotted lines show one lot of trees that would be left after thinning if the alternate trees on the solid lines were removed. Eight vacancies are found on the dotted lines and 8 weak trees or undesirable varieties, a total of 16, or 20 per cent of the total after thinning. If the trees on the dotted lines were removed and those on the solid lines retained there would be 14 missing trees and 12 weak trees or undesirable varieties, a total of 26, or 32½ per cent of the total after thinning. This diagram illustrates the value of platting the orchard before any thinning is done.

If the original trees stood 16½ feet apart on the plat before thinning they would stand 23.3 feet apart after thinning. If 24x24 feet before thinning they would be 33.9x33.9 after. The latter is a good distance but 23.3x23.3 feet will be found too close after a very few years of proper handling. They can be thinned by again taking out alternate rows leaving the trees 33x33 feet.

If the trees have been crowded, it is sometimes desirable to prune back more heavily from the sides those trees that are to be removed, and leave them standing for one or two years, thus allowing the tree which is to be permanent an opportunity to become accustomed to the greater supply of sunlight gradually. This plan also offers opportunity to secure a partial crop of fruit from the trees that would otherwise be removed. No trees, however, should be allowed to crowd when this method is used and it may be necessary to cut back severely each year. Thinning out of the trees can be done
Fig. 4. Plan for thinning an old orchard.
at any time but probably the late winter and early spring offer the best opportunities.

FILLING VACANCIES IN OLD ORCHARDS

Providing there are vacancies in the orchard after the thinning out of undesirable trees, if properly handled it will pay to fill these with young trees. It does not usually pay to attempt to grow an orchard on an old orchard site, but providing the ground is to be worked any way, it will pay to have vacancies filled. To do this most successfully, the tree holes should be dug, or better still, blown out with dynamite, the fall before setting.

With a crowbar or similar instrument make a hole two or three feet deep where the new tree is to be planted. Two feet is deep enough and requires less fuse. At the bottom of this hole insert one-half stick of 40 per cent dynamite, or similar explosive. When this is exploded the ground will be loosened several feet in all directions, if the soil is comparatively dry. When the soil is wet the dynamite compacts it making only a small hole. It is preferable to do this work in the fall and after filling the depression with manure allow the fall and winter rains and snow to leach the plantfood from the manure into the soil and also allow the soil to settle together where crevices have been formed by the explosion. In the spring the manure may be removed and the tree planted. Fresh soil taken from some distance should be filled in around the roots of the young tree. By loosening the soil with dynamite the young trees have a much larger feeding surface. Numerous reports show the successful filling in of vacancies of old orchards by this method. It is claimed that these trees will make a much more rapid growth than those set with a spade. Providing the holes cannot be dug in the fall, it will be advisable to mix well rotted manure with the earth that is filled about the trees.

PRUNING

The next step is the most important operation of orchard renovation—pruning. Any one of several other operations may be omitted, and yet, the work be successful, but if the old trees are not pruned they will not bear satisfactory crops of apples. Pruning should be thoroughly understood before proceeding, but there is nothing difficult about the work if it is given a little attention.

Before discussing the manner of doing the work, the reasons for each operation should be considered. Trees are pruned for several reasons.

First.—To regulate the size and shape of the trees. Such pruning may more properly be called the training of the tree. Many old, neglected orchards have grown so high and have developed so unsymmetrically that the size and shape of the trees need correction. To aid spraying and picking, trees should not be allowed to
Fig. 5. Pruning tools. 1 and 2. Hand pruning shears. 3. Long handled pruning shears. 4. Curved double edged pruning saw. 5. Swivel pruning saw. 6. Straight double edged pruning saw. Numbers 1, 3 and 5 are recommended.

grow higher than 25 feet. Taller trees should be brought down.

Second.—To remove diseases. Nearly all old orchards contain trees with a large amount of blight, and other cankers. The care of these trees is discussed later.

Third.—To influence the vigor and health of the tree. The removal of a proportionately large portion of a tree takes away wood and leaves that use up plant food or sap furnished by the roots, and makes it necessary for that portion which remains to grow more rapidly to utilize this plant food. In other words, if the demand for plant food is lessened by cutting off some branches the remaining branches have a larger supply to draw upon. The result, if this work is done while the trees are dormant or before growth starts in the spring, will be a much larger wood growth following the pruning. The trees are thus invigorated and strong healthy growth results. Care should be taken not to cause the tree to develop woody growth to such an extent as to decrease fruitfulness.

Pruning during the summer after the active growing season is past usually does not stimulate wood growth but has the opposite effect. Therefore, those trees which are growing too vigorously at the expense of fruitfulness should be pruned just at the end of the active growing season. A good time in Iowa is the last half of June. The trees should be relieved of the immense amount of wood which is a load upon its feeding surface. But the pruning should not be
so severe as to unbalance its activities. It is well to have an ideal tree in mind but in these orchards no attempt should be made to cut out all that is needed to reach the ideal the first year. The pruning should extend over three, or even four, years.

Fourth.—To regulate fruitfulness. To understand the effect of pruning on the bearing habit of the apple it is necessary to know how the apple tree bears its fruit. The blossoms and resulting fruit are usually borne on the end of short fruiting spurs. Bloom and fruit are frequently borne at the ends of twigs, but this is unusual rather than common. It is needless to say that these spurs, except in very rare instances, should never be removed. Many trees are bare of fruit spurs except at the very ends of the branches. Each fruiting spur usually bears a blossom bud only once in two years. In other words, the fruiting spur which bears fruit in 1914 in all probability will not bear fruit in 1915, but will again produce in 1916. Where a large percentage of the spurs produce in a single season we expect alternately a heavy and light crop. Some varieties, as they grow older, have this habit very markedly fixed, though while young, they may bear moderate crops each year.

PRUNE TO KEEP TREES VIGOROUS

If the trees are pruned just enough to keep them in good health and vigor, approximating as near as may be the condition of the young tree, they can, in a large measure, be prevented from alternating their crops. In other words, all fruit spurs should be kept in a vigorous healthy condition, though not so vigorous as to cause them to grow into long slender twigs. Fruit spurs in densely shaded trees are usually slender and weak. The tree should be opened up sufficiently to allow them to develop normally. Thinning out too many large branches or topping the trees back too severely will often throw these spurs into rapid growth at the expense of fruitfulness. Therefore, the thinning out of just sufficient wood from all parts of the tree, to admit sunlight and air, and the topping back of strong growing branches, sufficiently to give the fruiting spurs a healthy growth will give best results.

How is one to judge the amount of pruning necessary to give the fruiting spurs the right vigor? Generally speaking, weak, slender and dying fruit spurs indicate too little pruning while the development of water sprouts and long twig growth indicate that the pruning has been too heavy. Too heavy pruning, while undesirable because it upsets the normal activities of the tree, may increase bearing wood for subsequent crops.

Heading in, or topping back, tends to increase the number of fruiting spurs, while thinning out all parts of the tree tends to increase the health and vigor of the spurs already borne by the tree. However, heading in, if not too severe, also tends to increase the vigor of the fruit spur.
Fig. 6. Duchess of Oldenberg. Before pruning.

Fig. 7. Same after pruning. The top has been brought down and the surplus wood thinned out.
In pruning an old orchard, these steps may be taken:

First, cut out all "water sprouts" that are not needed to fill vacant spaces. Water sprouts, as a rule, will not bear fruit for several years, but by bending them, cutting them back, or in some other way checking their growth, they can be made to bear the second or third season. These water sprouts may be trained to fill vacant parts of the trees, and when left should be headed back for at least one-third of their length.

Second, remove all cross limbs, i.e., those that cross each other and also those that crowd or rub each other. Remove all dead wood also. After these operations, in all probability, no more wood should be removed the first year. It is important, however, that a sufficient amount of light be given the trees and it may be necessary to open them up more.

Do not remove the fruit spurs along the body of the branches unless they are broken or diseased. This is too common a mistake. Many orchards are so pruned that no fruit spurs are left on the inner under parts of the tree while the outer branches are left so dense that fruit buds will not form.

In the second year it may be well to begin the cutting out of some of the thick heavy heads and the topping back of long slender limbs, either side branches or tops. In all pruning it is better to prune from the top down, rather from the bottom up. Too much wood is apt to be removed from the top of the tree in the latter case and not enough from the top.

DISTRIBUTE THE CUTTING

The cutting should be distributed throughout the top, removing a larger number of smaller branches rather than opening up the top by the removal of a few large limbs. A systematic thinning of the entire top is necessary. With a pair of hand pruning shears clip branches from one inch in diameter or less from all over the outer portion of the tree. It will be necessary to use a ladder for much of this work.

If the tree has developed a tall central leader this should be cut back. From a tree that is 25 to 30 feet high ten feet of the top of the central leader may be profitably removed in order to throw the growth into the side branches. If higher the cutting back will need to be proportionately greater. But if the cutting needs to be severe the top should be brought down gradually, cutting back a few feet each year over a period of three or four years.

Horizontal branches may be cut back also and is desirable where the trees lack vigor.

In topping back the upright branches the cut should be made just above a good healthy, strong, growing, side branch which will serve
as a feeder and prevent a large amount of water sprout growth at
the cut and will also heal over the wound earlier. The cut should
preferably be made at an angle so that it will shed water better,
and also to assist the healing process. To throw long horizontal
branches upward, make the cut just above a strong upright growing
branch.

The weaker trees should be pruned and cut back the most severe­
ly. In some such cases the trees may be shaped up in a single sea­
on but with most of the trees the work should be done more gradu­
ally to prevent a rapid growing, sappy wood, subject to blight and
winter killing, and requir­
ing much subsequent care. Instances are on record
where trees have been ma­
terially injured or killed by
cutting away too much of
the top at one time. The
vigor­
ous growth and water
sprout development may be
reduced by removing the
dead wood and more brushy
part in the winter or spring
and then complete the prun­
ing the following June.

In the removal of large
limbs that are diseased or
undesirable cut parallel
with, and as close to, the
parent branch as possible.
This wound, while larger
than a cut perpendicular to
the parent branch, will heal
much more readily. Stubs
such as are shown in fig. 8
offer free access for the en­
trance of numerous rots. It
is sometimes desirable with
large limbs to cut them off
at some distance from the parent branch to prevent splitting and
then remove the stub later.

For proper spraying and picking trees should not be more than
20 to 25 feet high. With but few exceptions by careful handling
trees can be cut back to that height even though 15 to 20 feet
must be removed. It is not desirable, however, to treat the trees
any more severely than is necessary, and the removal of a large
amount of wood, whether in large branches or in tops, is undesir­
able. Where much wood is removed a rank growth will follow and some trouble from blight may result. This heavy growth must be carefully handled the next season. It is important that these sappy growths be removed the next year to throw strength to the fruiting wood.

WHEN TO PRUNE

The time of the year to prune these old orchards will depend somewhat upon their health and vigor. Trees which have been stunted, or which are not growing as rapidly as they should, had best be pruned before growth starts in the spring. This together with proper soil treatment will produce a healthy wood growth. Wounds naturally heal best when made at a season of the year when growth is most active. Those trees which have been making considerable twig growth at the expense of fruitfulness will pay best if pruned in May or June after growth has started. Winter pruning tends to produce wood growth, while early summer pruning checks wood growth and helps develop fruit buds. Summer pruning will help to decrease the number of water sprouts which follow severe pruning.

But most of these old orchards are low in vitality and need stimulating so that in all but exceptional cases pruning during the dormant season is recommended. This season also offers better opportunity to employ labor at an ordinarily slack time of year.

Heavy freezing and thawing weather following pruning may cause some damage so that where feasible to do so March and April are the better months for this work.

All wounds made in the pruning should be disinfected. For this purpose copper sulphate or blue vitrol solution, formalin solution, corrosive sublimate solution and other preparations are useful. Wounds which are more than an inch in diameter should then be painted with white lead and raw linseed oil, using as small an amount of oil as will make the paint work well. If ten days or two weeks is allowed to pass after the wound is disinfected, the paint will stick better to the dryer surface.

WARNING

Where blister canker, which is described in the following paragraphs is present in the orchard greater care in orchard renovation is necessary. As Ben Davis, Gano, and some other varieties are especially subject to this trouble it will pay to give them special treatment and prune only as much as absolutely necessary for good orchard practice. These varieties should be cut back less severely than is recommended in the foregoing pages and where necessary to lower the tops it should be done by slow degrees. Each and every wound should be carefully watched to see that this trouble does not enter. If it develops the top should be cut back to the next side branch as described before. The pruning tools should be disinfected
after each cut is made. This treatment should be made independent of and in addition to the disinfection of the wounds as given in the last paragraph above. For disinfecting the pruning tools a rag dipped in kerosene may be used. Corrosive sublimate solution may also be used.

BLISTER CANKER

Of the cankers which are prevalent in Iowa, the Illinois, or blister canker is by far the most destructive. Descriptions and treatment for this disease are given by Beach in bulletin No. 127, and by Pammel in Bulletin No. 131, Iowa Agricultural Experiment Station.

Fig. 9. Blister canker on apple in different stages of development.
This disease was found in a limited number of cases in the summer of 1911, but had done a comparatively small amount of damage so far as the utter destruction of the trees was concerned. In the summer of 1912, literally thousands of trees as well as a great many entire orchards were practically destroyed by this trouble in many parts of Iowa. As pointed out in the bulletins referred to, weather conditions, heavy cropping, and other factors prior to the season of 1912 were the contributing causes to the destructiveness of the disease. It was present in the state prior to 1912 but conditions favorable to the spread and destructiveness were not present until 1912.

BLISTER CANKER CONTROL

With very few exceptions, the affected old orchards, composed largely of Ben Davis trees, are beyond recovery. Where the orchard is made up of disease resistant varieties a great deal can be done toward eradicating the disease. In attempting to stamp out the trouble, it will be well first to take out all trees in which the disease has entered the body of the tree, providing it is not localized in a small area. Where possible to do so, it will be much better to remove any cankered limbs, making the cut at some distance below the diseased area as the disease penetrates the wood for some length. After this, the remaining trees which are affected should have all cankers carefully cut out, cutting well back into the live tissue. These wounds should be carefully scraped and treated with some disinfectant like corrosive sublimate, which is best, and then covered with some good covering, white lead and linseed oil being the most easily obtainable.

If the wounds are very large they may be covered with cement. In applying the cement it is best to drive nails closely together part way into the wood so that the cement will adhere to the tree. The cement should be mixed with a comparatively small amount of clean sharp sand, not more than one part of cement and two parts of sand.

One of the best coverings for these wounds is asphaltum paint. An objection to its use is that it needs to be kept above the melting point when applied. A small stove may be carried about to keep the material warm while it is applied. Care should be taken to avoid asphaltum paints which can be applied without heating. These are usually dissolved in kerosene, gasoline or other solvents, all of which are detrimental to the trees. There are several prepared paints on the market which are said to be non-injurious. These have not been thoroughly tested by the experiment station and no recommendations are given at this time.

It has not been determined just how effective the above treatment will be in controlling blister canker. Providing weather conditions are favorable, i. e., an abundance of moisture available, the disease
should be easily controlled, but in very dry seasons when the wood is deficient in moisture it is doubtful whether any methods of treatment will be effective.

One encouraging fact in regard to this disease is that it is not destructive to Jonathan, Winesap and some of the less important varieties grown in the state.

As blister canker is a wound parasite, it can only enter the tree through a break in the bark, every effort to prevent its entrance should be put forth. Care when pruning to prevent the shoes of the pruner from breaking the bark should be taken. Rubber soled shoes would prevent many wounds which serve as an entrance for the disease.

General sanitary methods should be used about the orchard to cut down the ravages of this trouble.

TILLAGE

If the orchard is in sod and has not been making a satisfactory growth, the sod should be plowed and the ground thoroughly cultivated for a few years. Old orchards covered with blue grass sod are almost as effectually covered to prevent the rainfall entering the soil as though a roof were built over them. Of those grass crops ordinarily grown it is the opinion of agronomists that timothy and blue grass are the hardest upon the soil. Certainly neither is good for an orchard sod.

The best time for plowing is early in the spring as soon as the frost leaves the soil. The ground is usually loose and moist then and plows more easily. Also most of the small root hairs by which the trees take up moisture and plant food from the soil die in the winter and less injury results if the plowing is done before these begin to form in the spring. If the orchard has been in sod for several years it will not be well to plow deeply as too many feeding roots will be destroyed. After cultivation has continued for some time, it can be gradually deepened, thus forcing the roots to greater depth. It will be unnecessary to plow close to the tree in these old orchards as the bulk of the feeding roots are not near the trunk but at some little distance therefrom. The plow should be followed by a disc to cut up the sod. The harrow should be used frequently, at least once each week during the spring and summer; if the soil becomes packed by heavy rains, it should be disced after each rain. All cultivation should cease after the middle of July and some cover crop sown.

COVER CROPS

The cover crop is planted to check growth in the tree so it may properly ripen, thus preventing winter injury, and to catch and hold the snow. It also serves as a protection to the roots in dry, cold winter. The cover crops should be plowed under in the spring be-
fore dry weather comes on and cultivation continued until the
middle of July.

In plowing on steep hill-sides that are apt to wash, it will be well
to follow the contour and plow around the hill. Good results have
been obtained by leaving a strip of sod in the tree row from 6 to 10
feet wide and cultivating in the middle.

Some method of conserving moisture for use by the trees during
hot dry summers is imperative and cultivation seems to offer the
cheapest way.

**SPRAYING**

The use of sprays for controlling insects and diseases is accepted
by all progressive fruit growing communities as a necessity.

To rid an orchard of its fungus and insect pests, the first spray­
ing should be given just as the blossom buds are separating in the
clusters. In this application, it is most important to use some
fungicide. Bordeaux mixture is most effectual in the control of
scab but lime sulfur will very materially check its growth. For the
beginner who is not familiar with the making of bordeaux mixture
it will be better to use lime sulfur. The directions for making and
diluting both of these liquids are found in Bulletin No. 127 of this
station which will be sent free on application.

While the fungicide is being applied at this time, it will not cost
any more for labor to apply an insecticide which will help to control
all leaf eating insects. Moreover, it is especially important to apply
an insecticide at his time to control the canker worm. Three pounds
of lead arsenate to 50 gallons of water is recommended for this pur­
pose. Paris green and other arsenicals may be used, but at the
present time lead arsenate appears preferable because it is non-in­
jurious to foliage.

The second spraying should be applied immediately following the
bloom, or about the time the greater percentage of the blossoms
have fallen. The important thing in this application is to lodge the
poison in the base of the blossom or calyx. It has been shown by
careful counts that three-fourths of the young codling moths enter
the apples at the bottom end in the early summer months. By
driving the spray into... is part of the fruit, these young worms are
poisoned before they damage the fruit. In making this second ap­
lication high pressure, from 150 to 200 pounds is desirable for the
most effective control of the worms. Such a pressure, however, can
hardly be obtained except by the use of high grade machinery. It
seems desirable to apply a fungicide also at the same time the in­
secticide is applied in this second spraying, and lime sulfur is recom­
manded.

During wet seasons, when apple scab is prevalent, a third spray­
ing should be given about two to three weeks after the second
spraying. An application at this time of lead arsenate will hold in
check codling moth as well as the green fruit worm and any leaf
eating insects.
A fourth spraying, or the third in dry seasons when it is not necessary to apply the spraying just described should be given July 15 to 25, depending upon the development of the codling moth. At this time, or soon after, the second brood appears and the young worms enter the side of the fruit. In case apple blotch has broken out, it would be well to apply bordeaux mixture at the same time. Some benefit may be derived from its application in preventing further spread of apple scab.

SPRAYING MACHINERY

For orchards of ten acres or more, a gasoline power sprayer is highly desirable. These can be purchased at from $150.00 to $300.00. For from five to ten acres of orchard, it is barely possible that a horizontal double action pump fitted to a tank will be most economical. Where the orchard is small, ranging from 50 to 200 or 400 trees, a good barrel outfit will suffice. The double action pump can be purchased at from $35.00 to $65.00 each; the barrel pumps at from $10.00 to $40.00 each.

There are many hillside orchards in Mills county in which it would be difficult to spray with an ordinary gasoline power outfit because of the danger of tipping over. Several companies, however, are manufacturing spraying machines with the tanks hung low so that this danger is practically eliminated.

To do effective work in spraying several small appliances should be included in ordering a spraying machine. Good hose, guaranteed to withstand high pressure, is necessary. At the end of each lead of hose a good cut-off should be provided. A bamboo spray rod from 8 to 12 feet long is necessary for the best work among tall trees. At the end of this spray rod should be provided either an angle connection or an angle nozzle. Where power sprayers are used, a "Y" or "U" should be provided so that two nozzles may be attached. This greatly facilitates the work. For the first, third and fourth sprays a nozzle which throws a fine mist is desirable. For the second spraying, a nozzle which will throw a driving spray is best. In this case it is desirable to throw the mixture with considerable force in larger drops so that it may penetrate the blossoms, while in the other sprays it is desired only to cover the surface of the fruit and foliage. Among older orchards a tower will be found indispensable if thorough work is to be done. This tower need not be more than 8 feet high from the ground to the platform.

TOP WORKING

In many of Mills county orchards twenty to thirty years old are trees of undesirable varieties, either little known sorts of early varieties which are not easily marketed. Many of these trees might be made to pay a profit by top working them to more desirable varieties. In some cases Russian varieties are extensively found. As a rule these prove hardy and vigorous but are not good commer-
cial sorts on account of early ripening. However they do make excellent stocks upon which to work later ripening standard varieties. Because of the heavy demand for nursery stock in the late 80’s and early 90’s when the older orchards were planted, many mixtures of varieties occurred. These odd varieties are objectionable as they ripen at different seasons and necessitate much travel from tree to tree to avoid mixing fruit at harvest time. Where this is true, it will also often pay to change these varieties to those desired whether in the commercial or home orchard.

Top working is not difficult if the essential factors are understood and simple directions followed.

Grafting is employed to propagate a tree or plant that bears superior fruit or flowers or foliage. It does not improve the varieties propagated, except as it may increase size or production. It simply perpetuates the characteristics of the individual tree or plant from which the cions are cut.

The cion is the cutting from the tree to be propagated which is inserted into the stock upon which it is desired to grow a new top. The cion is usually about six inches long and should be taken from the previous season’s growth, as older wood is less suitable for grafting. The cion should have well ripened wood and well developed buds.

Trees to be used for stocks should be in good health and vigor. It is useless to try to graft trees that are low in vitality. The union between stock and cion should take place soon after the top working is done and the wounds should heal rapidly. These requirements can only be secured in healthy vigorous trees.

The cions should be dormant when inserted in the stock. They may be cut and stored before hand if desirable. Pack in damp moss and store in a cool cellar or bury them a foot or two below the surface of the ground and they can be kept indefinitely. If too wet, they are apt to mold. If too dry, they will not grow. They should be protected against freezing because freezing is a drying process. Cions may be shipped long distances if these requirements are observed.

Grafting can most conveniently be done, as a rule, just before growth starts in the spring. The wounds will heal most rapidly if the cuts are made at that time. However, the work may be done after several inches of growth has taken place if the cions are kept dormant.

The union, upon which success depends, takes place at first between the cambium layers of the stock and cion. These must be brought in close contact and held there. The cambium layer is the active growing part of the tree and is situated just between the bark and wood. Where the bark of the stock is thicker than the
A McIntosh Red apple tree before top working.

Fig. 11. Some trees after top working, showing about the proper amount and distribution of work to be done in the first season.
bark of the clon, it is necessary to set the clion back from the outside surface of the stock to bring the cambium layers together.

The cut surfaces should be protected from air and rain. Air evaporates the sap of the tree and also may carry disease. Rain helps to furnish conditions favorable to the development of rot.

Health, vigor, close contact of cambium and protection are the only essentials for success. Any workman can by careful work make a large percentage of grafts grow.

A saw will be necessary to cut off large limbs. One like that shown in fig. 12, is preferable. Smaller branches may be cut with a small pair of hand pruning shears or a knife. A grafting chisel like the one shown in fig. 13 is very handy and it will pay to secure one if a large amount of grafting is to be done. The cleft to be described later may be made with a saw, though it will not be as smooth, making it more difficult to secure close contact of the cambium layers. In addition to the chisel referred to, a mallet or short club will be needed to split the stock. Grafting wax is required for covering the wounds.

There are several ways of making and applying the wax. The preferable method is to keep the wax warm and apply it with a brush. In this method melt together 6 parts of rosin, 1 part of beeswax and 1 part linseed oil. This may be kept warm in the orchard by means of a small stove in a sheet iron cylinder which can be carried through the orchards. However, the wax will remain soft for some length of time. Care should be used not to apply the

Fig. 12. Details of cleft grafting.
wax too hot as injury to the bark would result. This is not apt to occur with moderate precaution.

A soft wax may be made and applied by hand. Melt together one part of tallow or linseed oil, two parts of beeswax and four parts of rosin. After cooling, pull like taffy and wrap in oiled paper until used. Tallow or other grease should be applied to the hands when using this wax.

Waxed cloth may be made by soaking muslin in the wax while hot.

From three to five years should be taken to work over an old tree entirely. Only a small number of branches should be worked each year. These should be distributed well over the tree, always taking care to leave branches to protect the young cions against the sun, and to furnish foliage to keep the tree in a healthful condition of growth. Select the most vigorous branches first. These will usually be found in the center of the tree. The weaker branches will not furnish sufficient sap and the more strongly growing ones will rob them.

If it can be avoided, it is not desirable to graft branches more than 2½ inches in diameter, but larger branches may be used successfully with careful work. Figs. 10 and 11 will illustrate about the amount and the distribution of grafting to be done the first year. The original form and symmetry of the tree should be maintained so far as possible.
The stubs should not, as a rule, be more than six to twelve inches long. The smaller outer ones are cut closer than the larger ones near the base or head of the tree. The larger branches need shade and side branches should not be pruned away to expose them. The grafts should be distributed throughout the tree.

In completing the work the third or fourth year, more branches should be grafted than will be finally needed. These can be cut out later after the new head is well formed.

When removing larger limbs for grafting it is well to make the cut at some distance from where the cion is to be placed to prevent splitting. This stub is then cut to the desired length.

For larger branches the cleft graft is commonly used. The spring of the wood holds the cion firmly in place. A cleft is made with the grafting chisel, taking care to get a smooth cut and then a cion cut to fit is inserted. On horizontal limbs the split is made so that one cion does not come above another.

The cion is usually about six inches long though one as short as three inches may be used. It should have a bud near the top or smaller end and one at the butt at the point where it leaves the stock. The butt end of the cion should be cut to a long, smooth wedge shape. One edge of the wedge should be a little thicker than the other so that when it is inserted in the split of the stock with the thick edge outward, the fit will be closest there.

Fig. 11. Kerf graft on top worked tree properly waxed and wrapped with cloth to protect the wax from the sun.
The split is wedged open with the point of the chisel and the clons carefully placed one on each side of the larger branches. Care should be used here to see that the inside of the bark of both clon and stock come in close contact. This may be accomplished by setting the clons at a slight angle. The chisel is removed and all cut surfaces, including the tips of the clons, covered with wax. The wax about the stub should then be wrapped with cloth to protect it from melting in the hot sun of summer and exposing the cut surfaces to the air.

In larger branches, several clons may be set by sawing a long, shallow, trough shaped cut through the bark and carefully trimming it with a sharp knife and cutting the clons to fit. This increases the chances of one clon growing. See figs. 12 and 13.

In either case, if more than one clon grows, all but one should be removed after one or two years, retaining the strongest or most desirably placed.

After the grafting is done, the trees will demand careful attention. The removal of so much wood will cause a large growth of water sprouts which are apt to rob them of sap. Some of these should be removed and the others cut back in June and probably once or twice later in the season. The branches and stubs should be shaded, but too much growth will smother out the young clon growth. If the clons make too long and slender a growth, it may be well to pinch them back, forcing them to make a more stocky growth.

The whole process is a shock to the tree and it will need care to revive as quickly as possible.

While this work would be expensive if undertaken on a large scale, a few trees can be worked in a comparatively short time and as the topworked tree will bear fruit in from three to five years after the clons are set, the results are sufficiently prompt to make it more desirable in many cases than to remove the old tree and plant a new one.

CONCLUSIONS

Apple orchards can be made to pay a profit in most localities in Iowa. The principal factor lacking at present is the men who are willing to make orcharding a business venture and to give it the attention that they would do any business that they expected to make a success.

It was a common theory among the farmers, as well as among fruit growers and others, that the climate of Mills county was not adapted to the growing of fruit. Late spring frost was the principle factor cited as a reason for this belief. Nevertheless it is a well known fact that the danger of late spring frosts and freezes which damage the fruit crops diminishes from south to north, the reason being that the plants bloom later the farther north we go and are therefore held back till after the danger of frost is past. Iowa can grow late winter apples over a large portion of the state and the nearer the northern limit of late winter apple production we go
the less danger there is of late frost injury. During the past six years Iowa has had but one serious loss from damage to fruit by late spring frosts and freezes. Apple orchards may be protected against frost by the use of orchard heaters but this means a protection is recommended only to those who by the adoption of methods of culture have brought their orchards up to their maximum production. Unsprayed, unpruned, and otherwise neglected orchards will not pay for this protection.

The results secured by the use of manures in Mills county orchards are indicative of the necessity of giving more attention to the plant food in the orchard soil. Manures if they can be secured at a reasonable price are the best fertilizers for orchard use.

The results of pruning and spraying in Mills county orchards as shown in the tables in the fore part of this bulletin are also indicative of the value of these two important orchard operations. Neither can be entirely neglected and success be assured. Spraying is absolutely essential in the growing of marketable fruit.

Apple orchards where well cared for have paid, and are paying excellent profits on the money invested. They produced profitable crops with less care in the early history of the state. At that time there were few if any destructive insects and diseases to lower the profits of the grower. Large plantings were made between 1880 and 1900 as a result of these easy profits. These came into bearing after the introduction of the pests referred to and those men who did not care to properly protect their trees against the pests and against drought found that their orchards were not profitable. This has been the history of practically all the older fruit growing regions and was the expected result.

The question of over-production of apples is often discussed by fruit growers in the state and various opinions are held. There is but little doubt that the home market will consume a large part of the fruit grown in the state if that market is developed by proper methods of grading and advertising. The markets of the country at large will be open to properly grown fruit from Iowa as there is no question but that such fruit when properly packed and advertised will successfully compete with that of any region. The greatest difficulty in the marketing of the fruit will be that not enough fruit will be produced to attract the larger buyers to the local community. By organization of the growers and a careful study of the markets this difficulty can be overcome.

The toll of destructive insects and diseases has been pointed out. These pests will in reality prove a blessing in disguise to the man who will properly care for his fruit. By rendering what little fruit the neglected orchard will produce, unfit for market, they will leave the market entirely open to the better fruit produced by the careful orchardist. Such conditions are to the advantage of the man who will care for the old run-down orchard and plant new trees to replace the old when they have passed the age of profitable production.

For the men who do not care to make orcharding a prominent part of their business on the farm it will be better to remove all but a few trees for the home supply and put the remainder of the ground now in orchard to some crop that will be properly cared for. But a careful consideration of the foregoing pages and the profits to be derived from the orchard crops, is urged before the decision to remove the orchard is reached.