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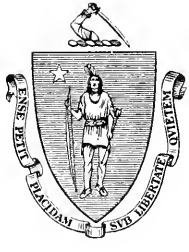
A promising young Massachusetts apple orchard.

MASSACHUSETTS AGRICULTURE.

BULLETIN NO. 2. DECEMBER, 1913.
FOURTH EDITION, REVISED.

APPLE GROWING

ISSUED BY THE
STATE BOARD OF AGRICULTURE, STATE HOUSE, BOSTON, MASS.
WILFRID WHEELER, SECRETARY.



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INTRODUCTION.

Apple growing in Massachusetts has received a great stimulus within the past five years, largely due to a sudden realization that good apples could be grown here as well as in other parts of the country, and also to the relatively high prices of western apples.

Early in the history of Massachusetts, and up to the time of the civil war, apple growing was considered very profitable, but soon after that period insect and fungous pests made their appearance in such numbers that many orchards were either destroyed or allowed to run out. Apple growing thus became an adjunct to general farming, and has so remained until the stimulus of western competition began to make itself felt.

Apples should be grown in our State in sufficient quantities to at least supply our own demand, for certainly no spot on this earth was ever more favored for growing this fruit. Soils and climatic conditions are of the best; markets are near and good; and success is assured, provided the grower will exert a reasonable effort.

There have been many new orchards planted in the last few years, and many old trees have been renovated and are now bearing good fruit. The young orchards are now supplying some of the very highest quality apples in our markets.

Many of our growers are realizing more and more the necessity of pruning, spraying and fertilizing, and also the need of carefully grading their product, that a high, even standard may be maintained. These find no trouble in marketing their products. Massachusetts people are using many apples and would use more could they be sure of getting a uniform grade in every package.

While apples will grow in almost every part of our State, sections which seem to have particular adaptation for this fruit are Essex, Middlesex, northern Worcester, Hampshire and Franklin counties. Land in large tracts is fairly abundant in the counties named.

We can grow better flavored apples here than in the west, particularly if we grow those varieties which are more or less native to our soils, like the Baldwin, Northern Spy, McIntosh, Palmer Greening, Wealthy and Rhode Island Greening. This should encourage our people to grow more apples.

As our apple crop increases in size it must be handled through co-operative associations, which will guarantee the grade of the package. We look forward to the day when this business will be on a secure footing, and apples may be bought with the same surety of getting an honest package as are manufactured articles at the present time.

THE ADVANTAGES OF NEW ENGLAND AS A FRUIT-GROWING CENTER.[1]

G. A. DREW, GREENWICH, CONN.

Not so very many years ago it was the general opinion that agriculture held out little inducement as a profession anywhere in New England. If a young man signified his intention of going farming, he was looked on as an object of pity or held up to derision. Even in our own agricultural colleges, where agriculture should have had its stoutest champions, the impression sometimes prevailed that those in authority often felt obliged to apologize or explain their connection with it.

Now all this is changed or fast changing. Farming is no longer looked on as a discredited occupation; the young man sees a future where his father saw only a meager existence of drudgery, and our agricultural colleges are no longer ashamed of having agriculture spelled with a capital A. Many causes have combined to bring about this result, such as the congestion in our cities, the high price of foodstuffs, improved conditions of country life; but more than all else people have come to a realization that after all there is no place like New England to live in, no place that combines so many advantages and where agricultural opportunities have so long lain dormant.

The cheap land of the west is a thing of the past; the free homesteads there are all taken up; crops can no longer be profitably grown without certain expenditure and intelligent care; in fact, the western country has approached or is rapidly approaching the same agricultural conditions that confronted New England years ago.

New England is the home of conservatism. It is just beginning to dawn upon her that she is still an agricutural factor to be reckoned with; that her soils are not worn out.

[1] Agriculture of Massachusetts, 1911.

but only need intelligent care; that she possesses strategic advantages that are of wonderful value. With this awakening she needs more the spirit of the west to see her strong points and let others see them also. With the conditions she must change as well. The day of the general farmer has gone by. Raising an acre of corn, some potatoes, a few tons of hay, dabbling in poultry, making milk to fatten the contractors, besides harvesting what apples grew in spite of neglect, have in my opinion been the curse of New England agriculture. To be a poultryman, dairyman and fruit grower combined has as much of logic in it as for a professional man to try to be a preacher, doctor and lawyer, all in one. All lines of agriculture have their rewards for those who master their subject. Specialization, in my opinion, is the keynote of the hour. Success depends on the man and his location. Fruit growing has been my specialty; it is on this subject and the advantages New England offers along these lines that I wish to speak.

A few years ago I gave a talk on the growing of fruit in a certain Massachusetts town within thirty miles of Boston, trying to point out what a wonderful opportunity was at its very door; how the town itself was in one of the best natural fruit sections of the State; how this market called for first-class apples, but went to the Pacific coast to get them; how it hungered for small fruits, but had to go beyond the Hudson before this demand could be satisfied. Here was the land naturally adapted to these crops within teaming distance of Boston, in case the freight rates were excessive; here was the market trying to get the best fruit that could be produced, and able to pay for it; yet when I told them that they could produce apples which would sell for as much as or more than the highest market quotations, and small fruits also, they thought I had indulged in some flight of fancy, or was carried away by my enthusiasm. "What," they said, "sell apples in boxes for $2 and $3? Why, that is all that we can expect for barrels; and, besides, the commission men want them that way." "Set out currants where apples in Belmont and vicinity control the market! How can we expect to compete?"

The trouble, my friends, it seems to me, is that we in New England have looked at this fruit business from a too narrow point of view. We have allowed our markets to slip away from us, and given the public the impression that the "big red apple" of the west is the only apple for it to buy. We have got into the habit ourselves of thinking that New England used to raise good fruit, before so many insect enemies and fungous diseases came, but that now the struggle is too unequal. If it had not been for these pests and diseases I shudder to think of the condition fruit growing would be in now. It has been a blessing in disguise. We have to fight for what we get, and nothing is worth having that does not represent effort and skill.

Let us briefly consider some of the specific advantages New England offers. Think what our near-by markets mean to us. Within several hundred miles of Boston are twenty or more millions of people, the great majority of whom are consumers, not producers. Wealth to a great extent is concentrated here. People of means generally buy the best the market affords. It is to these same people that the Pacific coast fruit growers, three thousand miles or so away, are catering; but think what a handicap they are under. It costs them about 50 cents freight to place a box of apples on the market, while with us it is only a fraction of this. We should be able to take advantage of local conditions, but they are often unable to ship their fruit in time for a rapid rise in price.

When I was in Hood River, Ore., last November, the Union was shipping only a few cars of apples daily, when they should have been shipping fifteen or twenty, but they could not get the refrigerator cars, they did not have adequate facilities for storing, and much of the fruit went down. On account of the danger of freezing in crossing the Rockies, it is almost essential that fruit be shipped from there before December 1.

This shows how absolutely dependent they are on the railroads, their only means of reaching the eastern market, while we may be far more independent of them. It is seldom necessary to ship in refrigerator cars, and, moreover, many mar-

kets are within teaming distance, while the automobile truck will soon be an important factor.

This nearness to the best markets of the country, then, is one of the greatest advantages New England has to offer the fruit grower; but almost of equal importance is the average price of fruit land. A few years ago we heard much about the abandoned New England farms; to-day this is seldom mentioned. Desirable land here is not cheap to-day by the earlier standards, but compared with the market price of fruit land in the west it would seem ridiculously low. There orchard land without improvement sells as high as $1,000, while bearing orchards sell for several thousand dollars per acre.

Although our farm values have gone up considerably in the last few years there is still much land in New England which can be bought at reasonable prices, varying, of course, as to accessibility, location and freedom from stumps or boulders. I think that we will all admit that, other conditions being favorable, good cleared land is worth from $75 to $100 an acre for fruit-growing purposes. A few years ago farms could be bought for much less per acre than these figures, with the buildings thrown in.

Another great point in favor of New England is that many of these farms contain old orchards which have managed to exist in spite of neglect. Unless the tree trunks are in too advanced a stage of decay these orchards may be reclaimed and made to pay a revenue almost from the start. Try the modern way of handling these orchards. Cut off the extreme high tops, so that the tree can be more easily and cheaply sprayed, the fruit more economically harvested and the danger from high winds greatly lessened. Clean out the scale, preserve the trunks from decay, get new bearing wood, cultivate and spray thoroughly, and even on these old trees you will get fruit that will surprise you.

We will have to admit that the Pacific coast fruit which is placed on our eastern markets has a wonderful finish which we find hard to equal. The bright sunshine and cool nights there seem to be particularly favorable to the development of these qualities, which have given them their slogan of "the

land of the big red apple," which has attracted the eye of the public and been a great advertisement for their products. Granting them their due, it is time we met them with one of our own, for ours is truly "the land of the *good* red apple," though it is not necessary for an apple to be red to be good. Educate the public to please their appetites rather than their eyes, all the while striving for color and finish. Compare our New-England grown Gravensteins, McIntosh, Palmer Greening, Wagner, Northern Spy, yes, even our Baldwin and Greening, with their Ben Davis, Jonathan, Spitzenburg, Winesap and Newton. The flavor of the home-grown product is without question superior, and this the consuming public should know. It may take time and money, but a campaign of education on this point is worth a great many dollars to New England.

The eastern markets offer a good chance for disposing of the poor grades of fruit which in the west are practically waste. Perhaps I should not emphasize this too strongly, as our aim should be to grow as few culls as possible; however, there is a legitimate use to which our poorer grades of apples may be put in supplying the mill towns and poorer classes of people, who otherwise would never have any fruit at all.

From a fruit-growing point of view, then, we have the most important factors for success in our favor. We can buy our land at a reasonable figure; we are so near the best markets that we can ship our fruit at low expense and sell it at maximum prices; the apples grown here are of a better quality than those of the west. It only remains for us to take advantage of our strategic location to command not only our own but reach out for the world's markets. At present the west holds the commanding position, the choicest grades of fruit. Why? Simply because it is in it on a business basis, is better organized and realizes the necessity of attending to every detail in the most exacting manner.

The New England fruit shows have done much to stimulate interest and point the way we must follow. The high standard set by the last exposition, in particular, must be the basis, not only for show purposes but for the strictly commercial method of grading and packing.

There are a few growers who already have seen the opportunity and have established their business on a solid foundation, yet how few are these in number; possibly not more than a dozen in all New England.

My aim has been to point out the advantages New England offers as a fruit-growing center, but I dislike to leave it without a word on a few of the essential matters of practical detail.

We are still woefully weak on the thoroughness with which we attend to the various operations, as spraying, pruning, cultivation and fertilization, besides picking, packing and marketing our product.

It is not enough that we prune; we must prune regularly, prune for a purpose, and see that the cut surfaces are protected so that decay may not set in. It is not enough that we spray; we must spray at the proper time, with the proper materials and with sufficient force. This latter point cannot be emphasized too strongly in regard to the first spraying with poison, just after the blossoms have fallen. Cultivate thoroughly the first part of the season; it is the cheapest way to get a sufficient amount of growth. In July or August, when cultivation stops, sow cover crops to save the volatile elements of plant food, and add humus to the soil. Study the plant-food problem, but study it as to your individual requirements.

No two orchards should be fertilized exactly alike. It is a matter you can determine only by experiments. The rigor of the times and results of the harvests are the best criterion to go by. Whatever may be said in favor of mixed fertilizers for general farm crops does not, in my opinion, hold true in orchard work. It costs only a little more to spread the different chemicals separately; they can be put on at a time more suited to crop requirements, and, most important of all, you will save money by so doing. Of all three elements of plant food, the nitrogen should be used with the greatest caution, particularly in a fruiting orchard. Do not overdo it; depend as much as possible for nitrogen upon turning under leguminous crops, and then add basic slag or lime to keep your soil from becoming sour.

Thin your bearing trees. It is not until lately that we have come to realize how essential this is as an orchard practice. Begin the latter part of June, when the fruits are about the size of walnuts; pick off all wormy or inferior fruits; see to it that the trees can carry their load. If one thinning is not sufficient, keep at it. This is the way that the westerner grows 85 to 90 per cent of extra fancy box fruit. It is the best paying proposition in fruit growing that I know of, and yet one of the least practiced. New England fruit should be picked with care, and always placed in boxes, not barrels. The westerner considers twenty-five boxes a good day's work; we generally require considerably more. There is no question in my mind, commission men to the contrary, but that we should try to establish a box trade for our best grades of fruit, pack it with extreme care, wrap the fruit, and label it as to grade, number of apples, variety and name of grower. The westerners use the grades, extra fancy, fancy and choice; with us only the first two should be placed in boxes, the poorer grades in barrels.

Of course, this change cannot all be made at once; certain trade will still require first-class fruit in barrels, and must be catered to. In time, however, I look to see all our fancy higher quality fruit in boxes, for the simple reason that the consumer demands it. There is less chance for deceit, and it is a much more convenient size to handle.

I have spoken principally of the apple, because it is the king of fruits, all points considered. There are just as good chances in New England cultivating the peach, pear, quince, sour cherries, grape and many small fruits if attention is given to location. What has been said about the apple in many respects applies to these others as well. This is one of the strong points about New England fruit-growing possibilities, — that its opportunities are not confined to the cultivation of one fruit alone, — for within its boundaries one may find suitable places to grow almost any fruit that will grow in the temperate zone, according to one's preferences and capabilities. There are some who fear the small grower cannot hold his own with some of the larger developments contemplated. I do not share this view. The one who comes

into intimate contact with the work, handles the spray rods and picks the fruit can do it better himself than can another delegated by him.

Possibly a word of caution may not be amiss to those who, without any experience, would plunge headlong into fruit growing as a vocation. It is not a get-rich-quick proposition; time and patience are required; methods which the more experienced consider a life study cannot be learned in a day. Again, there are many who fear overproduction when the orchards now being planted come into bearing. They do not take into account the fact that only a small proportion of trees planted ever come into profitable bearing; that insect enemies and fungous diseases may raise havoc heretofore unheard of; that our population is rapidly increasing, and that there are many people on the face of the globe who do not now have a chance to purchase an apple for a reasonable price. Undoubtedly there will come a period of lower prices, and this will render co-operation a necessity; co-operation will bring better distribution of the product, all of which is as it should be.

I am not one of those who greatly fear this overproduction of fruit. I have heard the same fear expressed ever since I can remember, and it has not come yet. Granting this possibility exists, what about the orchards three thousand miles away, on the Pacific coast? Are not they the ones to suffer, not New England?

Mr. H. J. Wilder. What cover crops would you recommend for northern Massachusetts, at an altitude of from 1,000 to 1,500 feet?

Mr. Drew. Personally I prefer rye and hairy vetch. Rye will grow almost anywhere except where the soil is too wet, and with a leguminous crop forms an ideal combination. I would sow it generally in August, though there might be some seasons when it could be sown earlier or later, owing to drought or unusual rainfall. In the spring I should plow only one way, and let some of the vetch mature. On a soil where it was necessary to save all the moisture I should plow earlier than on a soil where this was not so necessary. Where

a great deal of humus is being plowed in a sufficient amount of lime should be applied to keep the soil wet.

Mr. Geer. How often do you cultivate your land?

Mr. Drew. An orchard should be cultivated very thoroughly the first part of the year, as it tends to preserve the moisture in the soil. Under ordinary conditions cultivate about once in ten days, sometimes oftener, and keep it up until the latter part of June. Some seasons it would be advisable to run over into July. It depends entirely on whether the orchard is a young or a bearing orchard, and the variety of fruit you are growing. With the Northern Spy I should stop cultivation sooner than with other varieties, because the tendency of that tree is to make too much growth.

Question. In renovating an old orchard would you invariably tear up the sod?

Mr. Drew. In almost every case. Sometimes it is not advisable to plow, as the roots are too near the surface, in which case the use of the cutaway harrow early in the spring, going first one way and then the other, will, if persisted in, accomplish all that is aimed for in plowing.

Mr. W. C. Jewett. Have you had any experience using mulch?

Mr. Drew. Not with the strictly mulch method. I have sometimes, when I was not getting the color I wanted, seeded down and cut the hay several times during the season, letting it lie where it fell. In this way I have grown some nice fruit, and developed better color than I could by cultivation alone.

Mr. Jewett. Mr. Drake, who follows the strictly mulch method, gathering up the grass and placing it around the trunks of the trees, out as far as the branches extend, grows better and higher-colored apples than most growers, and takes the greater part of the premiums at shows around Worcester. In addition, he loses very few apples, as they are not injured when they fall from the trees. He admits that the system is more expensive, in time and fertilizer both, than the cultivation, with a cover crop, but he thinks it the best and cheapest for him.

Mr. J. J. Erwin. Do you advise planting vegetables in a young orchard?

Mr. Drew. I should certainly do something of that sort to pay the first expenses, but I should do it with caution, taking care that whatever is grown does not prevent the tree from spreading out and making a good shaped tree, or cause growth too late in the fall. Too many people get carried away with the immediate results in growing such catch crops, and lose sight of the ultimate results.

Mr. Erwin. Would you grow currants with your trees, or independently?

Mr. Drew. If I grew currants in the apple orchard I should take the greatest pains to see that they were free from the San José scale, as they are very prone to be subject to this insect. I should spray against the scale every year. They do that on the Pacific coast, counting it good insurance, and I think we must come to that in New England.

Mr. S. H. Reed. Which is the better for the scale, lime and sulfur, or soluble oil?

Mr. Drew. One is about as good as the other. In bad cases I prefer the oils, as they spread, while the lime and sulfur stays where it is applied. In severe cases I use 1 gallon of oil to 12 of water, although 1 to 15 is the proportion usually recommended. Spraying with oil when the bark is dry doesn't do as much harm and is more effective than when the bark is wet. In the spring, just as the buds unfold, spray thoroughly with lime and sulfur. There is nothing better to clear off fungous diseases and kill the eggs of plant lice.

Mr. Reed. If you have no San José scale, and spray only as a preventive, you would use the lime and sulfur in the spring only?

Mr. Drew. I should; and I should always advise the use of home-mixed solutions, unless a person had only a few trees.

Mr. Reed. Do you put any lime and sulfur solution in with arsenate of lead in the spring?

Mr. Drew. That brings up to the subject of summer spraying. A few years ago everybody was telling us to use the Bordeaux mixture, and we all admit that it has been one of the best fungicides we have ever used; but for several

years it has rusted the fruit so as to hurt its appearance very much. Then came in the commercial lime and sulfur sprays, which, if not used with caution, are liable to injure the foliage, and sometimes do not control fungus as well as the Bordeaux. I have used the self-boiled lime and sulfur solution (Scott's formula; Scott of the United States Department of Agriculture) on apples and peaches. On apples I have used it at a rate of 10 pounds of lime and 10 pounds of sulfur to 50 gallons of water, and then added 2 to 3 pounds of arsenate of lead, spraying just as soon as the blossoms drop. In Massachusetts, where the gypsy and brown-tail moths are prevalent, I would use at least 5 and even 10 pounds of arsenate of lead in cases where the moths were numerous.

The self-boiled solution is one of the cheapest and one of the most effectual solutions for spraying. You take, say, 10 pounds of good rock lime and heat it, or apply enough water so that it will begin to slake, and then sift in the powdered sulfur. Cook the sulfur by the heat of the lime. Let that slake until the lime is all disintegrated, and keep adding water. When a slight orange precipitate is being formed, stop the action by drenching with cold water; otherwise sulfides, injurious to foliage, will develop. Possibly this is a little more complicated than using the commercial solution, but in spite of that I prefer it for apple spraying, and for peaches would not use anything else, only I would use Mr. Scott's formula, — 8–8–50 instead of 10–10–50.

Mr. Reed. How many times do you spray in the summer time?

Mr. Drew. Some seasons vary and some apples vary. The first spraying is the all-important one. It should be applied with force, thoroughly and just as the blossoms fall. It should be repeated about two or three weeks afterwards. That generally will be sufficient for such varieties as the Baldwin, and those not subject to fungus. For the Fall Pippin or Spy or Greening, or some of those more subject to a fungus, three or four sprayings are not any too many.

Mr. H. A. Parsons. Is it too late now [December 5] to spray, if you did it on a warm day?

Mr. DREW. No. I would not spray in freezing weather, but it is an excellent time now to spray to kill scale, provided you can have at least six or eight hours without freezing.

Mr. H. A. TURNER. If you had part of an orchard bearing the Ben Davis apple would you advise keeping the trees along, or grafting them?

Mr. DREW. That is a matter for an individual to decide for himself. The Ben Davis, from the practical point of view, possibly has a certain function. It will keep better than any other apple, and may be taken out of storage as late as July for culinary use, when you can't get any other apples. I wouldn't recommend anybody's planting the Ben Davis in New England, as they grow apples enough of poor quality in the western States without our doing it here.

QUESTION. Do you spray a limb without any blossoms just as thoroughly as those with blossoms?

Mr. DREW. I would take the precaution of treating it just the same, even if the tree did not show any indication of bearing fruit, just as I would thoroughly fertilize the tree, or a whole orchard, that wasn't going to bear that year. I would not fertilize it just the same, but I would fertilize it.

Mr. REED. How do you fertilize apples, peaches and pears in both young and bearing orchards?

Mr. DREW. I would fertilize in connection with cultivation, so that trees would make, say from eight to ten inches' growth a year, and produce good colored, sound fruit that would stand up. There is nothing better than hard wood ashes to give these results. Manure is all right in giving growth, but in a bearing orchard it should be used with caution. Among chemical elements I would depend on nitrate of soda, but would use it only in small amounts, because it will produce great foliage, but fruit that will not stand up in transportation. For potash, I would use high-grade sulfate of potash as an annual dressing, at the rate of 100 to 250 pounds to an acre. For phosphoric acid, I generally plan on giving my orchards an annual dressing of somewhere from 400 to 600 pounds per acre, and a lot of our best growers of peaches and apples in Connecticut are using it as heavy as 1,000 pounds per acre.

I believe in setting out orchard trees with the expectation of getting the best results, and so growing them as to get the best results, in six to eight years. With the Spy you could get a result in eight years. You would get a certain amount of fruit from Baldwins in eight years, and some people will get results; but with such varieties as the McIntosh, the Wealthy, the Duchess and the Hubbardston, and quite a number of others, you can get profitable results in from five to seven years. To do that, in the first four years I should grow those trees fast, but not so fast as to make sappy growth. I should use a lot of nitrogen if the soil wasn't such as to contain it; but in the fourth or fifth year I should substitute for the nitrogen heavy basic slag or potash, or some such element. With McIntosh, Wealthy, Duchess and Hubbardston, I should plan to get profitable crops within five years. I am making those varieties do that.

Mr. J. A. Williams. Would you recommend setting out peach trees in between apple trees in a young orchard, thus getting a growth of peaches before the apples come into bearing?

Mr. Drew. A great many successful orchard men are doing that, and still there is an element of danger in it. As a general rule, you can get results from peaches in three or four years, and a peach tree spreads out, and generally when anybody sees the money coming in from peaches — and certainly it is good money when it comes in — he thinks he can keep the trees two or three years longer, and be so much richer, and that is a detriment to the apple trees. As a rule, if I were planting by the filler system I should use a variety of apples like the Baldwin or Greening, and then plant in the filler of McIntosh, Wealthy, Duchess or Yellow Transparent, or something of that class. The Duchess makes a good filler.

Mr. Williams. What do you advise for a distance in setting out an orchard of that kind?

Mr. Drew. I should set my Baldwins 50 feet apart in some soils, — in most soils from 40 to 45 feet apart — and interplant half that space each way with fillers. In the northern sections of New Hampshire and Maine, where the

trees tend to dwarf growth, you might set them closer; but in Massachusetts and Connecticut, where the soil is heavier, and trees make a good, vigorous growth, the ultimate distance of 40 by 40 feet is not too much. The object of the system is to get the fillers to bearing to help out the expense in the meantime. You must cut out the fillers.

Mr. J. L. Smith. You recommend dwarf trees?

Mr. Drew. The dwarf orchard is a good thing for school gardens, a city back lot or a test orchard, but not for a commercial proposition.

Mr. Smith. Would you put each variety by itself or intersperse them for better pollination?

Mr. Drew. I should not think it advisable to set out a great block of Baldwins without having some other varieties in a block close by to pollenize. I think bees are of great importance in proper pollenization.

Mr. Erwin. Some fifteen or twenty years ago there was an apple season and then a season when there weren't any. Was it from the fertilizer used or was it the season?

Mr. Drew. I don't know as I could explain why such a season existed. The seasons of plenty and scarcity are comparatively evenly balanced now, probably because the apple is more generally cultivated all over the United States. One section offsets another. Again, a person with several orchards will have some fruit himself every year.

Mr. Erwin. Don't you think it depends a great deal on the man? If a man takes care of his orchard, and uses the right kind of fertilizer every year, don't you think it has a tendency to give him apples every year?

Mr. Drew. Yes; that is, in connection with thinning the fruit all summer. There is hardly an up-to-date fruit grower in the west who does not thin his fruit very, very thoroughly several times during the bearing season. I don't suppose there are twenty-five people in New England who make this a regular practice. Thinning balances the trees, so that, with the exception of the Baldwin, you can get the trees to bear comparatively evenly every year, all other conditions being favorable.

Question. At what age do you set out your trees?

Mr. Drew. For an apple orchard my preference would be very strong one-year-old trees, except in sections infested with the gypsy and brown-tail moths and many fungous diseases, where I would set strong two-year-old trees. For a peach orchard I would set one-year-old trees without question.

Question. Do you put any fertilizer around the bottom of the trees?

Mr. Drew. No; I would not. I would prefer to get the soil into fine condition by planting a cultivated crop, like corn or potatoes, the year before.

Mr. Turner. For a general orchard of an acre or two what varieties would you set out?

Mr. Drew. In certain sections of eastern Massachusetts, with certain kinds of soil, I would set out certain varieties. The Gravenstein, Hubbardston, Williams and Red Astrachan do very well. But for the general grower there is no safer apple to plant than the Baldwin. For the special grower, who would give particular attention to growing and packing in boxes, there is more money in other varieties.

Mr. John Bursley. If you were going to purchase a piece of land for the purpose of going into the fruit business, would you rather pay $200 an acre for land within a city of 200,000 inhabitants, or go into the country and buy it at $20 or $30 an acre?

Mr. Drew. As a general rule I should rather buy the more expensive land. If I were going away back into the country I should want a pretty big proposition, where I could afford to employ quite a quantity of labor. For the distant land I would select winter varieties.

Mr. Reed. How do you eradicate the railroad worm?

Mr. Drew. I have never been bothered with it, but know people who have. The only way to control it is to pick up the apples as they fall and feed them to hogs, or dispose of them otherwise.

Question. What preventive is there for borers?

Mr. Drew. None that I know of. You should go over your apple trees at least once a year — peach trees twice a

year — and pick them out with a knife or wire. I prefer the fall for this work.

Mr. Turner. Fifty years ago we used to have magnificent Russets clear into the spring; what has become of them?

Mr. Drew. The general market does not call for many Russets. If you have a retail trade and ship them yourself, and people know enough to appreciate them, there is no better apple grown than the Roxbury Russet.

Mr. Asa Dodge. Why have the sweet apples gone from the market?

Mr. Drew. Because there isn't any great demand for them. There is no reason why a discriminating public should not call for some sweet apples, but I should be cautious myself about planting them too extensively.

Mr. Reed. Is it better policy to market your fruit as soon as possible or to store it?

Mr. Drew. That depends on the class of fruit. The poorer grades must be put on the market up to Christmas time, because people have not adequate storage facilities. The first-class apples, as a rule, bring a higher price after the inferior grades are out of the way, and therefore should be held.

Mr. Reed. Do you consider the Wealthy and McIntosh short-lived trees, and use them sometimes as fillers?

Mr. Drew. I don't think we know how long lived these trees are, because where would we find a Wealthy or McIntosh tree forty years old in New England? So far as the choice of a filler goes, the Wealthy will last as long as is required under that system. The McIntosh is a comparatively long-lived tree, and has a tendency to bear heavily every year.

Question. I have about ten trees of McIntosh in an orchard where there are forty Baldwins, all eighteen to twenty years old. The McIntosh bore the most the first four or five years, — more the first year than ever since. The Baldwin trees haven't borne heavily, but I think they have borne more than the McIntosh. The latter have had the same treatment as the Baldwins, but are not more than two-thirds as large. The soil is a clay loam; I have raised good potatoes on it. I

have used no fertilizer save stable manure. The orchard has not been cultivated for the last four or five years.

Mr. Drew. Well, I would make them bear some way. I should try putting on some slag and potash, and should withdraw any source of nitrogen. If that didn't make them bear I should root prune them. If one method doesn't work, use another. I would broadcast the fertilizer over the whole surface, not up against the trunk, because the feeding roots are on the extremities every time.

Question. Is it inexpedient or a bad plan to set out an orchard if care is taken to fertilize and to keep the earth within three or four feet of the tree dug up for a few years before ready to plow?

Mr. Drew. That method is practically used by one of the best, if not the best, fruit growers in New England, A. A. Marshall of Fitchburg; but in spite of that fact I do not think ordinary people would succeed with it.

Question. Would you set Northern Spies and then graft over to McIntosh or Baldwins?

Mr. Drew. Under ideal conditions that is all right; but you are taking a great many chances, — a dry season when the buds will not take, insects that eat the buds, canker from an imperfect union. There is no question but what the Northern Spy stock and the Tolman Sweet are the strongest.

Mr. Bursley. How would you proceed to set trees on rough ground that could not be plowed?

Mr. Drew. I should set out the trees and then spade around them by hand. Hand labor is more costly than team labor, as a rule, but there are thousands of acres in New England where fine fruit could be grown in that way.

Question. What do you think of putting pigs into a piece of land that is rough and stony?

Mr. Drew. I would put the pigs in before I set out the orchard; I would not have them in afterward.

Mr. Turner. What is the difference between the Snow and the McIntosh?

Mr. Drew. The Snow apple belongs to the same group of apples as the McIntosh. It is smaller, not as delicate in flavor and does not adapt itself to so wide a country. It will

keep possibly a little longer, but won't sell with the McIntosh and is too small to box. The McIntosh has all the good qualities of the Snow apple without the imperfections.

Mr. ERWIN. What is your cold-storage system for apples?

Mr. DREW. Our system is to build a cold-storage plant and hold our apples in cold storage, and that is the ideal way; but the ordinary grower, as a rule, cannot afford to build a complete cold-storage plant as it is certainly expensive. I should either have a well-ventilated, natural cellar in which to hold my fruit, or pack my very choicest fruit in the fall and put it in cold storage wherever I was going to dispose of it, taking it out as the market warranted. If you can't afford cold storage on your own place you must depend on the cold-storage places in the larger cities.

Mr. ERWIN. We have just built a cold-storage plant under the ice and brine system, similar to the one designed by Madison Cooper for the Massachusetts Agricultural College at Amherst. Where a lot of ice is available it seems to be the most economical system from a farm storage standpoint.

Mr. REED. Can you prevent the fruit from sweating?

Mr. DREW. We prevent its sweating to a certain extent by the use of calcium of chloride. If apples are not put directly from sunshine into cold storage, but their temperature is lowered gradually, they will not sweat.

Mr. TRULL. Would you advise any one to set out a peach orchard on newly plowed sod ground?

Mr. DREW. I would not hesitate at all, but I would not let the peaches set in the sod. I see no great objection, other than it is harder than planting them in soil that has been cultivated for a year.

QUESTION. What do you call a good, thrifty Baldwin tree, five years old, worth?

Mr. DREW. I don't know. A bulletin from the State college gave the estimates by certain correspondents in all the New England States of an apple tree, forty years old, at from $25 to $250. A good, thrifty Baldwin apple tree, five years old, is worth $5 anyway.

Mr. J. L. ELLSWORTH. This financial question has brought to my mind the fact that Mr. Russell had a very,

very productive tree last year, a very profitable tree. He won the prize that was offered by the Board of Agriculture last year for the most productive tree. There is no reason why you all should not have just such trees, — 30 to the acre.

Mr. F. A. Russell. This tree was a natural fruit tree. About twelve years ago we grafted it to the Gravenstein. The tree bore only a few bushels each year until last year, when we picked 60 bushels of fruit and sold the crop for $56 out of the field. I did not thin the apples and this year got about 3 bushels, but there is another year coming, when I hope to get 60. The tree must be thirty-five or forty years old.

Prof. W. P. Brooks. There are one or two facts concerning the questions that have been asked about which I have made a discovery or two. The experimental orchard at Amherst has been managed in a sort of modified grass mulch method; that is, the growth of mixed grass and clover has been cut twice each year and allowed to lie where it has fallen. Until the last year or two the results have been very satisfactory; but last year, in particular, three-quarters of the fruit at least was almost worthless, because it was stung by the curculio. When the fruit is stung it stops growth at that point, a dark-colored or greenish spot is formed, and when ripe the surface is uneven and the interior gnarly. If the grass mulch creates conditions favorable to the hibernation of this insect, as it is believed, it is going to condemn this method absolutely.

My own orchard of forty old apple trees, located not far from the experimental orchard, has, under tillage, fertilization and spraying, increased its product from 10 barrels of miserable fruit in 1908, when I bought it, to 90 barrels of fine fruit this fall.

The question as to bearing every year has been brought in. I presume that many of you personally have Baldwin trees in your orchards which bear a quarter or a third of the tree one year, and the balance the next year. I am satisfied that the character of the season has nothing to do with it. My own explanation is that some time back in the past a certain section of the tree was defoliated, and the part that was not de-

foliated matured its fruit. And then later, the defoliation having occurred early, that part of the tree had a chance to recover and make growth, which would enable it to bear a crop the following year. The reason why a Baldwin apple tree does not bear every year is that the energies of the tree are so largely consumed in maturing the crop of fruit that there is not enough energy left to make growth and perfect buds for the following year.

It is all a question of creating conditions such that the tree can make sufficient growth and mature buds the following year; and if you thin enough and till the soil thoroughly, to create good moisture conditions and good soil conditions, and fertilize, it can be done.

A gentleman wanted to know whether nitrate of potash was not just as good as sulfate. I am pretty sure it is not. We are comparing the two, and find that the sulfate trees are much larger and have given much more fruit.

Putting manure in a cone around the trees is a practice which I should oppose. If there is any part of an orchard that does not need manure or fertilizer, that is the part, for there are few or no feeding roots there.

FIG. 1. — Boxes of western apples. Two-two diagonal pack on Spitzenbergs and three-three off-set pack on Grimes Goldens. This is the kind of packing we must do to compete with the west.

WESTERN METHODS IN NEW ENGLAND ORCHARDING.[1]

F. C. SEARS, PROFESSOR OF POMOLOGY, MASSACHUSETTS AGRICULTURAL COLLEGE.

Even the most casual observer, if he gives the subject any consideration whatever, must be impressed with the fact that eastern fruit has been almost entirely crowded out of the better class of our eastern markets. It still commands a part of the second and third and fourth class markets, where worm-holes and bruises and apple scab are not considered insurmountable objections to an apple; but who ever sees a sign displayed these days in any high-class fruit store, "Choice Massachusetts Apples" (or Connecticut or Vermont or Maine apples)? There are honorable exceptions, of course, to this exclusion of our eastern fruit, men who care for their orchards and who pack their fruit carefully and skilfully, and whose fruit commands the highest market price. But these men have personally overcome the prejudice which exists in the minds of most consumers against our eastern apples. The vast majority of New England orchardists, however, send their fruit to the general market and take what is left after the several "middlemen" have received their share, and little enough it is, as a rule.

All this is discouraging to any one who is interested in eastern orcharding, and who would like to see the industry take its place where it belongs, as one of the leading branches of farming in New England, and as the equal, if not the superior, of orcharding anywhere in the country.

The situation would be far *more* discouraging were it not for the few cases alluded to above, where men are already making the orchard business a splendid success here in New England; and were there not certain factors which warrant

[1] Agriculture of Massachusetts, 1909.

one in believing that we have only to take hold of the industry in a business-like way to make it the equal of orcharding in any other section.

Let us briefly review the situation with the western apple growers and see what factors have contributed to their success. To begin with, their orchards are most of them young, many of them right in their prime and others just coming into bearing, so that the fruit which they are producing there at present is the very best that many of these orchards will ever produce. I do not believe that the importance of this factor is half appreciated by our New England orchardists, who are trying to compete against this class of fruit with fruit from orchards long past their prime. Until we get orchards on a par with the west as to age, we shall not be competing with them on anything like an equal footing.

In the second place, the orchard business is a great industry with them. Whole districts do little else than grow apples, and with this immense capital at stake, and with every man in the section talking and thinking and even dreaming of nothing but apples, the industry is bound to forge ahead. This is a well-recognized principle in *any* industry, yet one which we have systematically neglected here in New England. If Denmark had had only a handful of men scattered over the country who were engaged in dairying, it would never have become the leading dairy country of the world. And if we are to put the orchard industry of New England on a satisfactory footing, one of the first steps that must be taken is to get more people engaged in it. I have repeatedly urged the importance of this, for I believe that too much stress cannot be laid upon it.

The third factor which has certainly contributed to the success of the western fruit is the fertility question. Their lands are new, virgin soils, full of all the elements of plant food, and the fruit grown on them has all the raw materials at its disposal which it can possibly use at any stage of its development. We here in New England are growing the fruit which we expect to compete with it on lands which are many of them already worn out with constant cropping, and

which are in addition too often forced to grow two crops every year, — a crop of fruit and a crop of hay.

The fourth factor in their success is spraying. It is a business proposition with them, and they never neglect it. One hears of orchards which are sprayed five, six, seven or even more times in a season; and experimental spraying at the Oregon Agricultural College has shown that 99 per cent of their apples can be kept free from worms or fungous diseases, and many of their orchardists are approaching very close to this in actual practice by proper spraying. With us in New England the orchard which is sprayed at all is the exception; and usually one, or at most two, sprayings are all that even these orchards receive.

A fifth element of their success is certainly cultivation. It is thorough and continuous, so that all the power of the soil goes to making fine foliage and fine fruit, instead of being divided up among weeds, grass and fruit trees, as is too often the case with us.

The sixth factor in the conquest of our markets by western fruit, and the one which more than all others has given them the inside track, is, in the writer's opinion, their method of handling and grading and packing their fruit after it is grown. Even with our faulty methods of growing fruit, we produce a lot of fine apples but nine-tenths of them are not marketed so as to command the highest price which their quality would warrant; while with the western grower the grading and packing is such as to insure the apples reaching the consumer in perfect condition. Not only is every apple perfect or practically so, — the few blemished ones which they produce being discarded, — but they are graded so that all the apples in each box are exactly alike. Fig. 1 shows two boxes of western apples, — a box of Spitzenbergs, from A. I. Mason, Hood River, Ore.; and a box of Grimes' Golden, packed by Stirling & Pitcairn, Kelowna, B. C., which the writer had shipped to Amherst for use in his classes in pomology. And though these boxes came clear across the continent alone, by express, thus receiving much rougher handling than they would if shipped in car lots, as is usual,

yet so perfect was the packing and so careful had been the previous handling of the apples that they arrived with practically every apple in perfect condition; and the apples in the middle of the boxes and in the bottom were just as good as those on the top. This is certainly the key to western success in getting gilt-edged prices for their fruit. "A dozen Oregon Spitzenbergs," or "a box of Colorado Winesaps," has a definite meaning, just as much so as "a dozen California navel oranges," and customers are willing to pay for this certainty of getting something which is good.

The seventh and last factor in the success which I shall mention — though there are doubtless a few other minor ones which might be included — is their climate. I believe that the dry, sunny weather, which most of their famous apple sections have, puts a color and a "finish" on their fruit which it is difficult to get here in the east. Mind, I don't say that it *can't* be done here, but certainly it *isn't* very often, even in the few well-cared-for orchards of which we can boast. That, it seems to me, is the only factor in the situation which need disturb the man who wants to go into orcharding here in New England; and, as I shall try to show, this is more than offset by advantages which we have.

Let us turn now to the situation here in New England, and see what factors there may be to encourage the prospective orchardist to select New England as his field of operations. In the first place, land values are very much in favor of New England. Men have been "going west to grow up with the country" for so long that prices for land in any of the good fruit sections are abnormally high, while they are correspondingly low here in the east. One hears constantly of the wonderful prices which are paid out there for raw lands, or for land just set to orchard, while $1,000, $2,000 and even $5,000 per acre have been refused for bearing orchards. Here in New England, on the contrary, splendid orchard land can be bought for $5, $10, and up to $50 per acre. No country in the world abounds more in ideal orchard sites than New England. Fig. 2 is typical of hundreds of sections here, where high, rolling lands, with splendid orchard soils, can

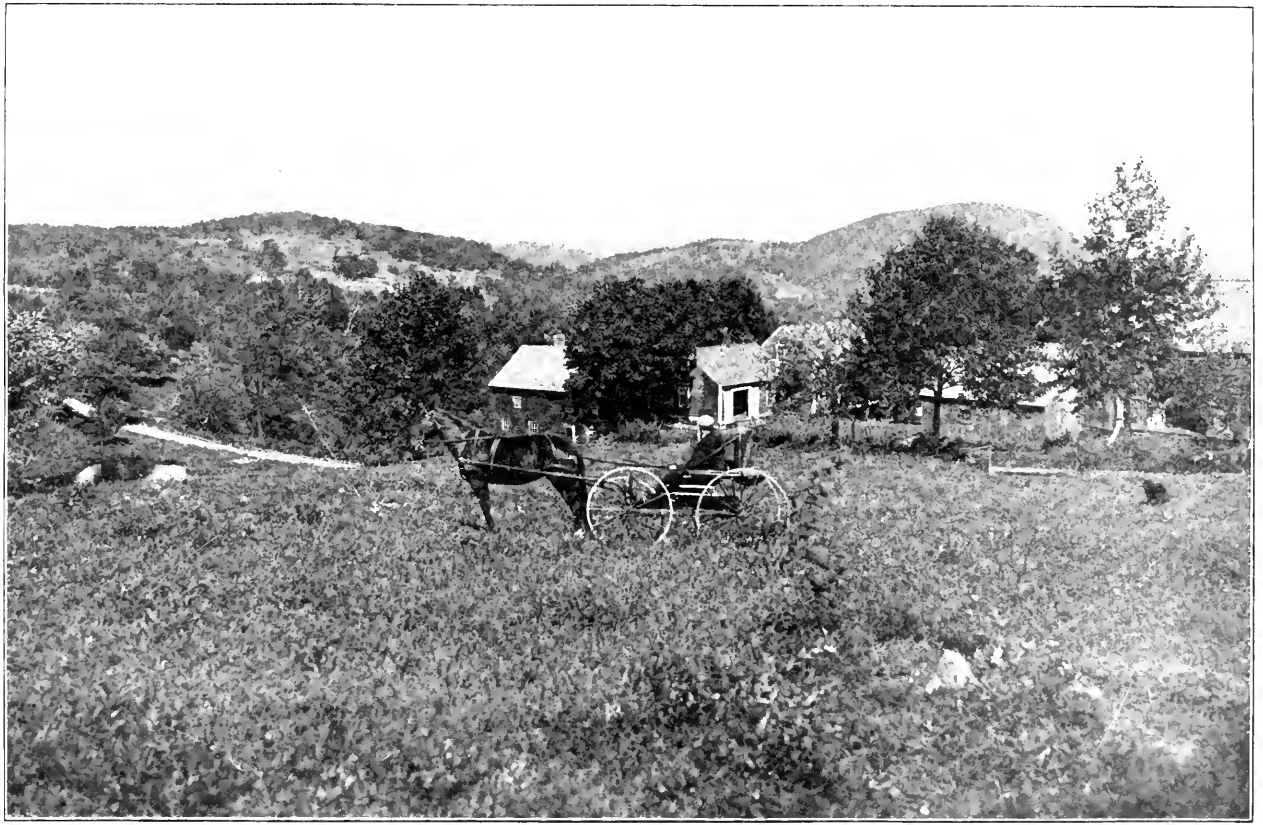

FIG. 2.— Good New England apple country. There are thousands of acres like this to be had at from $10 to $50 per acre

FIG. 3.—Clean culture in the orchard. Notice the tug-less harness, which prevents injury to the trees; also, that the soil is kept like a garden.

be had at prices which will give the man starting an orchard on them a tremendous advantage over the man who starts on the high-priced lands of the west. If one can buy land ready to set out to trees at $25 per acre, — and this can be done in many parts of New England, — he has just one-quarter of the capital to pay interest on which the man has who uses $100 land, and his chances of paying dividends are that much better. The skeptical may ask, "If this is so, why have our New England lands so long gone begging?" and the writer frankly admits that he would like to ask that question himself, though he certainly does not want to be classed among the skeptical as to New England's possibilities in orcharding. As nearly as it has been possible for the writer to figure out a reply to this question, — which is certainly a legitimate one and an important one, if we are to convince those intending to go into orcharding that New England has distinct advantages to offer them, — the reasons are about as follows: —

1. There is the almost universal feeling that an orchard is a long-time investment; that it is going to take years before any returns will be received from it; that, while it might be all right as an investment for one's children, the one who planted it could not expect to get much out of it; and this feeling has been heightened and strengthened here in the east by the records of small family orchards, set years before the orchard was thought of as a serious business proposition, and without any care whatever they *have* taken a long time to come into bearing.

2. We are so largely a suburban community here in New England that truck crops and dairying have been profitable; and once these branches were started, they naturally kept in the lead, as farmers are proverbially conservative and slow to change into new lines.

3. There has been too long a feeling here in the east that we could not compete with the west in *any* line of agriculture. When grain crops were the main feature of farm operations, and when the grain States of the middle west were first opened up, it *was* a one-sided fight; and our eastern

farmers came to feel that anything which the western farmer *could* produce he was bound to win on, and they have therefore the more assiduously stuck to truck and dairying, where they were safe from that competition. But just as at the "National Corn Show" last year it was a young man from Connecticut who took the prize for the highest yield of corn per acre in the United States, and who is now giving pointers and selling seed corn to his western competitors, so I believe that if the eastern orchardists will only try it, they can as fully and easily upset the notion that the west has an absolute and iron-clad lead in the production of apples.

Next to the question of land, and more important in some ways, I should place the matter of the quality of New England-grown fruit. I believe that there is no other section where the flavor and aroma and juiciness and sweetness, and, in fact, all those factors on which we base our estimate of the quality of an apple, are more highly developed than right here. This is not my own judgment alone, though I have had many opportunities of comparing the fruit from this region with that from other sections, and particularly with the far western apples so generally found in full possession of our best fruit stores. And almost without exception, when our eastern apples were as well grown and had been as carefully handled, — which I am sorry to be obliged to admit was not always the case, — almost without exception I have had no hesitation in saying that the advantage in quality lay strongly on the side of our home apples. Prof. John Craig of Cornell, one of the highest authorities on such matters, one of the judges at Oregon's "National Apple Show" last year, and a man who has had frequent opportunities of testing this matter, has repeatedly expressed the opinion, both publicly and privately, that for *quality* eastern apples were in the lead. The late Charles Downing held the same view. He received apples from all over this continent where they were grown in his day, and expressed the opinion that the mountain regions of Virginia and North Carolina and the orchard sections of higher latitude — Nova Scotia, New England, etc. — produced apples of the highest excellence

of any that he received. And the same opinion has been expressed to the writer on many occasions by those who have taken the pains to test the comparative merits of our New England apples and those of Oregon, Colorado and other western sections. Now, if this is so, the importance of this one fact more than outweighs all other possible advantages that the west can have over us. "Quality" ought to be our motto. to be kept constantly before the attention of our growers, from the time they select their varieties till the ripe fruit is put in the hands of the consumer in absolutely perfect condition as to growing and handling. It ought to be dinged into the ears of the consumer and in every way possible brought to the attention of the other senses, — particularly his sense of taste, — until to call for New England apples would be not the *last* but the *first* thing that he would think of doing.

A third factor which certainly *ought* to stand in favor of the New England orchardist is the matter of markets. If he is competing on anything like equal terms with his western competitors in other respects, it would certainly seem that the fact that he is right in the midst of the best markets in the world, while his competitors are three thousand miles *away* from them, ought to give him the difference in the cost of freight and express rates as a margin of profit, or a handicap over his competitors. The thing to do then is to *make* the terms equal, to so adopt up-to-date methods, — whether they be western, northern, southern or eastern, — that this market factor *shall* stand to our credit. Unfortunately, this nearness to markets has in the past worked as much, if not more, against as for New England fruit; for, while the grower of good fruit finds it easier to get his product into the hands of the consumer, so does the man with wormy or windfall apples for sale, and as at present the old, worn-out orchards of New England are producing an unfortunately large amount of this class of fruit, the customer is led to believe that this is about all we grow here. While our western friends are so far from market that no one is rash enough to ship windfalls or other refuse on here, so they are spared the

reflected odium of this trash in the markets, and their fruit ranks correspondingly high with consumers and with everybody who loves a fine thing. Only a few days ago the writer was provided by the secretary of the State Board of Agriculture with a box of apples for demonstration purposes which cost $5 in hard cash. That was the market rate for these apples, held over in cold storage. They are less at the beginning of the season, of course, but such is their reputation that they are always high.

The foregoing discussion presents the main facts of the orchard situation, both east and west, as the writer sees them. It only remains to "sum up the case," and to make some specific suggestions as to putting our orchard industry on its feet in accordance with the general principles already given — as to adopting some western methods. The writer suggests, to those who may be thinking of planting an orchard, the following points: —

First, if possible, put out as much as 10 acres of orchard. The equipment for running the orchard costs as much for an acre as for 10, and the cost of setting it is very little indeed, comparatively. An orchard in which the writer is interested cost less than 6 cents per tree to fit the land and set the trees. The trees themselves for 10 acres ought not to cost over 15 cents each. Furthermore, with an orchard of this size one can afford to do many things, and will be enthused to do many more, in caring for it which one would not with a smaller orchard. By all means make the orchard large enough.

Second, use the greatest care in choosing varieties. Get prolific ones, for there is no profit in growing an orchard which doesn't bear. You must get the bushels if you are going to get the dollars. If possible, get varieties which have been grown in that particular locality. By all means choose high-quality ones. In the writer's opinion, the Ben Davis ought never to be planted, — in Massachusetts, at all events. Possibly it may be allowable in parts of Maine, where better sorts will not grow; but an eastern Ben Davis is such a poor thing, as compared with those of the middle

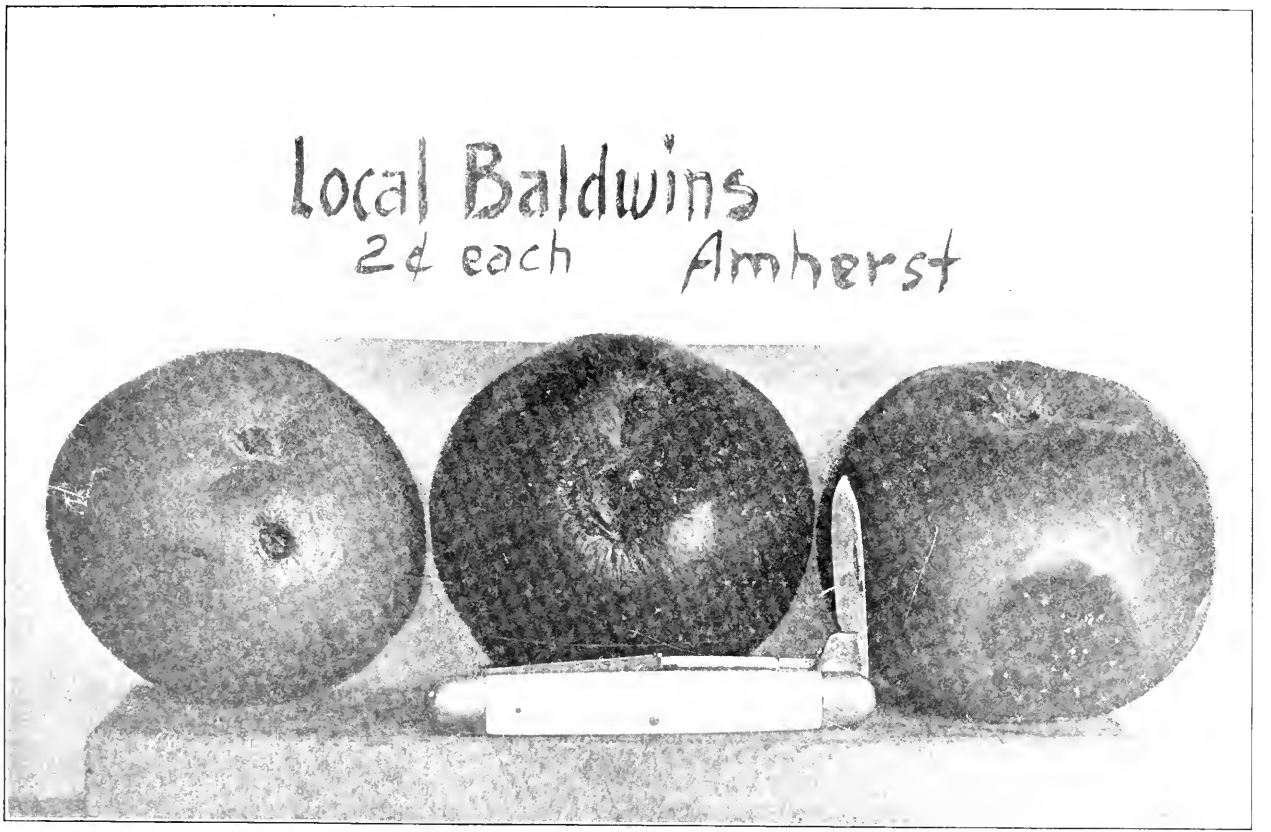

FIG. 4 — Local Baldwins. A worm-hole furnished with every one, and still they sell at 2 cents each.

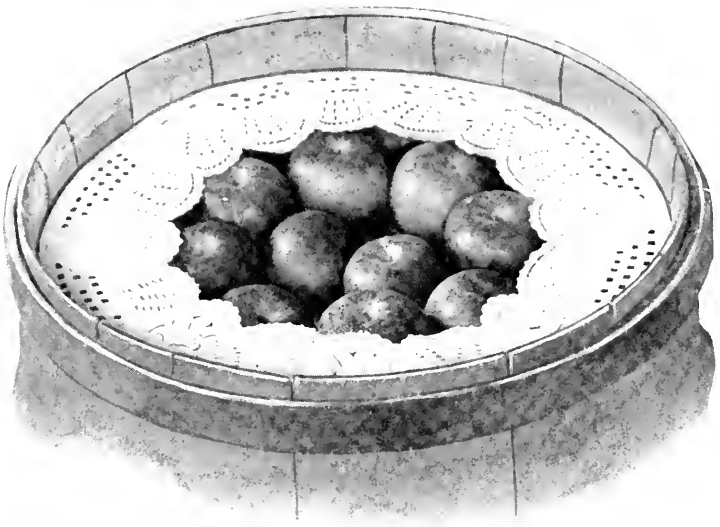

FIG. 5. — A well-packed barrel of apples. The "lace circle" adds to its attractiveness, and with good apples it is good business to use it.

west, and the variety is such a poor thing anyhow, that we certainly cannot afford to grow it in the Bay State. Select popular varieties, if you can. People don't know the Rome Beauty nor the Wismer's Dessert as they do the Baldwin, the Rhode Island Greening and the Hubbardston.

Third, plan to practice clean cultivation in the orchard from the beginning, if possible. It means better care in so many other ways. It means better acquaintance with every tree in the orchard, and consequently better attention to its needs. In particular, it means less borers, and in localities where they are troublesome this is a very important point. If absolutely impossible to cultivate, on account of the steepness of the land, — and there undoubtedly are thousands of acres of splendid orchard land on the hillsides of New England, — then practice the so-called "sod-culture" method; that is, mow the grass and weeds which grow on the land, and leave them for a mulch about the trees.

Fourth, begin to fertilize the orchard as soon as it is set, and keep it up every year. In the writer's orchard each tree is given 1 ounce of nitrate of soda and 1 pound of a mixture made at the rate of 5 pounds of basic slag or of acid phosphate, to furnish the phosphoric acid, and 3 pounds of high-grade sulfate of potash. This is scattered about the tree — not close enough to injure the trunk — as early as the land is in good condition in the spring. For bearing orchards we use 500 pounds of slag or acid phosphate and 300 pounds of high-grade sulfate of potash per acre. Mr. J. H. Hale uses 1,000 pounds of bone meal and 400 pounds of muriate of potash. Either of these formulas is high feeding, but high feeding pays with trees as truly as with steers; and particularly if one is starting an orchard on old pasture land, or lands which have been otherwise depleted of their plant food, — and these sorts of lands often offer ideal orchard sites, — it is imperative to get the plant food back into them, and in liberal quantities, too.

Fifth, spray the orchard. It is not always necessary to spray it during the first few years, but, on the other hand, it is sometimes absolutely necessary if the trees are to be

saved. Rose chafers will sometimes drop down on them, or crawl up, in a night, and prompt measures and strong poisons are necessary to prevent great damage. A good spray pump ought to be bought when the orchard is set, and kept in readiness. Keep an eye out for the San José scale, and for anything else which may attack the trees, and keep ahead of them. When the trees come into bearing, spraying becomes still more imperative. The codling moth is always rampant in our orchards, and wormy apples are tolerated in a way which is ruinous to our reputation. Fig. 4 shows some Baldwins which were on sale at a fruit store in the town of Amherst, and practically every one had a worm in it. One of the most prominent orchardists of Massachusetts stated to the writer last year that in his opinion the Canadian law, which allows 10 per cent of wormy or otherwise defective specimens in No. 1 apples, was far too strict, and that his own No. 1's that year would average nearly 50 per cent wormy. Until we get a different view from this of what is allowable in No. 1 fruit, the west will continue to take charge of our best markets.

Sixth, practice thinning when trees set heavily. This gets rid of the defective specimens of fruit before the tree has had the drain of bringing them to full maturity, and the result is better fruit for that year, and more likelihood of a crop the following year. Some varieties need thinning far more than others, but any variety of any fruit which tends to overbear will be benefited by it; and it is by no means as expensive an operation as many people think.

Seventh, and last, handle the fruit with the greatest care, grade it with the greatest accuracy and pack it with the greatest skill and honesty. In picking and sorting, the fruit ought never to be tossed about or let fall. No apple should be let go of until it is in contact with those already in the basket. Pad baskets and tables, to avoid bruising. For packages use the regular bushel box for all the best grades of apples; either 10 by 12 by 20 inches inside measure, or 10½ by 11½ by 18 inches. The old, flat bushel box used for vegetables ought to be abandoned. The box ends should be

of three-fourths-inch stock, the sides of three-eighths-inch, and the top and bottom of one-fourth-inch. For the top, bottom and sides good clean spruce, straight-grained and free from knots is best. It must be good stock, to provide strength and springiness with lightness. Where barrels are used, — and they will undoubtedly long continue to be our main package, — get new ones, if possible; second-hand ones are never entirely satisfactory. Grade and pack with the greatest care. Carry out J. H. Hale's famous motto, found on his labels, "U C Top U C All." Use the lace circles shown in Fig. 5, and do everything possible to make the package and its contents attractive.

And, above and beyond all, *have faith in the industry.* Talk New England fruit to your friends and neighbors and customers. Tell them we can grow the finest apples in the world and that we ought to take hold and recover our lost markets. And then *practice what you preach.*

THE INFLUENCE OF SOIL VARIATION ON CROP PRODUCTION.[1]

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The influence of soil variation on crop production is best illustrated perhaps, by the development of special crops in different sections of the country. In many cases the highest development of such crops has taken place under a definite and restricted range of soil conditions. We are inclined to look at special crop districts already developed as examples of agricultural adaptation that were bound to appear in the natural course of events. We are also inclined to forget the many individuals who have fallen by the wayside in helping to develop such districts. Yet it is exceedingly doubtful if any section or locality in this country has earned a reputation for producing some crop well without having its course to that success marked by many failures of the individual farmer. There was a first man, for instance, to make some money in growing tobacco in the Connecticut valley. His neighbors followed him. The kinds of soil upon which they tried this crop were diverse, and the quality of the tobacco equally so. Hence the prices received yielded a profit or a loss, as the case might be. The use of commercial fertilizers was begun, and in the keen struggle to successfully produce this crop, which promised high profits when well grown, every kind of fertilizer offered for sale was tried. Perhaps it is not stating the case too strongly to say that for a time it was felt that if just the right fertilizer could be secured we should have the magical key to more universal success and profit. Where the soil conditions and the care given the crop were favorable the use of commercial fer-

[1] Agriculture of Massachusetts, 1911.

tilizers generally paid well enough to warrant their purchase and to establish a more or less rational system of selecting and applying them. Thus has the most profitable field practice with tobacco in the Connecticut valley been developed.

But some fields would not produce a grade of leaf that could be sold at a profit; and this occurred, too, where the same seed was used, and where the same conditions of fertilization and care were supplied. Such failures were unquestionably due to an unfavorable soil. I recall instances where men failed to produce crops profitably notwithstanding the fact that their endeavors were as vigorous and as intelligently applied as those of more successful neighbors. These men have been, in some cases at least, victims of the lack of soil adaptation to the crop they were trying to grow, and I fear that local judgment of their ability as farmers has not infrequently been uncharitable.

But a much more common loss has resulted from the trying out of fields whose adaptability to tobacco was guessed at by the individual farmer. One year's experience on a new field has often been sufficient to show its lack of adaptability to this crop, and the loss entailed not heavier than could be borne, but such trials have in the aggregate been very expensive, both for the individual and for the public. They have been of great advantage, however, to the individual farmer of to-day in giving him opportunity to avoid similar mistakes if he will avail himself of the experience of his own community.

The correlation of all these results and best crop practices found under a wide range of conditions can hardly be undertaken by the individual, as it involves problems at least of State and probably of National scope. In many cases careful experimentation is necessary before safe conclusions can be drawn, and it is the endeavor of the National Department of Agriculture, together with various State organizations, to solve as many as possible of these diverse farm problems. It is the province of the field work of the Bureau of Soils to solve one of the several important factors of crop growing, namely, how to select soils so that the different crops, and,

where possible, the different varieties of the same crop, may be grown with most profit. It is for this economic reason that the study of soil adaptation to crops is of so much importance.

In the Connecticut valley of Massachusetts and Connecticut the physical character of the soil not only determines what specific crops shall be grown on the different types, but the adaptability of those soil types to such special crops has in turn been the principal basis of land valuation there for the last half century. On my father's farm there were three principal types of soil. On the western third a sandy loam gave an excellent quality of wrapper leaf tobacco, and for this reason was bought at a price of $200 an acre, without buildings. It was not nearly as good for corn or grass as the medium brown loam on the eastern third of the farm, which was then valued at approximately $100 an acre, nor as good for grass as the heavy, dark, silt loam of the middle third, at about $75 an acre. Because of the better yields of corn obtained from the loam, my father, in his early experience there, reasoned that it should produce a good crop of tobacco also. Forced to sell the product for about one-half as much per pound as that grown on the sandy loam, though all methods of fertilization and care were the same, he was not long in drawing the conclusion that he needed no further experience in determining the adaptation to crops of that particular soil.

When onions became an important money crop in the Connecticut valley he learned that the best tobacco soil on the farm produced the best quality of onions also, but that the brown loam would give a larger yield through a succession of seasons, and that the quality was not enough poorer to be of material consequence. The surrounding locality soon reached the same conclusion, and then the price of that soil type went up. But the price of the dark, silt loam in the middle of the farm has remained nearly stationary, because it produced a thick, gummy leaf of tobacco and a poor grade of onion. For the latter crop this soil does not dry out early enough in the spring. Then, too, its tendency to

form small clods which cause sore fingers during hand weeding is objectionable, and any rain at harvest time causes this somewhat sticky soil to adhere to the bulbs, and render them less salable. The tops do not cure down as well in the fall on this heavy, silt loam, and this causes some inferior onions, especially if the season be wet and late. No doubt many of you have noted similar instances with this or other crops in your own farm experience without realizing that it might be a case of soil adaptation.

In the rapid development of tobacco growing in Florida and near-by States during recent years soil selection has been one of the most important factors; indeed, within that very considerable district possessing a suitable climate, soil selection has been of chiefest importance, and this phase of adaptation has been carried even to the point of breeding tobacco to suit local soil conditions. Deep sandy soils and light sandy loams yield the thin elastic leaf desired for cigar wrappers, while a similar surface soil, underlain by a dark red clay loam subsoil — the Orangeburg sandy loam —yields a thicker leaf of much heavier body, that is worthless for cigar wrappers but very desirable for cigar fillers. These two types of soil occur side by side, often on the same farm, at the same elevation, and so of course under the same climatic conditions.

Sugar cane in the Gulf States grown on the soil type with the red clay loam subsoil mentioned above yields a syrup that brings a lower price than that from another type associated with it, — the Norfolk sandy loam, — which has a more plastic subsoil of yellow color. With other conditions equal, the latter soil also yields more gallons of syrup per acre than the type with the red subsoil. This is undoubtedly due to the greater freedom with which the cane-root system can penetrate the subsoil, as the red subsoil is stiff enough in some cases to hinder root expansion, — a condition to which the sugar cane plant is sensitive.

Sea-island cotton took its name from being grown on islands along the coast of South Carolina. Its long, beautiful staple is now secured in northern Florida and other Gulf

States when grown on deep, fine-textured, loamy sands similar to those of the sea islands which it made famous. But on the heavy soils, or even shallow, sandy loam surface soils underlain by heavy clay loam, a common soil occurrence in that region, it does not succeed, and is replaced by the short-staple varieties.

In southwest Minnesota a shallow glacial valley some three miles wide divides the upland prairie, which extends for many miles in transverse direction. The irregular valley walls range in height from 15 to 30 feet, or in some cases a little more. The valley soil is a clay loam, richly charged with humus. It is suited to grass and other forage crops, but wheat runs heavily to straw, none of the grain grading above No. 2, while much of it is No. 3. Wheat from the gray clay loam to the west of the valley, where the growth of straw and the filling of the heads is well balanced, gives a higher percentage of No. 1 grain. Grown on the brown loam east of the valley, the grade is about half No. 1 and half No. 2. These lands have been farmed only thirty to forty years, hence they have never been dressed to any appreciable extent with yard manure or commercial fertilizers. The superintendent of the elevator at the county seat where most of the grain is sold told me that he could tell on which of these three soil types a farmer unknown to him lived by the way his wheat graded. However this may be, the influence of the soil on the quality of the same varieties of grain is effectively shown by the money returns at the elevator.

The dark-colored valley soil referred to is of the same character as the famous corn soils of Iowa, and were the climatic conditions in Minnesota as suitable for the growth of corn, this type of soil would undoubtedly equal its prototype in Iowa for the production of that crop.

In southeast Michigan the profit from sugar beets grown for the factory follows closely the character of the soil upon which the beets are grown. Beets from light sandy soils have a high sugar content, with a high coefficient of purity, but the tonnage is relatively small. Moist, rich, clay loams yield a heavy tonnage, but the sugar content is low, and the coefficient of purity very unsatisfactory. The farmers' goal is to secure

the highest possible tonnage consistent with a high sugar content of satisfactory purity. This combination is best found there in a good, strong, sandy loam, underlain by a plastic light clay loam subsoil at a depth of 12 to 20 inches. Nearly as good is a deep, fine, sandy loam extending to a depth of 3 feet or more.

Without taking time for further illustration, the specific cases of soil adaptation to crops already described will be sufficient to show, perhaps, that many of our leading crops have reached their highest development on special types or conditions of soil.

It may be worth while to note here that our natural forest growth also indicates clearly that many varieties of trees succeed best on certain kinds of soil. The local name "black walnut land" is still used where that hardy tree grows to indicate a heavy type of soil. In southeast Michigan this is the "Miami clay loam." The hickory thrives in the northeastern States on the heavier soils. Black walnut and hickory are both deep-rooted trees. In the same region "hemlock land" always indicates a sandy soil, and the hemlock is not a deep-rooted tree. In the orchard districts of West Virginia the leading peach growers will not tolerate "white oak" land, but a mixed growth of "rock oak and chestnut," about one-third of the former and two-thirds of the latter, indicates a soil which has been instrumental in making one of the most famous fruit districts in the world. The rock oak and chestnut growth indicates a soil somewhat stronger than that of chestnut alone, as a better supply of moisture is maintained; when newly cleared it is more productive, and even on old ground better results are secured from fertilization. The subsoil is finer textured, that is, more clayey, than the chestnut subsoil, but still is not so heavy as the white oak soil. Yet on the latter some varieties of apples thrive. Carrying a step further the matter of soil adaptation to the different varieties of oak, it is a matter of common observation that poor and thin soils often support only the dwarfish black jack oak and the post oak.

Shreve has found in his forestry studies in Maryland that "the general distribution of the loblolly pine is determined

by historical and climatic factors, yet its relative abundance at different localities within its area is determined by the character of the soil."

Having dwelt at some length upon the importance of soil selection for the several different crops, I want to call your attention at this point to the fact that the character of the soil upon which a crop is grown is only one of several factors necessary for successful crop production. Climatic conditions, embracing not only absolute temperatures but also the rainfall, air drainage, soil drainage as effected by topography, — the only kind considered until recently, — elevation above sea level and with reference to local topography, fertilization and care, are all important. No one of these factors may be studied effectually unless the other factors influencing production can be balanced. So soil comparisons can be of value only when the other conditions are equalized, and to do this a large number of field comparisons is essential.

Let us now go a step further, and consider not the adaptation of soils to a given crop, but rather the adaptation of soils to different varieties of the same crop. For some time I have been especially interested in working out the conditions of soil on which each variety of apple does best, and to some of these soil adaptations I now ask your attention. Later any discussion pertaining to them will be welcomed.

Baldwin.

If soils are thought of as grading from heavy to light, corresponding 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 Bureau of Soils (see table below) 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.

Scheme of Soil Classification, based upon the Mechanical Composition of Soils.

[Millimeters.]

Class.	1. Fine Gravel. 2-1	2. Coarse Sand. 1-.5	3. Medium Sand. .5-.25	4. Fine Sand. .25-.1	5. Very Fine Sand. .1-.05	6. Silt. .05-.005	7. Clay. .005-0
Coarse sand,	More than 25 per cent of 1, 2.		–	–	–	0–15	0–10
	More than 50 per cent of 1, 2, 3.			–	–	Less than 20 per cent of 6, 7.	
Medium sand,	Less than 25 per cent of 1, 2.		–	–	–	0–15	0–10
	More than 20 per cent of 1, 2, 3.			–	–	Less than 20 per cent of 6, 7.	
Fine sand,	Less than 20 per cent of 1, 2, 3.			–	–	0–15	0–10
						Less than 20 per cent of 6, 7.	
Sandy loam,	More than 20 per cent of 1, 2, 3.			–	–	10–35	5–15
						More than 20 per cent and less than 50 per cent of 6, 7.	
Fine sandy loam,	Less than 20 per cent of 1, 2, 3.			–	–	10–35	5–15
						More than 20 per cent and less than 50 per cent of 6, 7.	
Loam,	–	–	–	–	–	–	15–25
						Less than 55 per cent of 6.	–
						More than 50 per cent of 6, 7.	
Silt loam,	–	–	–	–	–	More than 55 per cent of 6.	Less than 25 per cent of 7.
Clay loam,	–	–	–	–	–	25–55	25–35
						More than 60 per cent of 6, 7.	

Scheme of Soil Classification, etc. — Concluded.

[Millimeters.]

Class.	1. Fine Gravel. 2–1	2. Coarse Sand. 1–.5	3. Medium Sand. .5–.25	4. Fine Sand. .25–.1	5. Very Fine Sand. .1–.05	6. Silt. .05–.005	7. Clay. .005–0
Sandy clay,	–	–	–	–	–	Less than 25 per cent of 6.	More than 20 per cent of 7.
						Less than 60 per cent of 6, 7.	
Silt clay,	–	–	–	–	–	More than 55 per cent of 6.	25–35 per cent of 7.
Clay,	–	–	–	–	–	–	More than 35 per cent of 7.
						More than 60 per cent of 6, 7.	

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 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 the finer grades, but soils also occur, though comparatively rare, which would be too heavy for this variety were it not for a marked content of the coarse sands, the effect of which is to make the soil mass 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 sufficiently clayey to retain a good moisture supply; that is, plastic, not stiff. If the subsoil be so clayey or heavy that moisture does

not percolate down through it readily, a Baldwin of poor color with a skin more or less greasy is the usual result.

Referring to the effect of a heavy, clayey soil on the growth and quality of apples, Hedrick of the Geneva Experiment Station, in Bulletin 339, published last summer, states that "The station soil is not an ideal one for apples. Though well drained, the land is yet hard and heavy, and much of the time unworkable, coming from the plow in great lumps hardly to be crushed. In such a soil the root run is limited. — a fact we have had forced upon our attention in early spring, when the soil is wet, by the blowing over of several trees. Manifestly, food would be better utilized by trees in a soil where the roots could develop better. Despite the physical condition of the soil, apple trees make a very fair growth and the fruit sets in abundance, but with most varieties — and the Rome used in this experiment is not a marked exception — the apples run small, fail to color well and do not always mature properly."

The ideal to be sought is a heavy, fine, sandy loam, or a light, mellow loam underlain by plastic, light clay loam or heavy silt loam. It is fully realized that many will not possess this ideal, but the soil that most closely resembles it should be chosen. If corn be 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 this variety.

Mention was not made in the above description 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 be not that color the successful orchardist will make it so by the incorporation of organic matter through the growth of leguminous crops, or otherwise. 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.

To modify, however, by the addition of humus, the physical condition of a sand until it resembles a sandy loam, or so to change a clay until it resembles a clay loam as far down as tree roots ordinarily extend, is unquestionably an expensive process, and as orchards are grown for profit, the soils on which they are to be planted should be so selected for the different varieties as to furnish the most favorable conditions possible, before going to the additional expense of trying to change their character artificially.

While soils so deficient in humus as to be leachy in the case of sands, but stiff, intractable and cloddy in the case of clays, clay loams, and loams, should have their humus content increased until these unfavorable conditions for crop growth of any kind be overcome so far as possible, it is utterly futile to maintain that by the addition of plenty of humus the physical characteristic of any given soil may be so changed that its inherent physical character is negligible so far as its adaptation to crops or to different varieties of the same crop is concerned. The agricultural practice of the eastern United States is replete with instances of special soil-crop-variety adaptation.

While the hills of Massachusetts include a great deal of ideal Baldwin soil or soil that resembles the ideal closely enough for practical purposes, they also include a great deal of soil that is not well adapted to the Baldwin. The greatly superior color of the fruit from some orchards when compared with that from others on a different kind of soil — elevation, slope, methods of culture and fertilization being virtually the same — gives striking evidence of the importance of the soil factor. On just this basis the fruit from some orchards sells for a higher price than that from others. This illustrates the economic advisability of selecting the orchard site with soils adapted to the variety to be planted.

Rhode Island Greening.

As the best prices for the Rhode Island greening are usually obtained in New York City, the general aim of the commercial grower will be to meet the preferences of that market. The demand there for a "green" Greening has usually been stronger than for one carrying a high blush. Bearing this ideal in mind the soils adapted to this variety are distinct from the Baldwin standard. In fact, these two varieties, considered as standards, differ so markedly in soil requirements that the soil adaptations of other varieties may well be compared with either the Baldwin or the Rhode Island Greening soil standard. A surface soil of heavy, silty loam or light, silty, clay loam underlain by silty clay loam excels for the "green" Rhode Island Greening. 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 grown on a soil too sandy, the Rhode Island Greening lacks fineness of grain, flavor and the juicy quality in greater or lesser degree, depending on the extent of the departure from those soil characteristics which contribute to its production. If a high blush is desired, however, to supply other market conditions, a soil somewhat warmer than that described should be selected, — a deep, light, mellow loam or productive, fine, sandy loam being favorable. To secure a "finish" of this character soils approaching more nearly to the Baldwin standard are best adapted.

The Rhode Island Greening is 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 roughly estimated as ¼° north of the forty-first parallel. South of that it becomes a fall apple, and keeps very poorly.

Hubbardston.

Compared with the Baldwin soil requirements, the heaviest soils desirable for the Hubbardston lap over for a little upon the lightest soils desirable for the Baldwin, while at the other extreme the Hubbardston will utilize to advantage a more sandy soil than most other varieties. 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. A subsoil containing enough clay to make the fine sandy material somewhat coherent, or sticky, is not objectionable, 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 to have greasy skins and a deficient color, while the flavor is insufficiently developed.

Northern Spy.

This variety is one of the most exacting in soil requirements. To obtain good quality of fruit, *i.e.*, 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 produces 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.

Wagener.

In northeast Pennsylvania, where the climatic conditions are not greatly dissimilar to those of this State, Wagener is one of the most profitable sorts for filler purposes. It gave remarkable results, too, in Massachusetts this past year in the eastern part of the State at a very low altitude, and in the western part of the State, at an altitude of nearly 1,200 feet, it is doing very well indeed. The tree is normally somewhat 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 soils, also light sandy soils, should be avoided. The Wagener thus fits in nicely with Northern Spy in soil requirements, and its habit of early bearing makes an effective offset to the tardiness of the Northern Spy in this respect.

McIntosh.

This is an apple of high quality that is now very popular. As McIntosh trees of sufficient age for safe comparisons are rarely available in this State over any considerable range of soil conditions, no positive statement is made concerning the soil preferences of this variety. The indications are, however, that the heavier of the Baldwin soils as described are desirable for the McIntosh.

Tompkins King.

The Tompkins King is fully as exacting as 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, *i.e.,* 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 the 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 rather than 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 soil must be brought to a productive condition. Subsoils inclining toward stiffness in structure should be carefully avoided.

Fall Pippin.

Soils adapted to the Fall Pippin are somewhat wider in range than those described for Northern Spy and Tompkins King. In fact, this variety may be very successfully grown on the soils described for both the Tompkins King and the Northern Spy. It is preferable, however, that the surface soil be a fine loam rather than the open-texture loam described for the Tompkins King.

Grimes Golden.

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 plant-

ing has been widely heralded; and as a result this variety is now being planted in some sections with too little discrimination with reference to both soil and climate.

The best general guide is to plant Grimes where the Rhode Island Greening tends to become a fall apple. This would eliminate it as a Massachusetts sort. 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 well be utilized for the Grimes. It is recognized that some growers as far north as New York may dissent from this view, but I have yet to see the Grimes grown at its best in the Rhode Island Greening region. 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, neither 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 Grimes a favorite sort both for family and for commercial use. For a special box trade it is particularly valuable.

Even as far south as Pennsylvania the Grimes is less hardy than some other sorts. It is very susceptible to collar rot, and the feeling prevails that a block of Grimes will show many "skips" as early as fifteen to twenty years from planting.

Rome Beauty.

Rome Beauty bears the same relation to the Grimes in soil requirements as 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 intraregional overlapping of Rome Beauty and 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 Rome Beauty in its northern extension seek the same soil at a lower elevation for the same reason.

The Baldwin tends to become a fall variety with increasing distance south, and where this tendency is sufficiently pronounced to materially lessen its desirability, it may well be replaced by the Rome Beauty, which is adapted to the same kind of soil.

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 whether it will become a leading commercial sort in either region.

Ben Davis and Gano.

These varieties are mentioned, not to encourage their planting in Massachusetts, for it is believed that they should not be planted here, but rather to show their relation to other varieties better adapted to conditions in this State.

Both Ben Davis and Gano 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 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 the 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 straggling.

Both of these varieties as planted in New York, Pennsylvania and States farther south in the Appalachian region 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, the mountainous areas of Virginia and West Virginia that are well adapted to these varieties, and they are also profitable sorts in western New York and in the Hudson valley. But many orchards have been planted, especially in West Virginia, on thin shale hills, where the soils are so poorly adapted to apple growing that not even the cosmopolite, Ben Davis, can bring satisfactory results. This is not the fault of the variety, and in fact the Ben Davis will probably bring better returns from such soils than any other variety. In the southern Piedmont region the Ben Davis drops so early in the season that it is not of commercial importance. In the southernmost Appalachian districts it may be grown, but only for the late fall trade in the extreme southern markets, as there is no call for it farther north.

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. A potent point to be considered, nevertheless, by the eastern growers is the outlook for future markets.

While the Appalachian region is admirably adapted to the production of varieties which yield well and are far superior to the Ben Davis and Gano in quality, the Ozarks have yet to find an apple of high quality which approaches the Ben Davis in prolificacy. And although varieties may, and probably will, be developed which will replace the Ben Davis even there to some extent, except possibly for exacting shipment, it is certain to be grown there in enormous quantities for a long time. Hence there is and will be, so far as competition with that region is concerned, excellent opportunity for the Appalachian districts to grow varieties that do not have to compete with the Ben Davis, provided such varieties are grown, packed and marketed in accord with the most advanced methods. But this extra profit which may be obtained from such fruit will never be realized by the slack or average grower. For these two reasons, then, the Ben Davis and Gano are bound to remain as they are now, strong commercial varieties over a large area, but New England can just as well grow varieties of much better quality that will also bring good yields. Hence it would seem ill-advised to make further plantings of these sorts within her boundaries.

We have seen how several of our important crops have reached their highest development on certain kinds of soil, and in the light of this experience it seems inevitable to conclude that soils may be selected for different crops in accordance with their relative adaptations to the growth of such crops. In fact, there is nothing new or startling in this statement. It is simply summing up a long line of experience in the best farm practice in the country. Only the best farm practice, the most perfect soil adaptation and the most effective soil-crop management can long survive, because no other kinds pay as well. We have been forced by competition to recognize soil adaptation to different crops. It is a matter of economic efficiency.

Attention has been called to the further fact that the best results from certain varieties of some crops have been obtained under definite soil conditions, and this is especially well illustrated by different varieties of apples. Other fruits, such as the peach and the pear, show a similar range of soil adaptability as to the individual variety, but these will not be considered at this time.

Excellent opportunities for fruit culture in Massachusetts are abundant. No other State can grow a greater number of really good varieties of apples, and very few States can equal her in this respect. Yet choice fruit is constantly being brought into the State to supply her wants, while cheaper fruit is as constantly being exported because it is not grown as well as it should be. In common with other northeastern States Massachusetts possesses a climate in which a large number of varieties of apples thrive. Her soils vary greatly, but include large areas in the aggregate which are well adapted to produce all the choice apples the State can consume. This land may be bought, furthermore, at a low price, — in fact, at a lower price than in many States that now ship large quantities of apples a long distance to her markets. Massachusetts markets are unexcelled, and there are plenty of favorable soil areas within the State on sites suitable for orcharding that are adapted to productive varieties of high quality. It seems strange that such opportunities have not been taken advantage of more fully, yet I would not advocate that those without experience, or at least careful study, plant orchards extensively, even under the favorable conditions that Massachusetts affords. Orcharding is a business requiring a high degree of skill and much patience, and there is danger lest some be led by the present popular wave of enthusiasm for the business to engage in it without due consideration of these matters. Yet there is always a good opportunity for any one who will so study the business as to master it, and for such, conditions are highly favorable in Massachusetts.

VARIETIES OF APPLES FOR MASSACHUSETTS ORCHARDS.[1]

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I wish to disclaim at the outset any notion that the following list comprises *all* the varieties of apples which ought to be grown in Massachusetts. There are doubtless many others which might be added and no doubt some people will think that some which have been included might be omitted in favor of some which are left out. But, in general, I believe the list includes most of those varieties which are most suitable either for commercial plantations or for private orchards within the State. Arranged in approximately the order of their ripening, the list which I propose to discuss is as follows: Yellow Transparent, Red Astrachan, Williams Early, Oldenburg, Gravenstein, Wealthy, Fall Pippin, McIntosh, Hubbardston, Westfield, Blue Pearmain, Palmer Greening, Sutton, Wagener, Rhode Island Greening, Baldwin, Spy, Roxbury. Arranged as nearly as may be in the order of their commercial value in the State, they would stand as follows: Baldwin, McIntosh, Rhode Island Greening, Wealthy, Hubbardston, Williams, Oldenburg, Roxbury, Wagener, Red Astrachan, Sutton, Gravenstein, Fall Pippin, Westfield, Spy, Yellow Transparent, Blue Pearmain.

Before taking up this discussion of special varieties, I should like to call attention to some general points or principles on the subject which I think ought to be carefully considered by the intending planter before he makes his selections. If the orchards are to be grown for commercial purposes, the precise type of market to which it is the intention to cater ought to be considered and its demands studied.

[1] Agriculture of Massachusetts, 1909.

in order to meet the requirements. As a general principle, we may say that markets are of two types, and that a very different list of varieties would be selected for these two types.

There is first the general or wholesale market, where the apples are handled in large quantities, and where the producer never comes in touch with the consumer. The orchardist growing for this market perhaps sells his fruit to a buyer in the orchard, or loaded on the car, or he may ship it to a commission man. In any case, it is very much to his advantage to have a large quantity of fruit of each variety. If he has five hundred barrels of Baldwins, buyers are going to hunt him up and bid for his fruit; whereas, if his five hundred barrels are distributed among the seventeen sorts mentioned above, there would not be enough of any one kind to interest the buyer; and this same general consideration would hold in any type of general market. If he is shipping to a commission man, one hundred barrels each of five sorts will sell for more than five barrels each of one hundred sorts. As a rule, a man chooses this type of market if he is some distance from his market. If he is going to plant an orchard to cater to such a trade, he ought, in my opinion, to select not over five, and preferably about three, varieties. A less number than this does not provide for cross-pollination, and does not allow for the years when certain of his varieties will not bear. I believe that for a steady income from such an orchard a man is better off to have at least three varieties.

The second type of market is the special or personal market. Here the producer comes in direct or nearly direct communication with the consumer, — that is, he either peddles his fruit, or at most sells it to the man who sells it direct to the consumer. The grower perhaps runs a wagon of his own, or, if he does not do this, he sells to a grocery or fruit store which sells to the consumer. In either case he is so near the consumer that he gets the benefit of the good quality of his fruit, or the blame for its bad quality. He gets personal customers, who may say, "Yes, Mr. Jones, those apples we got last week were fine; I want some more like them." Or, to the grocer, "When are you going to have some more of Mr. Jones's

apples?" In either case Jones wants to be in a position to supply the demand; in other words, he does not want to work up a market for his Yellow Transparents, and then drop it when Williams Early are in season, and allow his customers to forget all about Jones before his McIntoshes come on. I have known a man, and a good business man, too, who refused 50 cents a barrel more for his Spies than he could sell them for to his regular customers, merely because he did not want to break the connection. For such a grower as we are now considering, I do not believe that ten or a dozen varieties are too many. This may sound like rank heresy, but if the varieties are selected with the proper care and consideration, I am sure that it is right.

But, whichever market one is working for, there are certain characteristics in fruit and tree which ought to be considered, though their relative importance will vary somewhat. I have a great weakness for score cards, because it seems to me that they will help us to reduce our judgments to a more definite basis, and help one who lacks experience to give more nearly proper weight to each point. I have therefore worked out the following score card, which I have used in my classes with good results, and which I believe will help the intending planter to give the proper rating to each variety: —

Score Card for a Commercial Variety of Apples.

	General Market.		Special Market.	
Tree,	40		35	
1. Heavy bearer,		20		15
2. Early bearer,		10		10
3. Healthy and vigorous,		10		10
		40		35
Fruit,	60		65	
4. Fair size,		10		5
5. Good color,		20		15
6. Good quality,		12		30
7. Keeps well,		10		10
8. Ships well,		8		5
	100	60	100	65

This is by no means an ideal score card, but it represents fairly accurately my notions as to the comparative value

of the different points. To discuss each of these points briefly: —

Tree. (*1*) *Heavy Bearer.* — I have rated this higher for the general market than for the special, because we do grow varieties for the latter which are not especially heavy bearers, because their quality is such that it pays to grow them. In any case it is important that we get the fruit; nothing is more discouraging than an unproductive orchard.

Tree. (*2*) *Early Bearer.* — This needs little discussion. One of the great difficulties in getting men to set apple orchards is the length of time it requires to bring them into bearing. If they came in in two to four years, as peaches do, we should see far more apple trees planted. Those varieties which do come in relatively early are correspondingly welcome. I have rated this the same for both markets, because it seems to me that it is almost equally important. Possibly we could afford to plant for the special market varieties which are a little slower in coming into bearing, if their quality warranted it.

Tree. (*3*) *Healthy and Vigorous.* — This is certainly equally important for both markets and needs no discussion here. The common ailments which would lower the standing of a variety here would be susceptibility to canker, to apple scab on the twigs, a tendency to winter-kill, etc.

Fruit. (*4*) *Fair Size.* — I have given this double importance for the general market, as we frequently grow special varieties, as the Lady, Fameuse and Pomme Grise, for the special market, if their quality warrants it, when their size would condemn them for the general market; but it is certainly a fact that a fair-sized apple has the advantage, other things being equal.

Fruit. (*5*) *Good Color.* — I suppose this is practically equivalent to saying "red color," but not quite, as some yellow apples are more attractive than others. It seems to me that the craze for red apples is just as insane a notion as that for red Short-Horn cattle, or for Jerseys with a black tongue. But the craze is here, and the red apple sells better, particularly in the general market, than any other color.

Fruit. (*6*) *Good Quality.* — This is a crucial point with the special market, and I believe that it ought to be given more weight than is usual with the general market, particularly here in Massachusetts. We can grow apples of the highest quality; some other sections cannot. If we must compete with those sections (and we certainly must), why should we throw away this advantage by trying to grow Ben Davis? Even in the general market quality is appreciated, as any one will see by watching the market prices and observing the relative difference in price of McIntosh and even as good a variety as the Baldwin.

Fruit. (*7*) *Keeps well.* — There is undoubtedly a market for early apples, and yet, as a rule, the price rises as the season advances. In years when the crop is large and the price is low it is frequently the late winter sorts which bring the balance out on the right side. This is less important now that cold storage has become more perfect, but certainly it is still worth considering.

Fruit. (*8*) *Ships well.* — This is also less important than in former years, for methods of packing and shipping have improved greatly; still, it is even yet important, for if a variety ships well it requires less time and expense in handling, and it is more likely to come on the market in a uniformly good condition.

Let us now turn to a consideration of the individual varieties listed, considering them on the basis of the above score card.

(*1*) *Baldwin.* — The Baldwin is a chance seedling which was found at Wilmington, near Lowell, Mass., and there are few things which Massachusetts has more cause to be proud of than having originated the Baldwin. The tree is a strong grower, long-lived and vigorous, making a round-headed top of excellent shape, and is in most respects an ideal tree. It is hardy except in very severe climates. It does not come into bearing early, ranking about with the Gravenstein in this respect. As a rule, seven or eight years are required, under even good conditions, to bring it into profitable bearing. The tree is somewhat subject to canker, though not very seriously

so. It bears very abundantly in alternate years, and little or nothing in the odd years. Whether this tendency can be overcome by thinning, or by some other treatment, remains to be settled. The fruit is finely colored when well grown, of good size, regular in form, and runs as a rule very uniform, with comparatively few culls. It keeps well, the season being from November to March in ordinary storage, and it stands handling very well indeed. The quality is usually ranked from good to above, when well grown, but a poorly grown Baldwin is a poor thing. This point I think needs decided emphasis, as some of our well-grown Baldwins are the equal in color and attractiveness of anything grown in the famous northwest. On the other hand, some of our poorly grown Baldwins are the equal of almost anything disreputable in the apple line. The Baldwin is undoubtedly the most popular and profitable apple in New England and New York. A point worth considering is that it is one of the best export apples, particularly to England, where American-grown Baldwins stand very high. This means that in years when there is a large crop here we would have an outlet to foreign markets. To sum up its good and bad points: —

Baldwin.

Good points: —	Bad points: —
1. Well known.	1. Rather slow in coming into bearing.
2. Long-lived tree.	2. Overbears in alternate years.
3. Good bearer.	3. Not high quality.
4. Uniform grade of fruit.	4. Cankers.
5. Good color.	

(*2*) *McIntosh.* — Perhaps no other apple is more popular at the present time or more largely planted, than the McIntosh, and in my opinion it deserves all its popularity. It belongs to the Fameuse group, having originated in Ontario, Canada. The tree is a strong grower, hardy and healthy, one of the finest that I know. The side branches come out at almost right angles, so that the tree will bear an immense load of fruit without breaking down; the branches are well distributed; altogether, it forms a beautiful tree. It comes into

bearing relatively early, and bears well, though not overabundantly. It has a strong inclination to be an annual bearer when well cared for, which I consider a decidedly important point. The fruit itself is very attractive in appearance, being a bright, handsome red, with a waxy texture to the flesh, which is white, tender and very highly perfumed. The aroma of a good McIntosh is something to be remembered. Its season is from the first of September to perhaps the middle of November in ordinary storage, but it will keep in fairly good condition much longer than this. It is particularly good for holding its color and attractive appearance, which is a very desirable quality. It is not an uncommon thing to find good specimens of McIntosh as late as January or February, which, though they have lost something of their quality, are still very good eating. The fruit ripens unevenly, and has a considerable tendency to drop, so that picking should be done twice and perhaps three times. It is a very desirable variety for local or special trade, but will not stand rough handling. I believe that this last point is being overlooked, and that a good many men are planting the McIntosh who will not give it the type of handling which it demands. At present it is probably the most popular variety in Massachusetts.

McIntosh Red.

Good points: —	Bad points: —
1. Hardy tree, good shape.	1. Tender, requires careful handling.
2. Highest quality.	2. Scabs.
3. Finest color.	3. Ripens unevenly.
4. Uniform grade.	4. Drops.
5. Annual bearer.	

(3) *Rhode Island Greening.* — The Rhode Island Greening is thought to have originated in the State whose name it bears, and probably near Newport, although the records are not very definite. It would certainly stand next to the Baldwin as a commercial apple in New England, though the McIntosh is undoubtedly far ahead of it in the number of trees being planted at the present time. I believe, however, that the Rhode Island Greening deserves more attention than it is

receiving at present from those who are planting commercial orchards. The tree is reasonably hardy, winter-killing only in rather severe climates; it is long-lived and generally healthy, though it does not come into bearing early. Probably eight or nine years would be the usual time required to bring it into bearing. It makes a characteristic tree, being strong and vigorous, and, as already noted, healthy, although the fruit and foliage are both liable to scab, and in some sections the apple canker attacks it. The form of the tree is decidedly drooping, and for this reason it might be headed somewhat higher than the varieties of more upright growth. Its season is a little earlier than that of the Baldwin, and it is a good companion variety to plant with the Baldwin in commercial orchards. The fruit is a bright, handsome green in color in the autumn and early winter, but changes to a yellow color later in the season. It is undoubtedly one of the best cooking apples grown, and a Rhode Island Greening pie is fit for a king. It is by no means to be despised as a dessert apple. It is more nearly an annual bearer than the Baldwin, though not strictly annual, and the fruit hangs very well on the tree. The season is from late October until March, though varying somewhat with the culture and storage conditions; but it ripens very rapidly when subjected to heat, and is very liable to scald in storage, particularly with large, overgrown specimens.

Rhode Island Greening.

Good points: —	Bad points: —
1. Well known.	1. Sometimes scalds in storage.
2. Productive.	2. Color.
3. Good quality.	3. Scabs.
4. Fine cooker.	4. Not as hardy as Baldwin.

(*4*) *Wealthy.* — This variety was originated by Peter Gideon of Minnesota, from seed of the Cherry Crab. The tree is very hardy indeed, and a good, thrifty grower while young; but as the trees get older the rate of growth becomes more moderate, until when they reach middle age the growth is very slow, and careful cultural treatment is often required to keep up its rate of growth. The tree never reaches large

size, and, for that reason and others, is very useful as a filler. It comes into bearing very early; frequently fruit will be found on the trees in two or three years, though of course only scattering specimens. The fruit is of good quality and finely colored, being a light straw-yellow, splashed and striped and sometimes almost covered with a handsome crimson. It attains good size on younger trees, but on older trees, where, as noted above, growth has become slow, the fruit is apt to run small. This has to be overcome by severe pruning and high fertilization and culture. The fruit also needs to be thinned to get the best results. In any case the fruit runs very uniform both in size and shape, and for that reason it makes an excellent variety for boxing. The flesh is tender and juicy, and requires careful handling in order not to injure it. The season is September and October, slightly before the McIntosh; but it can be kept until December in good storage. The fruit drops badly from the tree, and the trees should be picked over two or three times. It is at present being quite largely planted, more so than many other varieties; but, as already noted, its special field is as a filler.

Wealthy.

Good points: —	Bad points: —
1. Bears very early.	1. Drops badly.
2. Hardy tree.	2. Ripens unevenly.
3. Good quality.	
4. Uniform grade.	
5. Good color.	

(5) *Hubbardston.* — This is another variety which originated in Massachusetts, having been found at Hubbardston, Mass., very early in the history of the State. The tree is vigorous, particularly when young, and comes into bearing early, frequently giving a fair scattering of fruit from the orchard at four years. The tree is only moderate in size, but bears heavily, at least biennially and sometimes annually; it is therefore a good variety to be used as a filler. It is apt to overbear in a productive year, and for this reason should receive careful attention, to keep the soil in a good state of fertility and the foliage free from fungous diseases or in-

sects. It will often be necessary, also, to thin the fruit, in order to keep it up to the proper size. The tree is considerably subject to canker where that disease is prevalent, and the fruit to the railroad worm. The fruit is of excellent quality, being firm, fine-grained and rich, and when well grown it is finely colored, with handsome appearance and attractive texture, which make it sell well. As a cooking apple it does not rank so high, and ought to be used fairly early, as after it has become more mild it is not nearly as good for this purpose as when it has more acidity. The fruit is uniform and of fair to good size, except when it overbears. Its commercial limit in ordinary storage would be December, and, as with many other varieties, the large-sized, poorly colored specimens do not keep as well as smaller, firmer and better-colored ones. When this variety is well grown it has proved a profitable market sort, standing at present close behind the Greening; and I should have no hesitation in setting it as a market variety, particularly on light soil, where it does especially well.

Hubbardston.

Good points: —	Bad points: —
1. Quality excellent.	1. Overbears and runs small.
2. Early bearer.	2. Railroad worm.
3. Handsome when well grown.	3. Loses quality as cooker.
4. Good bearer.	

(*G*) *Williams Early.* — This is another of our Massachusetts apples, and, like a great many things which Massachusetts has done, this is a good job. It originated in Roxbury, Mass., more than one hundred and fifty years ago, and in my opinion is one of the best and most profitable of the early varieties. The tree is rather a poor grower and is therefore often best top-worked on some better growing variety, as Pewaukee or Spy. It is a fairly good cropper, and has a decided tendency to be an annual bearer when it receives the right treatment. The fruit is only medium in size, but a beautiful bright red, with a very fine though mild flavor. Its strong point is for dessert, but, contrary to the opinion of some others, I consider it a very fine cooking apple. The

fruit ripens unevenly, so that it needs more than one picking; and, as it is tender both in skin and flesh, it ought to be handled with care and packed in boxes. It is a prime favorite in the Boston market, and I should not hesitate to plant it as a commercial variety.

Williams Early.

Good points: —	Bad points: —
1. Fine color.	1. Ripens unevenly.
2. Fine quality.	2. Tender flesh.
3. Annual bearer.	3. Poor grower.
4. Favorite in Boston markets.	

(7) *Oldenburg.* — This is one of the Russian varieties which has "made good" in America. It is especially valuable where extreme hardiness is required, but I believe it is worthy of a place in our list of commercial varieties for Massachusetts. As suggested, the tree is very hardy, but is of only moderate size. It grows vigorously while young. Its most valuable character, however, is its early bearing. Fruit is frequently borne on trees at three and four years, and fairly good crops are often borne at four and five years. It is also a reliable cropper, often yielding annual crops; and the fruit hangs well to the tree. The foliage is fine and healthy, and altogether it is a fine tree for a filler, where this system of planting is used. The fruit is of good size and very attractive, being a fine light yellow, with stripes and splashes of handsome red. It runs very uniform on the tree, with few culls, and is altogether a very good commercial sort. The flesh is firm but juicy, with a sprightly, sub-acid flavor, and, though not high in quality, is still passable.

Oldenburg.

Good points: —	Bad points: —
1. Hardy tree.	1. Fruit perishable.
2. Very early bearer.	2. Ripens unevenly.
3. Reliable cropper.	3. Only moderate quality.
4. Fruit hangs well to tree.	
5. Handsome color of fruit.	

(8) *Roxbury Russet.* — This is still another of the fine old varieties which have originated in Massachusetts, and

goes back to the seventeenth century. From a commercial standpoint it is undoubtedly the best of the russets, and is especially valuable as an export variety, the English market being particularly strong on russets, and especially the Roxbury, since it is marketed late in the year. It is being planted less since cold-storage facilities have improved, but I believe it is still worthy of a place among our list of market varieties. As a cropper it is somewhat variable, but has a strong tendency to annual bearing when well cared for, as it does not tend to overbear. The tree is medium to large in size, and rather a vigorous grower, making usually a flat top. Its principal weakness, so far as the writer knows it, is a tendency to European canker where that disease is common. It makes a characteristic twiggy growth, being full of short fruit spurs, and easily recognized by one familiar with the variety. The fruit is medium to large, being rather variable in both size and shape. It is sometimes oblate, sometimes somewhat conic, and almost always irregular in cross-section. For this reason it is not a good variety for boxing, though these objections apply less to the fruit on well-cared-for trees than on those which receive less care. The flesh is yellowish in color, very firm, but reasonably tender and juicy, with a sprightly sub-acid flavor. In quality it would rank, in the writer's opinion, as good to best. There seems to be considerable objection to it as a commercial variety for our American markets, but I believe that this objection is going to disappear as people become accustomed to attaching less importance to the red skin of an apple.

Roxbury Russet.

Good points: —	Bad points: —
1. Reliable bearer.	1. Canker.
2. Keeps late.	2. Russets not wanted.
3. Good quality.	
4. Well known.	
5. Handsome.	

(9) *Palmer Greening* (*or Washington Royal.*) — This is still another Massachusetts apple, having originated at Sterling, Mass. The tree is only moderately vigorous, even when

young, and attains at full age only moderate size, not nearly as large as the Rhode Island Greening. It comes into bearing reasonably early, from six to seven years, bears good crops biennially, but has very little fruit in the off year. The fruit is greenish in color, or yellowish when fully ripe, and usually has a distinct blush on the sunny side, making it a decidedly attractive apple to any one who is not wedded to a red variety. There is an indication of quality to a good Palmer Greening that is very attractive, particularly to one who has ever eaten it. It is especially valuable as a dessert apple, as its quality ranks from good to best. Professor Dickens of Kansas wrote recently of some Palmer Greenings which had been sent him for his class in pomology: "Two out of eight in my senior class pronounced it the best apple they had ever eaten, and they know Grimes Golden and Jonathan pretty well." It will keep till December, or even till March, in good storage, and its medium size and very uniform shape and size make it an ideal box apple. In my opinion, it ought to be grown more extensively in Massachusetts.

Palmer Greening.

Good points: —	Bad points: —
1. Extra quality.	1. Not well known.
2. Attractive appearance.	2. Biennial bearer.
3. Size and shape.	3. Rather a poor tree.
4. Fairly early bearer.	

(*10*) *Sutton* (*Beauty*). — The Sutton is supposed to be a seedling of the Hubbardston, and originated in Sutton, Mass. The tree is vigorous and healthy, but very upright in growth, making, in the writer's opinion, a very poor tree. One who had become familiar with the Sutton tree would always be able to pick it out. It has a marked tendency to bear biennially, which is an objection. While as yet not at all well known as a market variety, I believe it is worthy of trial. Beach says of it: "In color, texture, quality and season the Sutton is intermediate between the Baldwin and the Hubbardston." It is very uniform in both size and shape, being

rather above medium in size, and of a fine conic shape. It is excellent in quality, and of fine red color. It seems specially suited to the fancy box trade, but its flesh is a little too tender for the general market, though it is all right in barrels if handled carefully.

Sutton.

Good points: —	Bad points: —
1. High quality.	1. Scabs some.
2. Good color.	2. Not so well known.
3. Hangs on well.	3. Poor tree.
4. Productive.	
5. Even in size and shape.	

(*11*) *Gravenstein.* — This is a German variety, introduced into the United States about 1826. Its very attractive appearance and excellent quality make it popular, even in spite of the fact that as a rule it is not very productive. For cooking it is not excelled by any variety of its season, and when fully ripe and not overripe it is an excellent dessert variety. The tree is a very vigorous grower, in fact, too vigorous unless handled carefully, having a tendency to grow too late in the fall and to be damaged by the severe weather which follows. It is also liable to sun-scald and to canker. It comes into bearing fairly early, usually from seven to eight years, and is a reliable cropper, though not a heavy one, with a considerable tendency to bear biennially. The fruit ripens quite unevenly, and ought to be picked twice or even three times to secure the best results. The season is from the middle of September until November. It may be kept later than this in good storage, but the color fades badly if it is kept much beyond its season, far more than the McIntosh does. It is apt to grow a good many culls, particularly in the off year, running very variable in both shape and size. Where it succeeds, no other apple of its season can compete with it in the market. In quality it ranks from good to best.

Gravenstein.

Good points: —	Bad points: —
1. Fine quality, cooking and eating.	1. Shy or biennial bearer.
2. Handsome appearance.	2. Winter-kills.
3. Tree needs little pruning.	3. Collar rot, rank grower.
4. Well known.	4. Fades in storage.
	5. Sun-scald and canker.

(*12*) *Red Astrachan.* — This is another of the Russian apples which has achieved success in the United States, and which I would include as a commercial apple for Massachusetts. It is very early in season, following the Yellow Transparent, and being fit for cooking in July. It is consequently a profitable variety for local markets and for home use, while its attractive color combined with its earliness makes it popular. It is, however, very tender in flesh, and will not stand shipping well. It is principally valuable as a cooking apple, though well-grown, fully developed specimens are very good eating. The tree is medium in size, coming into bearing early, and is reasonably productive, though inclined to bear biennially. Its tendency to be irregular in both size and shape is rather a serious drawback to a commercial variety, making quite a loss from unmarketable fruit. The fruit drops considerably, unless several pickings are made.

Red Astrachan.

Good points: —	Bad points: —
1. Fine color.	1. Irregular in size and shape.
2. Very early.	2. Very tender in fruit.
3. Productive.	
4. Hardy tree.	

(*13*) *Fall Pippin.* — The origin of this variety is somewhat in doubt, but it is good enough so that its origin does not much matter. It ought to have originated in Massachusetts. The tree is large and rather vigorous, making a roundish, rather dense top. Both leaves and fruit are seriously subject to the apple scab fungus, which is a decided drawback where this disease is troublesome. The fruit ripens very unevenly,

which is another objection, as it means repeated pickings, which add somewhat to the expense. The fruit is large, of a fine, clear yellow, and decidedly handsome, having a clean, attractive appearance which makes it sell well. The flesh is fine-grained, tender and juicy, rather aromatic, and ranks as good to best in quality. It is a fine dessert apple, but is especially strong as a culinary variety. In storage it is a variable keeper, but in any case has a long season, owing to its uneven ripening, beginning in September and lasting well on towards Christmas. I should consider it among the best of the fall varieties for home use, and a good commercial sort.

Fall Pippin.

Good points: —	Bad points: —
1. High quality.	1. Subject to scab.
2. Popular in the market.	2. Ripens unevenly.
3. Attractive yellow color.	

(*14*) *Westfield* (*Seek-no-further*). — The Westfield, or Westfield Seek-no-further, is still another of the Massachusetts contributions to the list of fine varieties of apples. It originated at or near Westfield, in the neighborhood of Springfield, Mass. The tree is very hardy, healthy and long-lived, though inclined to be a biennial bearer. It is nevertheless a very reliable cropper. The fruit is of highest quality, with a nutty, aromatic flavor which one who has once known it cannot forget. It is not particularly attractive in appearance, being a rather dull, brownish-red, but when well grown, and especially when grown on sandy or gravelly soil, where it succeeds best, it often attains a fine, handsome red, which makes it really attractive. It runs very uniform in both size and shape, making it a good box apple, and as it is principally used as a dessert apple (not being a very good cooker), this is the way it ought to be marketed. Its season is from about October to February, but it will often keep in good storage much later than this. It stands handling and shipping well, and in a limited way I believe it would be profitable as a commercial variety. Certainly it ought to be in every family orchard.

Westfield.

Good points: —	Bad points: —
1. Fine quality.	1. Poor color.
2. Hardy.	2. Not good as a cooker.
3. Productive.	

(*15*) *Northern Spy.* — The Spy is one of the few important commercial apples which Massachusetts cannot claim, as it originated in New York. It is one of my sincere regrets that the Spy does not succeed better in Massachusetts. There are certain sections where it does admirably, particularly in Franklin County, but as a rule it has the reputation of not being a success with us. Whether it altogether deserves this reputation is a question, but certainly we do not grow good Spies in many sections. The tree is all that could be desired in health and vigor, making a fine-shaped, large tree, and living to a good old age, but it is very slow indeed in coming into bearing, in this respect standing at the foot of the list of reputable varieties. The fruit when well grown is about all that could be desired, being a fine, bright, pinkish-red in color, with a smooth, waxy skin, making an extremely attractive apple. The flesh is firm and crisp, but tender and juicy, and has a flavor that no one will forget, once he has eaten a well-grown, well-colored Spy. Both fruit and foliage are decidedly subject to the attacks of the scab fungus where this disease is prevalent, and its tender skin and flesh make careful handling necessary. But, with all its faults, I should say that in sections where it is known that the Spy succeeds it ought to be put down as one of our leading varieties. In other sections it had probably better be tried only on a small scale; but even here, unless it has been tried under favorable conditions, with modern treatment as to spraying, etc., I believe it is worth experimenting with.

Northern Spy.

Good points: —	Bad points: —
1. High quality.	1. Slow in coming into bearing.
2. Fine appearance.	2. Often does not succeed well.
3. Healthy, hardy tree.	

(*16*) *Yellow Transparent.* — This is the third Russian in the list, and is included principally because of its very early season, ripening in July, when every one is apple-hungry. The tree is very hardy and healthy, and comes into bearing very young indeed. Grafts often bear the second year, and sometimes even the year they are set, the trees usually bearing a reasonable crop the third and fourth years. It is a good, reliable cropper, but ripens so unevenly that it requires two or three pickings to secure the fruit in the best condition. The fruit is a very handsome, clear yellow, but both the flesh and skin are tender, and it therefore bruises easily and shows the marks of careless handling. It is a fine cooking apple, and good specimens are not by any means bad eating. Where early fruit commands a good price, and for near-by markets, it will prove a profitable variety. It is an excellent filler.

Yellow Transparent.

Good points: —	Bad points: —
1. Very hardy tree.	1. Easily bruised.
2. Handsomely colored fruit.	2. Does not stand up well in transit.
3. Early bearer.	

(*17*) *Blue Pearmain.* — This is a fine old variety, but is not very generally grown, and it is not recommended here except for the family orchard, or in a limited way in commercial plantings. To one who knows and likes the good old-fashioned sorts the Blue Pearmain is always very acceptable. The tree is a good, strong grower, and long-lived. The fruit is mild in flavor, but aromatic and fine, with a rich appearance in well-grown specimens which is attractive. The skin is a little rough and rather thick. The color is deep orange-yellow, splashed and striped and shaded with very dark red, and the heavy white bloom over this gives a bluish appearance. The flesh is firm, yellowish, moderately juicy and aromatic.

Blue Pearmain.

Good points: —	Bad points: —
1. Healthy, vigorous tree.	1. Not generally known.
2. Handsome fruit.	
3. Good quality.	

THE PLANTING OF A COMMERCIAL ORCHARD IN MASSACHUSETTS.[1]

F. C. SEARS, PROFESSOR OF POMOLOGY, MASSACHUSETTS AGRICULTURAL COLLEGE.

I presume it will come as a surprise to most of you when I say that I propose to make my own experience the basis of my remarks to you this afternoon, because a "professor" is not supposed to have experiences, but is expected to speak from a purely theoretical standpoint. However, perhaps some of those present are aware that the past spring Professor Waugh and I started a commercial orchard in South Amherst, a few miles from the Agricultural College, and it is about our work in this orchard and the problems which we have encountered and solved that I want to tell you. I trust you will pardon the personal pronouns that I shall be obliged to use, for, when all is said and done, it is what we have ourselves actually done, not what we have seen others do, or think ought to be done, which gives our opinion weight.

Stated briefly, our undertaking is as follows: we have purchased 150 acres of land, upon which we set the past spring some 5,500 trees, — apple, peach and plum, and we have ordered for setting the coming spring about 8,000 trees. Now, I mention this not to boast of the size of our project, but that you may have an idea at the start of what we have done and are planning to do; for while you may question our judgment, you will at least see that we are willing to take our own prescriptions, which is not always the case when doctors prescribe.

To begin with, may I suggest one or two considerations which led us to go into commercial orcharding, and to undertake it on the lines we have adopted. Of course we have both of us always had a strong belief in the business of grow-

[1] Agriculture of Massachusetts, 1908.

ing fruit, else we should not have adopted horticulture as a profession; and personally I believe that there is no better country in the world than right here in Massachusetts in which to engage in the business.

In the first place, Massachusetts can grow fruit of the very highest quality. We can't grow as good Ben Davis as they can in Colorado and Missouri (and personally I wish that we would stop trying to), but no country in the world can beat us on Baldwins and Greenings and Hubbardstons and a dozen other similar varieties, if we will only take care of our orchards. And while in the past anything has sold that was red and had the shape of an apple, yet as competition increases, and as people become educated up to an appreciation of what an apple ought to be, quality is going to count more and more, and Massachusetts will have more and more advantage, if she will only take it.

In the second place, we are right in the midst of the best markets in the world. There are 23,000,000 people within a radius of 300 miles from the spot where we now stand, and no equal number of people anywhere on the globe has a larger proportion who spend money freely for just such necessary luxuries as fruit.

But this nearness to markets is both an advantage and a disadvantage. It is an advantage, because we can get our fruit to market cheaply and quickly, and when we come to compete with Oregon, we ought to have the difference in freight and express as a lever on our side. But it is also a disadvantage, because we are so close to those markets that every man in Massachusetts who has a barrel of windfall apples sends them to market, in the hope of getting something for them; and though he usually realizes on this hope, yet sometimes he doesn't. And in any case, whether he gets anything out of it or not, he gives a "black eye" to Massachusetts fruit in general which it is often difficult to overcome. One of our greatest needs at the present time is to devise some scheme to keep poor fruit out of the market. Of course the ideal remedy for this is not to grow poor fruit, but until we arrive there, what are we to do?

In the third place, we took up orcharding on the scale on which we did, because we believed that that was the way to make it pay. I have repeatedly said, and I want to take this occasion to say again, that I do not believe fruit growing in Massachusetts could be given a greater impetus than by inducing 50 or 100 men throughout the State to plant from 10 to 100 acres of orchard. The trouble with our orcharding is, that it is usually a mere side issue to the general farm work. As Professor Bailey has said, "Men do not grow their crops of apples, they discover them." But when men go into the business of orcharding more largely, making it their principal line of work, then the orchard becomes an object of pride and care; it is no longer compelled to compete with the cows and the bugs and the hay crop, but is sprayed and cultivated and pruned and fertilized for its own sake. But in urging this desirability of large-sized plantations I wish it distinctly understood that I am well aware that it is sometimes overdone, — that men plant out acres of orchard where they should plant square rods. But for every orchard in Massachusetts that is neglected because it is too large, there are hundreds which are neglected because they are too small. It is very difficult for any man to become enthusiastic over a dozen Baldwin trees up in the back pasture, which every alternate year give a few barrels of wormy apples; it is impossible *not* to become enthusiastic over a 10-acre orchard which is every year the best paying part of the farm operations.

I might go on to cite cases where men have made comfortable livings out of small orchards and have become well-to-do with larger ones; for it has certainly been my observation that in those sections where orcharding flourished as a business, — where, as some one has said, it is an industry and not merely an incident, — there you will find the most prosperous farms and the best farm homes. I say I might go on to discuss this phase of the question, but I shall pass that over and proceed with the real subject which I want to discuss with you, — the planting of a commercial orchard; or shall I make it personal, and say the planting of *our* commercial orchard?

And first, just a word in regard to the soil conditions which confronted us; for in any orchard proposition this is one of the big questions, much more so, I think, than in general farming.

The land which we were setting was all of it badly run down. A large part of it was old sheep and cow pasture, which had been pastured for years without any return of fertilizers. One section of it had been cropped alternately with potatoes and rye until the rye had failed to reach knee-high, when it was planted out to "orchard." The trees of this section of "orchard" are now on the brush heap, and this land will be given a year or two to recuperate, and will then be replanted to *real* orchard. In one part of the old pasture, which was ploughed up and planted with squash the past spring, only two patches made a satisfactory growth and gave a good crop of squashes. One of these patches was in a corner of the field, and the other was an irregular section near the center. Inquiry elicited the information that the corner patch was where the bars to the pasture were located, and where the cows gathered at night before being driven home. The irregular patch in the center was where several trees had stood, under which the cows gathered for shade. These illustrations will serve to show the condition of the land, so far as past management, or rather mismanagement, was concerned. But naturally the land was an ideal orchard soil, a gravelly loam with rather a porous subsoil; just the type of soil to give a reasonably good growth to the trees, and high color and quality to the fruit. Furthermore, a number of old apple trees on various parts of the farms were making a sturdy, healthy growth in spite of all the different kinds of neglect which the owners could heap upon them. It was for these reasons that the location was selected, coupled with a firm belief that the fact of a soil being run down is of comparatively little moment, provided it is naturally a good orchard soil, and provided also that the owner purposes to see that plenty of plant food is supplied to the trees from the start, — two extremely important provisos.

The land for setting this first season was plowed as early

in the spring as the soil was fit for working, and was then thoroughly fitted, using a disc harrow, a spring-tooth and a smoothing harrow, and finishing with a planker. This left the surface smooth for laying off the orchard and setting the trees, by no means an unimportant item. After the trees were set, which I shall speak of more in detail in a moment, the land was kept thoroughly cultivated until time for sowing the cover crop, about July 10. There was always a team at work in the orchard, and sometimes two of them. And, notwithstanding the fact that we had one of the driest seasons within the memory of the proverbial oldest inhabitant, and the further fact that our soil was shy of humus (an extremely important factor in holding moisture in the soil), there was never a time throughout the season when the soil was not as moist as could be wished just under the dust mulch. It was certainly a striking indication of the value of cultivation. As soon as the trees had been set, an ounce of nitrate of soda was scattered about each tree, and a little later a pound per tree of a mixture made up of three parts high-grade sulphate of potash and five parts acid phosphate. The result was that nearly all of our trees gave us an entirely satisfactory growth this season, in spite of the past neglect of the soil. The apples grew from 1½ to 3½ feet, and many of the peaches as much, though, being on a drier soil, they did not average as much as the apples.

This matter of fertilizing is one which we intend to follow up, for I am firmly convinced that it is a very important factor in success with orchards. I believe there is as much difference in quality between a well-fed apple and one which is grown on poor, run-out soil, as there is between a beefsteak from a well-fed animal and one from a half-starved beast. I am convinced that this is one of the important reasons why the western apples, grown on virgin soils. as most of them are, have so much more attractive an appearance than much of our eastern-grown fruit. An instance bearing out this idea came to my notice on our farm this season. One of the farms bought had a small Baldwin orchard of 1 acre (adjoining the patch where the rye and

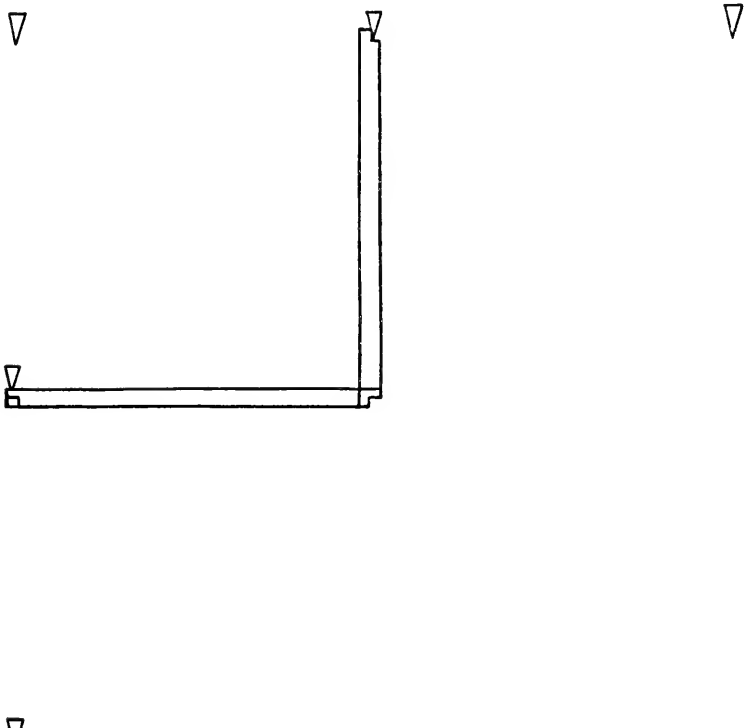
potatoes were grown), and also some scattering Baldwin trees about the buildings, one of which stood just by the hen yard, and where the ashes from the kitchen stove were dumped. The fruit from this one tree was as different from the rest as a Texas steer is from a Shorthorn. It had quality to it, — looked like the Oregon Spitzenburgs, — while that across the road was the usual uninviting type of Baldwin too often seen.

Another point which we intend to insist on is giving the young trees a balanced ration of fertilizer from the start. I believe that a very common mistake is made by assuming that the young tree needs only nitrogen for its growth, and that not until a tree comes into bearing is there any necessity of applying either potash or phosphoric acid. So long as our young trees are as big as Smith's of the same age, we are content, — mere bigness apparently being the only thing desired; whereas, if our trees got more potash and phosphoric acid from the start, they would far sooner turn from wood growth to fruiting. This I am obliged to admit, is largely theory, but it is a theory in which I firmly believe and on which I intend to act.

One other point before we leave this matter of fertilizers; and that is, the question of lime. I am satisfied that this is another line of orchard fertilization which is altogether too thoroughly neglected. It has been my observation that the very best fruit lands are those which have in them a large percentage of lime. It gives a sturdy, stocky growth to the trees, and a high color and fine quality to the fruit. We are therefore planning to give it a prominent place in our list of fertilizers, and have already taken up the question of where we can get it and in what form we shall apply it. There are four different forms in which it can be had: first, air-slaked lime; second, fresh-burned lime; third, hydrated lime; and fourth, ground limestone. Of these, we have decided on the last as the best for our purposes. It will cost us less than any of the others ($1 per ton at the kiln, or $4 per ton laid down in Amherst), and I believe for our purpose is better than any of the others. It comes finely ground,

and can be spread with a fertilizer sower. We shall use a carload of this the coming season, applying at the rate of 1,000 pounds per acre, and I shall be greatly disappointed if it does not prove a paying investment.

A great deal of care was exercised, in laying off the orchard, to have the rows straight in all directions, and I should like to emphasize the desirability of this point, in my opin-

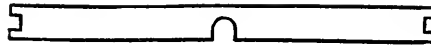


ion. It is often, in fact usually, neglected. Men will lay out a hen house, which is to stand for perhaps half a dozen years, and every corner must be perfectly square and every post perpendicular; but an orchard, which is to stand for two or three generations, is laid off with a plow, or the trees are stuck into holes dug at random. To me, the satisfaction of having good straight rows is worth ten times over the added cost of making them so, which, after all, is not great.

We laid off our first row with a transit, because one happened to be available, but a man with a good "straight eye" could have done nearly as well. This first row was run along one side of the field to be planted, and a stake was set every 16½ feet, the distance apart for the trees; as we are using fillers a cross row was then laid off at right angles to this, near one end of the field. This was all the sighting that was done. The rest of the stakes were set with two measuring boards 16½ feet long, with a small notch at either end. (The accompanying diagram will serve to illustrate the method.)

It was surprising to see how accurately and expeditiously the stakes were set, and it did not require high-priced labor to do it, either. Two Polanders, at $1.50 a day, one of whom could speak scarcely a word of English, did the whole thing; and we should be glad to compare results with anybody who has used a different method, for we feel decidedly proud of the way our trees "row" in all directions.

For locating the trees we used a planting board, a device by no means new, but which deserves a wider use than it gets. There are several types of them, but the one we used was about 4 feet long by 8 inches wide, with a notch at each end and one in the middle (see diagram). The middle notch



was placed against the stake set for the tree, a short piece of lath was then driven down in each of the end notches, the planting board was taken away, and the hole dug for the tree where the center stake stood. Then, when it came time to set the tree, whether it was that afternoon or the next day or the next week, the planting board was put in place on the two small stakes, the tree was slipped into the middle notch and was planted, and of course stood exactly where the original stake stood. Both of these methods — the setting of a stake for each tree and the use of the planting board — have been objected to by those who profess to know about such things, on the ground that they take too

much time; that they are slow and expensive methods. But when I say that it cost us just 6 cents per tree to set our standard apples, which we planted first; and 5 cents for the peaches, which followed; and that we got the price down to 4 cents per tree on the dwarf apple trees, which were the last set, — I think you will agree that it was not an exorbitant price. This included plowing and fitting the land, staking it off, digging the holes, trimming the tree and setting it out; and the difference in cost was largely due to the fact that the gang of men setting the trees became more familiar, each with his particular part of the programme, and consequently could do it more expeditiously.

The field operations in setting were carried on as follows: a gang of eight men and a foreman were used; the foreman and one man went to the place where the trees were heeled in for a supply of trees, which were prepared for setting by pruning back the main roots considerably and packing them into two oil barrels, partly full of water, which were fastened on a stone boat drawn by one horse; while this was going on, the rest of the gang were setting stakes and digging holes. When the trees arrived on the scene the whole gang went to setting, the foreman distributing the trees and the eight men dividing into pairs, one of whom set the tree while the other shovelled in the earth. About 150 trees were carried at a load, and when these had been set out the gang divided as before. In this way the operations went like clockwork, and the trees arrived at the holes with their roots thoroughly soaked and in the best possible condition to take hold and grow. And that the method was satisfactory from the standpoint of the trees is pretty conclusively shown from the records of the number that grew: out of 530 dwarf apples set, we lost 14; of 250 Hubbardstons, 6 failed to grow; of 500 Wealthy, 3 died; and of 650 McIntosh, only 3 died. This is a remarkably good record in percentage of living trees, even for a good season, but in a season like that of 1908, when crops of all kinds suffered severely, I think it demonstrates conclusively that our methods of planting were sound, not only theoretically but practically.

After the trees were set, the next matter was the question of height of heading; and on this, as on several other matters, I presume it will be generally considered that we have pronounced ideas. Nearly all of our trees were headed at 18 inches from the ground, — all of them, in fact, except the dwarf apples, which were headed at 12 inches, and a small section of peaches, which we headed at 6 inches; and we have been so much pleased with the growth of this 6-inch block, that, unless we get some new light on the subject, a large part of those to be set in 1909 will be headed at this height. They have certainly made a beautiful growth, and are shaping up into fine trees. To head in this way it is imperative that one-year trees be set. We used one-year trees the past season, whenever we could get them; but as the enterprise was started late, we had to take two-year trees of some varieties, and invariably the one-year tree out-grew the two-year. This is very natural, since the "shock" from transplanting (if we may call it that) would be greater with an older tree; and in our scheme of low heads, when the one-year tree is cut back to 18 inches we still have strong, vigorous buds for growth; while in the two-year trees the buds are all two years old on the trunk which is left, and do not push nearly so vigorously nor so evenly as on the one-year trees. It seems to me that practically all the arguments are in favor of the younger trees, and I should use them even if I were heading higher.

So far as the question of the low head is concerned, it seems to me that practically every argument is in its favor except the one of convenience in cultivation; and this can be gotten around by having orchard tools which can be spread out, so as to work some distance on either side of the team. A disc harrow, or any other, which is in two sections, can be separated so as to work well under the trees while allowing the team to pass by without injuring them; and, though some hand labor will be needed, the cost of this will not be one-tenth what will be saved on the other operations of the orchard. In pruning, spraying and especially in harvesting the crop, the argument is all on the side of

the low trees; and in these days, when we either have, or must soon expect to have, the San José scale in our orchard, we cannot afford to neglect any measure which will help us in the fight.

I am aware that in discussing the question of varieties I am taking up a very personal matter, — one on which men differ as radically as they do in politics; but it is also one in which everybody is deeply interested, and on the proper decision of which depends, to a great extent, the success of the plantation. In what I shall say I am not pretending to dictate or even advise any one else, but am merely giving my personal views and experiences, as I have in the other matters discussed.

I believe, first and foremost, as I have already suggested, that varieties for setting here in New England ought to be of high quality. I do not believe that we should set anything poorer in quality than a Baldwin or a Greening, and I wish that a great many trees of varieties better in quality might be set. But in saying this I am quite well aware that under present conditions, and with present methods of growing and handling apples, the Baldwin, and even the Ben Davis, may be the most profitable varieties to grow; for a McIntosh or a Spy will not stand the treatment that the great bulk of the apples grown here receive. This is an unfortunate condition of affairs, and ought to be remedied, but at present I believe the statement accurately depicts the situation.

As to the number of varieties which a man should set, that depends very largely on the type of market for which he is working. If for the general market, then the fewer varieties he has, the better. Two or three, say Baldwin, Greening and Hubbardston, would be the limit; and many men think that they make more money out of a single variety, especially if that variety is Baldwin. I am inclined to believe, however, that for the sake of cross-pollination there should be at least a few rows in the orchard of some other varieties, even in orchards which are catering to the general market; by which is meant, of course, where the owner sells his crop at the orchard to a buyer, or ships it to a commission man.

On the other hand, if a man is working for a special or personal market, — that is, if he is supplying regular customers, either directly or through some retail fruit dealer, — then it is perfectly legitimate for him to grow a much longer list of varieties; in fact, it is necessary for him to do so, for he does not want to drum up trade for his Wealthies and lose it when Hubbardstons are in season, only to work it up again for his fancy Baldwins or his Spies. He wants a succession of varieties, from the earliest to the latest, and for this purpose he wants from six to a dozen varieties. This is the type of trade which we hope to capture, and we are therefore setting a fairly long list of varieties.

Another question, to which we have devoted a good deal of thought and some experimenting, is the matter of cover crops. It is, of course, out of the question for us to use barn manure for our trees, and we do not wish to continue buying nitrate of soda any longer than is necessary, so it is imperative that we get a rank-growing, nitrogen-gathering crop, to supply us with humus and nitrogen. We used this year cow peas, soy beans, summer vetch and buckwheat. Of course, this last does not add nitrogen, but otherwise is an excellent cover crop, and one of the best for raw lands such as ours. None of these did very well for us this season except the buckwheat, but from experience in the college orchard we expect the soy beans to be one of our "stand-bys" when we get our land in better shape, and we shall give the others further trial. We shall try next year, also, the common "pea bean" as a cover crop. We used it the past season to grow as a crop between the rows, and it made a splendid growth, and would have supplied a large amount of humus and nitrogen had we plowed the crop under. Of course, it was sown early, in drills, and cultivated for some time before the orchard was "laid by," and I believe that many cover crops should be handled in this way to get the best results.

Still another vexed question which we had to decide, and which we perhaps decided differently from what many of my hearers would, was the question of the distance apart for

the trees. We set them, as I suggested in speaking of our measuring boards, at 16½ feet apart each way. This is close planting, but that is what we wanted. It is not what we should advise for a great many men, perhaps for only a very few, because with most men the trees will not be cut out when they begin to crowd each other, nor will they be pruned in such a way as to prevent crowding as long as possible. Both of these points we intend to look out for. We have used what is called the "filler system;" that is, our permanent trees are set 33 feet apart, but are interplanted both ways so as to bring the trees down to 16½ feet apart. For these fillers we are using such early bearing varieties as Wealthy, McIntosh and Duchess of Oldenburg, and for our permanent trees such sorts as Baldwin, Hubbardston, Greening and Gravenstein. We intend to practice repressive pruning, to head the trees in every year, so that they shall not begin to crowd for as long a period as possible. It ought to be possible to delay this crowding until they are fifteen years old, at the very least. But when they *do* begin to crowd, we are going to cut out the fillers and leave the entire land for the permanent trees. And right here is where the difficulty usually comes in, — most men will not cut out their fillers in time; I hope and believe that *we will*. It ought not to be any more difficult than pruning. When we prune, we cut away part of the tree for the good of the rest of the tree, and when we remove fillers we cut out some of the trees entirely for the good of those that remain. We may have to tell the foreman to cut out the fillers, and then go away ourselves and stay away till the job is done; but one way or another I expect to see those fillers come out before they have damaged the permanent trees.

The whole question of fillers narrows down to this: if a man can use fillers and bring them into bearing early enough so that they will be more profitable than growing an annual crop between the trees, and if he will then cut out the fillers, as suggested, it is a profitable scheme; but if he fails in either of these particulars, then the plan is a failure. Some people object to the filler scheme because, they say, the tree

has to be cut out just in its prime. But this has absolutely nothing to do with the question further than being responsible for most of the failures of the scheme. If the trees have been the most profitable thing you could have on the land while there, they have done their whole duty, and have vindicated your judgment in setting them out; and the fact that if they were somewhere else they might continue to be profitable, while an interesting fact, has nothing more to do with the question at issue than the price of gas.

The last point which I wish to discuss, and one which is also largely a personal question, though there are some general principles involved, is the matter of what crops to grow in the orchard for the profit to be gotten out of the crop, and not, as with cover crops, solely to benefit the orchard; for, while the bearing orchard, of course, uses all the land and pays a profit on it, or *ought* to, the young orchard is for several years a source of out-go, and the land ought to be planted to some crop which will yield a profit, and at the same time either directly benefit the orchard, or at least not injure it.

A crop to be satisfactory in an orchard must first of all be a cultivated crop. I do not believe in either a hay crop or a grain crop for an orchard, whether young or old. And if the crop is to be cultivated, the more thorough cultivation it requires and the more nearly its season for cultivating corresponds to that of the orchard, the better. I am sure that a cultivated crop is usually far better for the orchard than if no crop is grown, for unfortunately the average man will cultivate his annual crops when he might neglect his orchard.

Secondly, a crop to be entirely satisfactory ought not to disturb the soil late in the growing season, as, for example, in digging a crop of early potatoes. If the crop grows late in the season, which is in itself no objection, but rather the reverse, it ought to be something like cabbage or squash, which does not disturb the soil when gathered; or else late potatoes, which are dug so late that the trees will not have their growth prolonged. Of course this objection can be overcome by planting the crop far enough from the trees, but

this solution has its own weak points, as we lose the use of a lot of land which might just as well be giving us a profit.

Furthermore, the crop must be either something which the owner of the orchard can use on the farm (as a crop of turnips or mangels for stock feed), or else a profitable crop to sell.

The crops which we selected, having regard as far as possible to the above general principles, were beans, cabbage, squash and parsnips. They are all of them good crops, I think, and have in general proved satisfactory, and we shall use all of them another season.

In closing, I wish simply to say that, while I do not believe there are fortunes to be made in fruit growing, I *do* believe that there is money in it; for if a man will grow good fruit (and experience has abundantly demonstrated that we can do that here in Massachusetts), and if he will pack it honestly (and almost any man can pack good fruit that way), there is no more doubt in my mind about its being a profitable business than there is that John D. Rockefeller has found the oil business remunerative. And at the same time that a man is making money, he is also living one of the pleasantest, most wholesome lives to be found among farmers, and that is equivalent to saying, among *men*.

FIG. 1. — An apple tree in which the central leader has been allowed to develop. Such trees are inclined to grow too high. Compare with Fig. 2.

FIG. 2. — The open-center habit of growth. A well-balanced tree with plenty of room for the admission of light and air. Most orchardists favor this type of tree in preference to the type shown in Fig. 1.

PRUNING THE APPLE TREE.[1]

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The Ideal in Pruning.

The architect or builder, before building a house, selects a certain style of structure and this style is followed to the end. The man who would be successful in building up a fruit-bearing structure must also select a style or ideal, and this ideal should be kept constantly in mind throughout the various stages of development. The apple tree is a wonderfully tractable object and may be made to assume almost any shape. Any one who has tried to develop a spreading habit in a Sutton apple tree may disagree with me on this point, for this and some other varieties are sometimes difficult to train, but even the most obstinate cases may be brought under control if proper methods are followed. The methods that have proven successful with some sorts, however, may not be suited to others. For example, a young Greening tree will assume a spreading habit without any special effort on the part of the grower, while a young Sutton will require a severe check in its growth to encourage the production of fruit, the weight of which tends to bring the branches down to a horizontal position.

In the pruning of apple trees there are two distinct styles or ideals, the central-leader type and the open-center type, each with its corps of adherents. Figs. 1 and 2 illustrate these two types of structures. The supporters of the central-leader type claim that it is a stronger structure and not so likely to be broken down by wind and heavy crops of fruit. This is a strong argument, but it is offset by many disadvantages. With certain naturally spreading varieties, like Greening, Tolman Sweet, or Fall Pippin, it works very well,

[1] Crop Report, Vol. 25, No. 5, September, 1912.

but with the upright growers there is a tendency to grow too tall and to get out of reach of the spraying apparatus. In the west it is a common practice to grow trees with central leaders, and the result is very satisfactory. In the east, however, the climatic conditions are much different, and we require all the sunlight available to give the necessary color to the fruit. The open-center tree admits the maximum amount of sunlight, and with such a tree the work of spraying and harvesting is minimized.

To develop the ideal fruit-bearing structure we must commence when the tree is in the nursery row. Here the central leader is cut back and the growth of the side branches encouraged. It is well to have the main branches or scaffold limbs well distributed along the stem or trunk, and never should two opposite branches be allowed to develop at the same point, for a crotch formed in this way is likely to split. With most varieties the lowest branch of the tree should be started at a distance of about 20 inches from the ground and the uppermost branch about 30 inches. Three or four main branches are sufficient to form the head.

The main branches are headed in to about 8 or 10 inches when the tree is set. The following season the secondary branches in turn will need to be headed in. The growth may be directed to some extent by cutting back to a bud pointing in the desired direction. In this way a spreading habit may be induced by cutting back to a bud that points outward. Despite such precautions some varieties, especially when making a strong growth, are bound to grow upright. Trees of such varieties should be headed as near the ground as possible, and even then it will be necessary to check their growth in some way.

By regularly cutting back the upright branches and by eliminating the cross branches in the center of the tree an open-center habit may be developed and maintained. Short fruiting spurs should be allowed to develop along the main branches. Watersprouts or "suckers" if headed in will soon develop fruit spurs, and when the center of the tree is kept open the fruit borne here will have an opportunity to develop normally.

Orchard Renovation.

In the mature orchards of the east there appears to have been no effort to follow any particular style. Most of the orchards show signs of having received a few feeble and spasmodic applications of the pruning saw, or, to be more accurate, I should say a few slashes with the axe, and judging from the appearance of the wounds the axe was not always a sharp one. Many of these old orchards, although unprofitable, are in a good sound condition, and with a little judicious pruning, spraying, cultivating and feeding may be put on a profitable basis.

The pruning of these old existing trees, therefore, is the first problem that confronts the apple grower in the east. The work in most cases consists mainly in cutting out the central leader. Of course the remainder of the tree will require some thinning. All upright growing branches should be removed and the long slender branches headed in. All dead branches and stubs should also be cut off closely. Sometimes it will be necessary to clean out and seal up cavities, but if a large proportion of the trees require such surgical treatment it is doubtful whether the orchard will bear the expense. Knot-hole cavities, after being cleaned out, sterilized and having the surrounding wood sawn off smoothly, may be sealed up by tacking a piece of zinc over the freshly painted surface. The zinc plate should be slightly smaller than the wound, so that the bark will heal over the edge. Coal tar is the substance commonly used for sterilizing and painting the wounds.

This abnormal treatment, however, is "butchery" rather than pruning. When trees have been properly taken care of from the start there is no need for such treatment. Pruning should be regarded as a work of training rather than of correction.

Time to prune.

Regular annual pruning or training will give best results. A severe pruning once in three or four years upsets the equilibrium of the tree, and in the long run is not economical. As

a rule, pruning should be done while the tree is dormant. Some prefer to prune in the early spring for the reason that wounds made at this time usually heal over more readily. If the work is started in the fall it is more likely to get the attention that it deserves, and when the first suitable days for spraying arrive the trees will be ready. An additional advantage of fall pruning is found in that wounds made in the fall have a chance to dry out over winter and may be more effectively sealed up with paint in the spring than freshly made wounds.

Summer Prune to check Growth.

The practice of summer pruning as applied to apple trees is almost unknown in New England. Undoubtedly there are occasions when judicious summer pruning is justifiable, and in the hands of the skillful orchardist it is often a very profitable procedure. It should be remembered that during the growing season it is a devitalizing process and has the opposite effect to winter pruning. It is well known that when trees are making very rapid growth they are not likely to set fruit, and when a tree becomes weakened from any cause it immediately assumes the fruit-bearing habit. Knowing these tendencies, there seems to be no better way of regulating the amount of growth than by seasonal pruning. The rule is to prune in winter for vegetative growth and in summer for fruit. When trees are making a strong growth, then summer pruning is recommended. As a rule, the last part of June is the best time for summer pruning. It is seldom advisable to do a complete job at this season of the year, but just enough of the branches should be removed to check the growth. With young trees it is often advisable to summer prune to start them into bearing, but with mature trees he practice is seldom necessary, for sufficient check usually may be afforded by withholding nitrogenous fertilizers and by allowing weeds or some other crop to grow in the orchard.

A promising type of tree for renovating. When dead branches have been removed and top thinned it will make an excellent tree.

RENOVATING OLD ORCHARDS.[1]

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There are undoubtedly thousands of old apple trees in Massachusetts, some in orchards and others scattered about fields, which would pay good returns if they could be thoroughly "renovated" and thereafter be given proper treatment. On the other hand, there are just as many, and probably far more, which would be more profitable on the woodpile than anywhere else. The first question, then, for one to decide, if he owns such trees or orchards, is "Will it pay to make the attempt to get them into a thrifty condition again?" In the writer's opinion this depends on four questions: 1st, the age and vigor of the trees; 2d, the stand of trees in the orchard; 3d, the varieties; and 4th, whether the San José scale is in the orchard or the immediate vicinity of it. To discuss each of these briefly: —

1. *The Age and Vigor of the Trees.* — If the trees are vigorous, with good trunks and main branches, unaffected with canker or other injuries to the bark, it has been my experience that they can be brought into a profitable condition even though the tops are full of dead branches and they have been systematically neglected for years. This, of course, is supposing that the other factors mentioned above are favorable. It is truly surprising what can be done with an old orchard when it is taken in hand and given modern, up-to-date treatment. On the other hand, if the trunks or main branches are damaged with canker, or have been injured with cold so that the bark has fallen away in patches of any size, as very often happens, or if the trunk and main branches are badly rotted out in the center, then it is very

[1] Agriculture of Massachusetts, 1908.

doubtful if the orchard would pay for renovating. It must be remembered that the trunk is the highway by which the results of our improved care are transported back and forth from the roots to the top, and if this highway is in a demoralized condition we are not going to get the best results.

2. *The Stand of Trees.* — This, of course, is supposing that the trees to be treated are in an orchard, and it will be easily seen that if half of the trees are out it is not going to pay to cultivate and fertilize the whole of the land for trees which could be put on half of it. And it is seldom satisfactory to attempt to grow anything else in such vacant spaces in an old orchard, nor to plant young trees in the vacancies. If the trees are along fences or odd corners, so that cultivation of the soil will not be attempted, then the question of stand is less important, and may, perhaps, be ignored altogether. But in an orchard there ought to be a three-quarters stand at least to make it worth while to take the matter up, except under the most favorable circumstances.

3. *The Varieties in the Orchard.* — This is of less importance than the two points already mentioned, yet it is a factor that is decidedly worth considering and that has an important bearing on the cost of the renovating process. It is, of course, possible to graft over the trees, but this is both an expensive and a lengthy operation, and I should condemn an orchard to the brush heap which needed to be grafted far more quickly than one which already had the right varieties in it. Of course the question of varieties is very largely a personal one, and need not be discussed here, but I should mean by "right" such varieties as suited the grower and the markets for which he was producing, preferably standard sorts, like Baldwin, Rhode Island Greening and Roxbury Russet.

4. *The San José Scale.* — I should certainly feel much less like attempting to recover an old orchard which was infested with the scale, or even which was near an infested orchard, than one which was free from it and in a locality where it did not exist. I do not mean by this that I should despair of recovering an orchard where the scale was fairly

plentiful, for I have known of a number of cases where such orchards have been made thrifty and profitable. But it certainly does add a very serious element to the situation, and it is going to require both time and money to eradicate it.

The above, as I have said, are the main factors in deciding for or against the renovation of an old orchard, yet perhaps I have omitted the chief factor after all, and that is the man himself. If he has just come into possession of the orchard, and is making an attempt to clean up all along the line, I should have far more faith in the ultimate good results of the matter than if he were author and finisher of the neglect from which the orchard has suffered, even though he might have firmly determined to "do the right thing by the orchard" henceforth.

Having finally decided that the orchard is worth while, the work of renovating will fall naturally under the following heads: first, cultivation; second, pruning; third, spraying; fourth, fertilizing; fifth, cover-crops; sixth, grafting, — arranged somewhat in the order of their importance, though, of course, this will vary greatly with different orchards, and though all will be needed to secure the best results.

I have placed cultivation first because, though trees will often do well in sod, if otherwise well cared for, and though it may sometimes be necessary, even in attempting to revive an old orchard, to let the trees stand in sod. Yet, as a rule, to get them into satisfactory condition cultivation is the prime requisite, and will do more than any other one thing to start the orchard on the right road. It is usually difficult in an old orchard, such as we are considering, to do anything like a thorough job of plowing. If one can secure an ox team they will do the work better than a team of horses, as they will be able to get under the trees better, and the slow, steady gait of the oxen is better than that of most horses. Do not be alarmed over cutting some tree roots with the plow, even some large roots. A little root pruning will not hurt the trees, and the fresh, new feeding-roots, sent out from the broken and cut ends of the old roots, will very soon equal in absorbing ability the parts of the old roots which are cut

away. Another point in plowing is the question of throwing the furrow towards or away from the trees. One frequently finds an old orchard in which the plowing has been for years always in the direction of the trees, until each row stands along a ridge, with deep hollows between. Such an orchard should be plowed away from the trees, until the land gets back reasonably level again. After that it is well to plow the orchard alternately towards and away from the trees, — one year north and south and the next east and west. In this way the land can be kept in the best condition for the trees.

Occasionally it is impossible to do even a makeshift job of plowing, and then one can sometimes begin operations by running a heavy disc harrow through the orchard, to cut up the sod and start things in the right direction, and perhaps plow it the following year.

After the plowing has been done it is always advisable to use the disc harrow and follow it with the spring tooth harrow, going both ways with each one of them, and going over the land several times, so as to get the land in good tilth. After this, through the balance of the season, it is best to cultivate the land once every week or ten days, up to perhaps the middle of July. And let this weekly cultivation be thorough! If the two harrows suggested, disc and spring tooth, are available, it is well to run the disc over first, the long way of the orchard, and then finish with the spring tooth, the opposite way. This insures all the land being worked over, and leaves it more level than if one finishes with the disc, which of course is desirable on account of reducing evaporation. It is difficult to overdo cultivation at this season of the year, and with an old, neglected orchard I should feel inclined to let this be the principal feature of the programme, so far as the soil is concerned.

Now for our second point in the programme, pruning. This is apt to vary more in the extent to which it is needed and in the character of it which is best to apply than any one of the other factors. If the trees are very high, with little or no bearing wood near the center, as is very apt to

A poor type of tree for renovating. Trunk is too long and main branches have no bearing wood except at tops. If renovation is attempted this tree should be severely cut back to renew the top.

be the case, then they should be given very drastic pruning, so as to grow an entirely new top, a good many feet nearer the ground than the old one. It will practically amount to the removal of all the top in perhaps two years, and the branches should be cut down at least six or eight feet, and sometimes much more. This seems like heroic treatment, and it is, but in the great majority of cases, if the trees are otherwise healthy, they will send out a bushy top which, with judicious thinning, will make practically a new tree out of the old one. And one great reason why such old trees as we are now considering (tall, overgrown ones) are *not* profitable is that they are so tall that every operation — pruning, spraying, picking, etc., — is four or five times as costly as with lower trees. So it is absolutely essential to get them down nearer the ground if they are ever to be made profitable. On the other hand, if the trees are reasonably low the pruning may consist largely in thinning the top throughout, beginning, of course, with the dead branches, and then taking enough live ones to leave the head fairly open to light and air, and to the sprayer when that comes on the scene. Even in this class of trees (those which are *not* unreasonably tall), it is often possible to reduce their height to advantage, without materially altering their form, by simply cutting back each of the main, upright branches to one of its strong, main offshoots. The effect may not be just what we would like at the start, and the top may be somewhat thrown out of balance, but with a year's growth it will largely recover its symmetry, and even if it should not altogether the advantages of the lower top will offset any disadvantages.

Another point in this pruning, and one often neglected, is not to remove too large branches in the thinning. Of course, it is much easier to remove what one considers the required amount of wood by taking out a few large branches, but the results are much better if one will take comparatively small branches (not above an inch, and preferably much smaller, in diameter) and take more of them. This thins the top uniformly, letting in light, air and spraying materials to all parts equally; while the removal of a few large branches

leaves the top too open in some places and as thick as ever in others. Still another point which one should bear in mind in his pruning is to keep a sharp watch for diseased branches, and take these out in preference to healthy ones. The European and some other cankers are, in particular, liable to be found in such an orchard, and may be largely held in check by such pruning. And lastly, after the pruning has been done, and the wounds made have had time to dry up and "check" somewhat, all wounds of an inch and a half or over should be thoroughly painted with thick lead paint, to keep out moisture and prevent decay. White lead and boiled linseed oil make the best kind of covering for such wounds, but it is well to add a little brown color, merely to take off the glaring whiteness of the painted wounds. One frequently sees the advice to take the paint pot into the tree when pruning, and attend to the painting at once, when the limb is removed, but in the writer's experience the pruning tools are all that one wants to be bothered with at one time, and the paint will certainly adhere better to the cut surface when this has dried somewhat.

Our thirdly is the spraying problem. This is going to vary somewhat, according to the insect and fungous diseases which may be present in the orchard or locality. If the San José scale is there a thorough spraying with oil in the autumn, after the leaves have fallen, and with lime-sulfur just before the buds swell in the spring, will be found to be the most efficacious treatment. Where one does not have too bad an infestation of scale, in the writer's observation the best thing to use is the lime-sulfur, and one has the satisfaction of knowing that while he is driving this pest out of his plantation he is also most effectively reducing the vigor of a number of fungous diseases, which might have caused trouble later in the season. In this connection (fighting insects and fungi) one is frequently asked as to the desirability of scraping the trees to remove the rough, scaly bark. While this ought not to be necessary as a regular practice in orchards which are cared for, and especially in those which are sprayed, yet in the beginning I believe it is an excellent treat-

Trunk injured by cold. Such trees are not worth renovating.

ment for such orchards as we are considering. Certainly it will add materially to the effectiveness of any washes which may be applied to the trunks of the trees.

For summer spraying, we usually use some form of lime and sulfur (either commercial or self-boiled) and arsenate of lead. We make one application just after the blossoms fall and another three or four weeks later. Spray so as to wet the trees thoroughly, with as little drip as possible.

Of course, one may be confronted by special problems, like an acute attack of canker worms or a scourge of apple aphis, in which case a specialist should be consulted. But for all ordinary cases the foregoing programme ought to be entirely adequate, and it would certainly surprise most old orchards to receive half of this attention.

The fourth factor in our operations is the fertilizer question, which is naturally very closely related to our cultivation problems and sometimes has to be varied to suit the cultural methods adopted. At the beginning I do not believe it is desirable to apply any nitrogenous fertilizers, or if they are applied it should be in very limited quantities, and early in the season. A moment's reflection will show the philosophy of this. Trees which have been allowed to grow in sod, as the old orchards which we are considering will undoubtedly have been, and in soil which has been impoverished by constant removal of the grass as hay, and of the fruit, without any return of fertilizer, will have long, straggling roots sent out to forage at a distance for all the plant food possible. And these long roots will have comparatively few branches or small feeding roots, as it is a well-known fact that roots branch freely in a fertile soil and sparsely in a poor soil. Now when the land in the orchard is plowed and cultivated, and fertilizers are applied, the conditions become very much more favorable in the soil, and the roots begin to branch freely in response to these improved conditions. If the fertilizer has been applied in the form of barn manure, as is often the case, this requires some time to decay and get into soluble condition so that the roots can take it up, but when this has taken place it furnishes a large amount of highly

nitrogenous food which tends to stimulate a very strong wood growth late in the season. The trees having the root systems such as we have described, long and spreading, and having sent out an abundance of feeding roots all along these original main roots in response to improved conditions, are sure to take up an unusual amount of this plant food, much more than trees which have had regular care from the beginning, and which therefore have more compact root systems. The result is that the growth is continued very late in the season, that the new layer of tissue between the old bark and wood does not ripen up in the autumn as it should, and that when cold weather comes on it is no better fitted to withstand freezing than a potato or a cabbage, and is destroyed during the winter. Soon after this the bark separates from the wood, and the tree dies if the bark has been killed all round, or is seriously weakened if only part way. For these reasons, as I said in the beginning, I should advise withholding nitrogenous fertilizers almost entirely the first season. If the soil has any fertility to it at all the cultivation and consequent improved physical condition will liberate all the nitrogen that the trees need to make an entirely satisfactory growth.

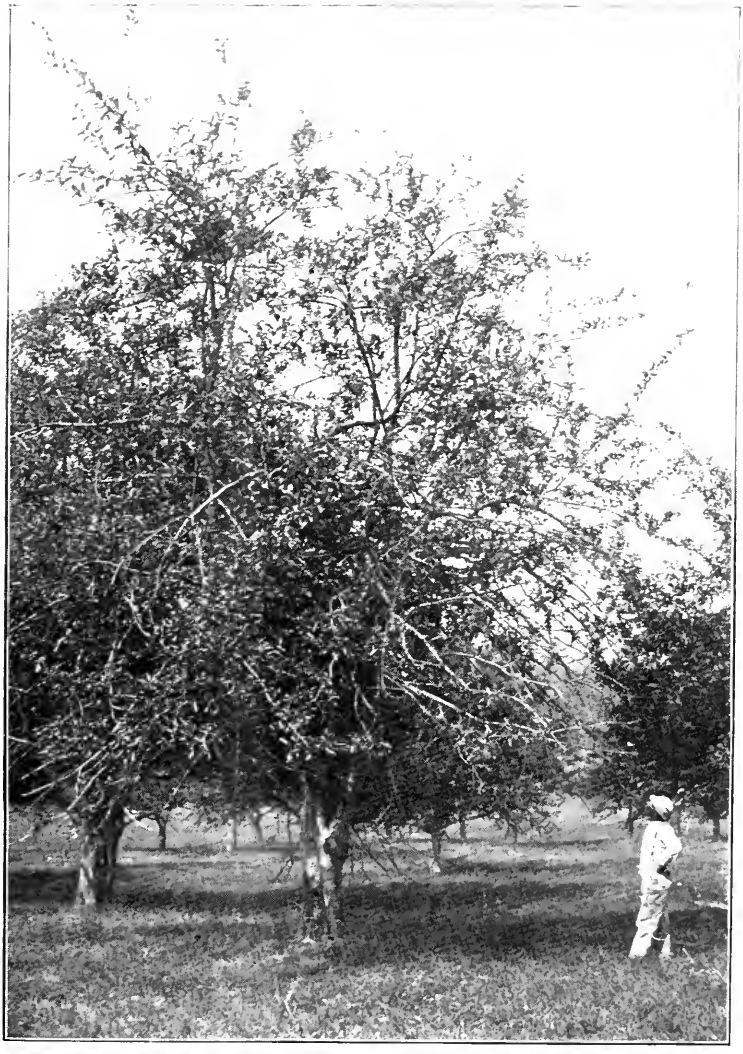
But of course these arguments do not apply to other fertilizers, and I should use them freely. I should begin with one or two tons of lime per acre. It has been my observation that very few old orchards indeed will not respond wonderfully to such an application. We need not discuss the usual methods of determining whether lime is needed, but I am satisfied that even when such tests as litmus paper, for example, fail to indicate a sourness in the soil, an application of a half ton of lime per acre will still be very beneficial to the trees. With apples particularly, but with all fruits more or less, an abundance of lime gives a shorter, stockier growth of wood, and fruit which, though perhaps a little smaller, is more firm, better keeping and more highly colored. This lime application need not be made every year, of course, but I should begin with it and should repeat it once every four or five years.

In addition to this I should give a yearly application of

potash and phosphoric acid. For potash we usually use 300 pounds per acre of high grade sulfate, and it is better applied as early in the season as possible and plowed under. I should favor plowing under all fertilizers, as it gets them down where the feeding roots are, and where they will be under such conditions as to make them most quickly available. Of course this is less important with the readily soluble fertilizers, but even with these I should favor turning them under.

In phosphoric acid one has the choice of several different forms, but probably the best two for the orchardist are basic slag and one of the superphosphates or acid phosphates. Where one is plowing the land I should favor the use of the basic slag, as, in addition to the phosphoric acid, it contains a large percentage of lime, which will assist in putting the soil in good shape. It will run usually about 15 per cent to 17 per cent of phosphoric acid, and from experience in many orchards it seems to be an admirable form. On the other hand, where one is not able to plow the land, or for any reason has decided not to, the superphosphate is the best form of phosphoric acid, as it is readily soluble, and will therefore get down to the roots of the trees more quickly and more certainly than the basic slag. As to quantities per acre or per tree, a good yearly application of the slag would be from 300 to 500 pounds per acre, or on scattering trees from 8 to 10 pounds per tree. Where the superphosphates are used the quantity applied should vary with the source of the material from which they were manufactured, but probably should be from one-third to one-half less than of the basic slag. These quantities are merely suggested as the usual ones applied, and it should be borne in mind that there is little danger in applying an over-dose of either potash or phosphoric acid, as neither one leaches out of the soil to any extent, nor does either one, when present in moderate excess in the soil, produce the injurious effect on the orchard that an oversupply of nitrogen does. They should be applied as early in the spring as possible, and worked into the soil as much as is possible with the method of culture adopted.

We come now to the question of cover-crops for the orchard, by which is meant some crop grown in the orchard, usually late in the season, and exclusively, or at least mainly, with the object of improving the soil of the orchard. That it can be made to play a very important part in the upbuilding of an old orchard has been shown time and again. Some of the best ones for Massachusetts orchards are buckwheat, rye, soy beans, turnips, dwarf Essex rape and the vetches. The chief advantages derived from their use would be that they take plant food away from the trees in the autumn and thus help to ripen them up; and they catch and hold nitrates in the soil after the growth of the trees has stopped, and when these substances would otherwise be washed out of the soil; that they help to pulverize and rot down the sod, which is especially important at the beginning; that when they are plowed under they furnish humus, which in turn furnishes plant food to the trees; and that in the case of soy beans and the vetches they help to keep up the store of nitrogen in the soil by what they take up from the air and store in their roots. This is by no means all that these cover-crops do, but it covers the main points, and serves to show how important they are. The general plan of their use would be this: that the orchard would be plowed as early in the spring as the soil would permit and thoroughly fitted as outlined earlier. Then thorough cultivation would continue up to the middle of July, when the cover-crop would be sown. The only important deviation from this course would be in the case of some of the leguminous cover-crops mentioned, particularly soy beans and cow peas, which often give better results if sown in drills earlier in the season, the middle of June or the first of July, and cultivate several times before the orchard is laid by. Of course, the objection to this is that the cultivation by this method is much more costly, since it must be done with a one-horse cultivator, a row at a time, instead of with a disc or spring-tooth harrow, covering three or four times the space. But even this objection is often, if not usually, overbalanced by the much better growth of the cover-crop.



Type of tree which should be cut back severely in renovating; 10 or 12 feet at least could be removed to advantage. Except for poor trunk (see Fig. 2), this tree could be very successfully remodeled.

After cultivation ceases and the cover-crop is sown nothing further is done to the soil until the following spring, when the cover-crop is plowed under, and the programme begins again. Where a good growth of one of the nitrogenous cover-crops can be secured it is often possible to obtain all the nitrogen needed for the orchard in this way.

I should feel inclined to begin with buckwheat as a cover-crop in starting an old orchard because it is peculiarly effective in rotting down sod and putting the soil in fine physical condition. This might be followed in a year or two with either soy beans or summer vetch.

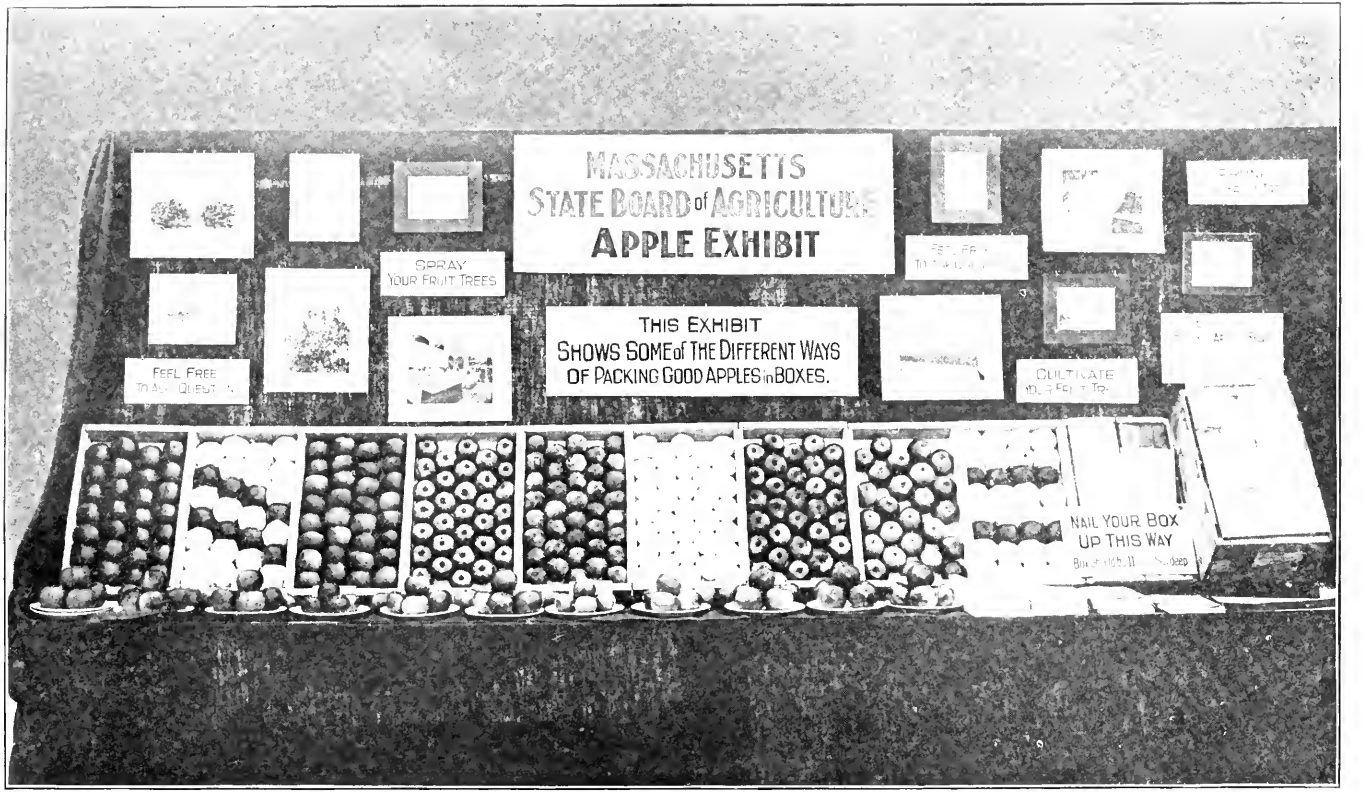
As to amounts of seed per acre of the different crops suggested the following will be found right for ordinary conditions: —

Buckwheat, . . .	1 bushel.
Rye, ...	1½ bushels.
Soy beans, . . .	1½ bushels broadcast; ½ bushel in drills.
Summer vetch, . .	1½ bushels broadcast; 1 bushel in drills.
Winter vetch, . .	1 bushel broadcast; ½ bushel in drills.

And lastly there is the question of top-grafting the trees. I have already said that I should consider the necessity of this a strong factor against the orchard, for it requires considerable time, two to four years, and not a little expense, to work over the trees into other varieties. But it frequently happens that odd trees in an orchard are of unsatisfactory varieties, and it is sometimes worth while to graft over an entire orchard where the trees are relatively young and otherwise in good condition. Where this is to be done I believe it is generally advisable to employ an expert grafter or grafter guarantee the scions to live. Of course in such a case will undertake the operation, or, if the orchard is of sufficient size to warrant it, a professional grafter can be secured from a distance. In either case it is better business, and more satisfactory generally, to pay by the stub, and to have the grafter guarantee the scions to live. Of course in such a case one must have confidence enough in the man to insure that

he will not put in grafts needlessly, but after all it is better to have too many grafts than not enough, and with a little knowledge and supervision on the part of the owner there is usually little difficulty on this score. If the owner is situated so that he can do so I should strongly advise his furnishing the scions himself, and too great care cannot be exercised in selecting them. They ought to be taken from bearing trees, and if possible from those of known productiveness, and they should be thoroughly well matured and not too long-jointed. Let them be selected while the trees are still dormant, and stored in moist soil or sawdust in the coolest possible place; if an ice house is available so much the better.

A great many problems will undoubtedly come up in renovating an old orchard besides those which have been discussed, and modifications will have to be made to suit special fruits, such as peaches and plums, but if a campaign along the general lines indicated could be made among the old, and at present profitless, orchards of the State, either cleaning them up or cutting them down, it would certainly do a great deal toward putting Massachusetts fruit on a better footing with both dealers and consumers, and it would make an addition to the income of the farmers of the State by no means to be despised.


MASSACHUSETTS
STATE BOARD of AGRICULTURE
APPLE EXHIBIT
SPRAY
YOUR FRUIT TREES
THIS EXHIBIT
SHOWS SOME of THE DIFFERENT WAYS
OF PACKING GOOD APPLES in BOXES.
FEEL FREE
NAIL YOUR BOX
UP THIS WAY

APPLE PACKING FOR MASSACHUSETTS GROWERS.

ALBERT R. JENKS, SPRINGFIELD, MASS., HORTICULTURAL ADVISOR, HAMPDEN COUNTY IMPROVEMENT LEAGUE.

The fast-growing commercial importance of the apple crop in Massachusetts demands that the packing phase of the industry be given intelligent study, and that all discoveries of proven worth be put into practical application. As the apple crop increases in size the cheaper grades will be pushed from the market. The selling price of the better grades will be lowered, thus making it possible for more people to use a large quantity of apples each succeeding year. Along with a lower selling price, the cost of production must be reduced and better methods of packing adopted.

Wonderful strides have recently been made in the methods used by fruit growers in the management of their orchards. Only very recently have growers begun to give more time and attention to the packing and marketing of their fruit. At present this is fully one-half of the problem. It is true that we have improved upon our forefather's method of harvesting his fruit, — that of shaking the apples to the ground and picking them up in sacks, or allowing them to fall off and then picking them up. It has remained for our western pioneer apple growers to teach us really up-to-date methods. Improved methods of picking must precede any advance in the packing of apples. Too little thought oftentimes is given to this phase. Apples may be excellently grown and finely packed, but unless they are carefully picked they will not bring the highest market price. It is very hard to know just when an apple has reached the stage when, if picked, it will keep the longest and still retain the

highest quality for culinary and dessert purposes. The time will vary according to the soil, its moisture content, the variety of apple, the stock, the exposure and the purpose for which the fruit is sold. Experience is necessary to determine this point, but there is less danger of picking too early than too late. A fair test of ripeness is to lift the apple gently and twist it slightly. If it parts readily from the spur, the apple is ripe enough to pick. If the apples are to be placed in ordinary storage they should be picked earlier than if they are to be put into cold storage.

Harvesting.

In picking apples handle them as carefully as eggs. Employ men who can pick with two hands. Great care should be exercised not to detach the stems, because when a stem is pulled out it breaks the skin; this allows the bacteria to enter the apple, resulting in rot and disease in an otherwise sound apple. Many markets refuse apples with 25 per cent. of the stems missing. Equal care should be exercised in picking apples to leave all fruit spurs unbroken upon the limbs. Each broken spur means that several apples are deducted from the next three or four years' crops. This is an absolutely unnecessary loss, if due care is exercised. Men should never be allowed to climb into the trees while picking, especially young trees, because broken branches and bruised limbs are bound to result from such a procedure. Wounds and bruises upon the limbs constitute ideal conditions under which canker diseases start and flourish. Light, strong stepladders should be used for low trees; for taller trees, light pointed ladders, which will fit into crotches in the limbs, are better than straight or round ladders. Extension ladders are necessary for very tall trees.

There are many kinds of picking bags, buckets and baskets upon the market. Most growers prefer the oak, splint, half-bushel basket which has a swinging bale, allowing the basket to be lowered into the barrel or other receptacle and the contents poured out without any danger of bruising the fruit. The baskets should first be oiled, thus making them more

FIG. 1. — A picking scene in a Massachusetts apple orchard.

durable; they should then be padded with canvas or burlap. Picking receptacles that open from the bottom are not entirely satisfactory at present, and picking bags tend to bruise the apples more or less. Heavy wire bent in the form of the letter S, with the upper part large enough to put over limbs and the lower part to fit the handle of the basket, are very useful. This will enable the pickers to use both hands. It is quite essential that practically all the picking be done by hand as, up to the present time, the patent pickers have not been so perfected as not to bruise the fruit, or else they are deficient in other ways. Patent pickers may be used for stray scattered apples.

The question of field receptacles for the apples now arises. This all depends upon the future use of the fruit. One must have previously decided whether or not any of the apples are of high enough quality to box. Many Massachusetts growers are adopting some of the good western methods. Box packing, the packing of apples in packages smaller than the apple barrel, generally the bushel box, is one of these good methods. Some Massachusetts growers, however, are adopting box packing long before the quality of their apples justifies this method. This is a serious mistake. The apple box should be used only for apples of extra good quality. The grower can realize the most money from his apples when packed in this way. For instance, it would be difficult to obtain $7.50 to $9 per barrel for good McIntosh apples, but there is an excellent market for A–1 McIntosh apples packed in boxes at from $2.50 to $3 a box. The fruitstand man likes the box package because he knows how many apples he is buying for a certain sum, and therefore knows how many he can sell for 10 cents and still make a good profit. The apples packed in this way must be sound and of a uniform size, color and shape. The consumer likes the box package because it is more attractive, and because he can use them all before they decay; satisfaction being given, additional sales are guaranteed. Quality being secured, it is still hard to say just what varieties should be put into boxes in preference to barrels. We are now testing out mar-

kets with box apples, and a few more years' experience will show which varieties may be marketed in this way. At present it looks as if the following varieties, if of high enough quality, should be boxed in order to secure the largest returns: —

Yellow Transparent.
Red Astrachan.
Duchess.
Gravenstein.
Wealthy.
Fameuse.
Winter Banana.
Wagener.
McIntosh Red.
Baldwin.
Sutton Beauty.
Alexander.
Rome Beauty.
Northern Spy.
King.
York Imperial.

Many of these varieties will yield even greater profits if put into smaller packages than the bushel box.

Above all things, do not box apples if they are not of the very best quality. The fact that many growers in Massachusetts have been boxing apples suitable only for sale in barrels has put eastern box apples into disfavor among the commission men. As a rule, it is well to box only a small fraction of a crop from old renovated trees, and grade the remainder for barrels and culls. Hampers, baskets, corrugated packages and other small receptacles have not yet become practical enough to demand the consideration of the average grower. They are suitable for special markets, and each individual must determine their suitability in his own case.

Apples which are to be boxed should be handled with even greater care than fancy barrel apples. The field receptacle should be of small dimensions, preferably something in the nature of a common bushel box. The apples should be laid into the box, not poured in. It is advisable to place a sheet of cheap paper between each tier of apples in the box, thus eliminating all danger of puncture from the stems of other apples. Do not fill the box entirely full, or, if this is done, risers should be used upon the ends of the boxes in order to be able to stack them without danger of bruising the

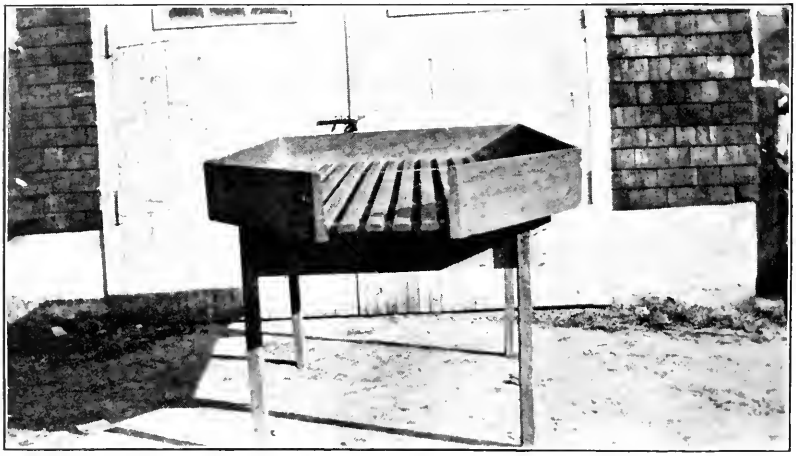


FIG. 2. — End-delivery sorting table.

apples. The ideal receptacle will probably be something in the nature of a box 36 by 18 by 11 inches. It is not practicable to box-pack apples in the field. They should be hauled to the packing shed, and immediately graded, packed and marketed, or put into cold storage.

If one plans to pack his apples in barrels it is always a debatable question whether or not the packing should be done in the field or in the packing shed. Local conditions oftentimes decide this question. It is generally better, however, to haul the apples to a central packing place, as the facilities for better and more rapid work can there be provided. Barreled apples thus packed generally bring 10 or 15 cents more a barrel, because, as a rule, the work is done better. Then, too, if the apples are brought immediately to a central packing house, they generally have an opportunity to become cool before they are placed in the barrels. This adds to their keeping qualities very materially. If the varieties are in large, compact blocks in the orchard, and the packing shed is quite a long distance away, it undoubtedly is cheaper to pack the apples in the field. In this case one needs no field receptacles, as the pickers can empty their baskets directly upon the sorting table. When the packing-shed plan is followed, cheap but firm barrels are probably the best field receptacles. These should be filled not more than four-fifths full. A low-down spring wagon, with a broad platform and broad wheels which will turn in under the platform, should be used. Such a wagon is shown in Fig. 1, opposite page 106. Recently, bolster springs have been placed upon the market. By using these springs almost any wagon may be made suitable for orchard use. Fruit hauled on such a wagon will be bruised but very little.

Barrel Packing — Standard Barrel.

Many different types of tables are in use for sorting apples for barrel use. The most common table is shown in Fig. 2. This represents what is called the end-delivery table, and is a very good table for use when one is careful not to handle the apples roughly. The dimensions are as follows: length,

7 feet; width at back, 3½ feet; height at front, 32 inches; height at back, 36 inches; height of side boards, 6 inches.

Spaces are left between the boards in the bottom of the table for the dirt and leaves to sift through. The boards must be of a soft wood and smoothed off, in order not to injure the fruit. The back of the table is purposely made five or six inches higher in order that the apples may roll down towards the front.

It is necessary to have three men working at such a table to get the best results. An upturned barrel is placed at the end of the table. On this is placed a basket for a certain grade, — the grade which is running the smallest. A man stands at the side of the table and sorts. He has one or two upturned barrels beside him which hold the baskets for other grades. The third man in the crew knocks the tail end out of the barrels, picks out the facer apples, puts them into the barrels and empties the baskets of the two sorters into their proper barrels. Three men working in a crew in such a manner will average about 40 to 45 barrels per day. One extra man can head up and stencil all the barrels put up by three such crews.

A heavier table is often used in packing-house work. It is 9 feet long, 6 feet wide and 33 inches high in front, with the table running lengthwise. The back of the table is 38 inches high and the side 8 inches high. The bottom is slatted, as in the end-delivery table. Three men are needed in the sorting crew, as at the other table. The only advantage of this table is the fact that more field barrels can be emptied upon it at one time.

The Sulzer bill, which was signed by the President Aug. 3, 1912, and which became operative July 1, 1913, standardizes the apple barrel and takes care of the grades of the apples. The bill follows: —

The Sulzer Bill.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the standard barrel for apples shall be of the following dimensions when measured

without distention of its parts: Length of stave, twenty-eight and one-half inches; diameter of head, seventeen and one-eighth inches; distance between heads, twenty-six inches; circumference of bulge, sixty-four inches outside measurement, representing as nearly as possible seven thousand and fifty-six cubic inches, provided that steel barrels containing the interior dimensions provided for in this Section shall be construed as a compliance therewith.

SEC. 2. That the standard grades for apples when packed in barrels which shall be shipped or delivered for shipment in interstate or foreign commerce, or which shall be sold or offered for sale within the District of Columbia or the Territories of the United States shall be as follows: *Apples of one variety, which are well-grown specimens, hand picked, of good color for the variety, normal shape, practically free from insect and fungous 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 percentum below the foregoing specifications, shall be "Standard Grade minimum size two and one-half inches," if the minimum size of the apples is two and one-half inches, in transverse diameter; "Standard Grade minimum size two and one-fourth inches," if the minimum size of the apples is two and one-fourth inches in transverse diameter; or "Standard Grade minimum size two inches," if the minimum size of the apples is two inches in transverse diameter.*

SEC. 3. That the barrels in which apples are packed in accordance with the provisions of this Act may be branded in accordance with Section two of this Act.

SEC. 4. That all barrels packed with apples shall be deemed to be below standard if the barrel bears any statement, design or device indicating that the barrel is a standard barrel of apples, as herein defined, and the capacity of the barrel is less than the capacity prescribed by Section one of this Act, unless the barrel shall be plainly marked on end and side with words or figures showing the fractional relation which the actual capacity of the barrel bears to the capacity prescribed by Section one of this Act. The marking required by this paragraph shall be in block letters of size not less than seventy-two point one inch gothic.

SEC. 5. That barrels packed with apples shall be deemed to be misbranded within the meaning of this Act:

First. — If the barrel bears any statement, design or device indicating that the apples contained therein are "Standard Grade" and the apples when packed do not conform to the requirements prescribed by Section two of this Act.

Second. — If the barrel bears any statement, design or device indicating that the apples contained therein are "Standard Grade" and the barrel fails to bear also a statement of the name of the variety.

the name of the locality where grown and the name of the packer or the person by whose authority the apples were packed and the barrel marked.

SEC. 6. That any person, firm or corporation, or association who shall knowingly pack or cause to be packed apples in barrels, or who shall knowingly sell or offer for sale such barrels in violation of the provisions of this Act, shall be liable to a penalty of One Dollar and costs for each such barrel so sold or offered for sale, to be recovered at the suit of the United States in any court of the United States having jurisdiction.

SEC. 7. That this Act shall be in force and effect from and after the first day of July, nineteen hundred and thirteen.

It is seen that there is but one grade and but three sizes, which are governed by the minimum size of the apples in each grade.

Any one desiring a copy of this law, with explanations and advice, may obtain it by writing to the International Apple Shippers' Association, 613 Mercantile Building, Rochester, N. Y. Any one desiring further information should write to the secretary of the State Board of Agriculture, Room 136, State House, Boston, Mass.

Owing to the frequent difficulty of obtaining apple barrels, one should order them in advance of the time they are needed. Use only new barrels for the best size and perhaps for the second best size. If second-hand barrels are used at all they should be carefully cleaned. Hard-wood barrels with elm hoops are the best.

The actual packing of the barrel consists in placing a corrugated head on the bottom of the barrel. The final top of the barrel is the bottom as it is being packed. If the quality of the apples warrants it, a fancy lace paper circle is next put into the barrel. An oiled or paraffined paper circle is put in next, which prevents any dirt which may possibly sift into the barrel through the cover from coming in contact with the fruit, and also prevents excessive moisture transpiration from the apples. The head of the barrel is now faced with uniform sized apples of a grade which is typical of the contents of the barrel. These apples should be of good color, or at least show good color around the stem ends.

Stemmers or small shears should be used to cut the ends from the long stems, so that they will not puncture the oiled paper circle and will rest more evenly upon the face end. This is sometimes omitted in strictly commercial work. The face layer is put in stem end down, in concentric circles. The outside or larger circle is placed first, of a uniform sized apple which will just fill the circle snugly. Each concentric circle is placed in the same way. The center will require one, two, three, four or six apples, varying in accordance with the sizes of apples used. The next layer is placed the same way by some growers, especially for their extra fancy and exhibition barrels. Most commercial growers now make the second layer by placing the heavy colored cheek of the apples in the cavities formed between the apples of the face layer. This method makes the barrel look much better when opened. About a bushel of apples is next carefully emptied upon these two face layers, before the barrel is shaken at all. The barrel should be carefully shaken then, and after each succeeding basket is put in, until it is full. The shaking, or "racking" as it is called, tends to work the apples down into all of the cavities. In this way a compact package is secured and possibility of bruising is eliminated.

The height to which the barrel should be filled varies according to varieties, and opinion on this point differs in different localities. It should be just high enough so that when the head is pressed in all apples will be held firm, and yet not so tight as to bruise them. The last layer should be placed with stem ends uppermost. This makes it easier to put the head in, and if by mistake the bottom should be opened, it will present a much better appearance. A corrugated head is also used at the tail end as it helps to prevent bruising when the tail is pressed in. It should be nailed in place with six three-and-a-half-penny nails. It is advisable also to nail liners to the tail end of the barrel. The barrel is reversed, and if it is to be shipped a long distance the head should also be nailed in a like manner as an added precaution. The head of the barrel should be stenciled in accordance with Section 5 of the Sulzer bill.

Barreled apples if held for any length of time should be placed on their sides. They should be packed in a car in this way. This method of storing prevents the fruit in a barrel from bearing the weight of other barrels, because the package itself bears it.

The following score card, or some slight modification of it, is generally used for judging the barreled apples: —

	Points.
Uniformity of size of apples,	20
Uniformity of color of apples,	20
Uniformity of shape of apples,	10
Condition and freedom from blemishes,	20
Attractiveness, including facing and tailing,	15
The barrel and trimmings,	5
Firmness of apples in the barrel,	10
	100

Box Packing.

The western growers have succeeded wonderfully with the apple box. This is due entirely to the fact that they were compelled to pack quality apples. Furthermore, they cannot afford to ship the cheaper grades of apples the long distance to the markets.

The Box.

The first consideration in box packing is the box itself. Many shapes and sizes have been used. At present, however, there are only two in general use. The dimensions are: Special, 10 by 11 by 20 inches, inside measurement; Standard, 10½ by 11½ by 18 inches, inside measurement.

The boxes contain a trifle less than a standard bushel, but when they have the necessary bulge they accommodate more than a bushel. The two boxes are designed for different sized apples, but the Standard is being used more and more, probably about 70 per cent at the present time. Apples are sold by the number in the box and not by weight or measure.

The ends of the box should be of one piece, ¾ inch thick, with the grain running crosswise; the sides should be ¼ to ⅜ inch thick and of one piece; the tops and bottoms should

be of two pieces each, a little less than ¼ inch thick, the two pieces making them more elastic. There should be two cleats for the top of the box and two for the bottom on each end. These hold the top and bottom securely, as the bulge has a tendency to push the thin boards over the nail-heads. The boxes generally come knocked down, and can be put together during rainy weather, before the season opens. Four nails should be used for the sides, at each end. Four or five penny cement-coated nails are the best; they hold better.

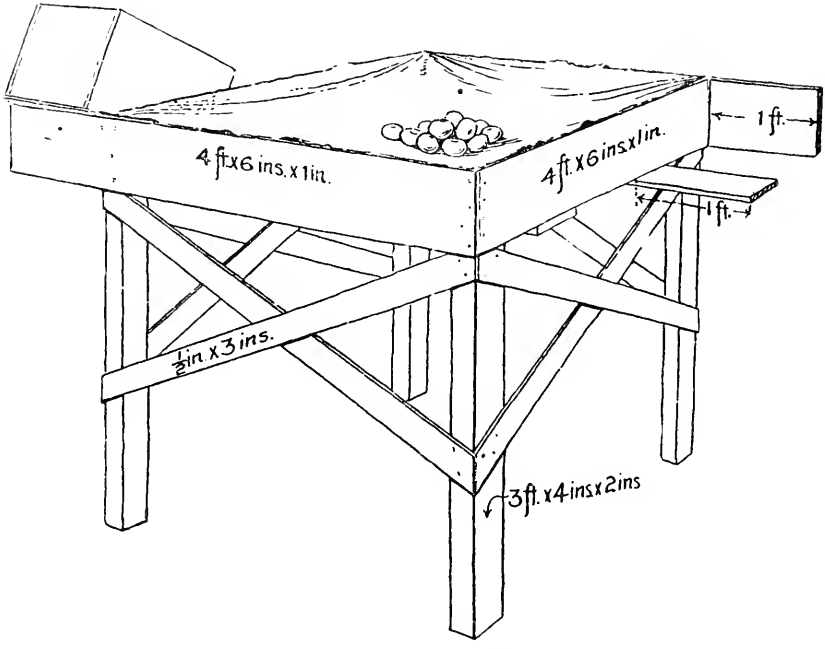


Fig. 3. — A convenient type of packing table.

The Packing Table.

The packing table, such as is shown in Fig. 3, is about 3 by 4 feet, made of 6 by 1 inch boards with 2 by 4 inch joists as posts. A stout canvas is stretched across the top of the boards. An old piece of rubber hose may be nailed along the top of the boards over the canvas to protect the apples from bruising. Shelves for holding the apple box are made at a slant on opposite corners of the table. Extra shelves may

also be made under the table for holding wrapping paper and other packing accessories, thus saving a lot of the packer's time by having everything convenient.

Grading.

As the apples are placed upon the table they are generally graded for size and color. It requires as much skill to grade apples well as it does to pack them well. Grading is sometimes done by machine, but machine grading is not entirely satisfactory at present. An amateur starting to grade for size should have a thin board convenient, with holes of the different diameters cut in it. Occasionally, when in doubt, he can try the apples in the different sized holes. It takes a great deal of practice for one to become an efficient grader, although some people learn very rapidly. Two men can pack to good advantage at one table. One may pack a certain size while the other is packing some other size, thus keeping the table fairly well cleaned off.

Lining the Box.

The box is lined on the bottom, sides and top with pieces of paper each 17¾ by 26 inches for the Standard box and 19¾ by 26 inches for the Special box. These are placed so that they overlap about 2 inches in the bottom of the box. They are long enough to cover the sides and the top, lapping over about 2 inches when the box is packed. The ends are rarely lined. Many growers crease these papers where the sides meet the bottom, which is really the top of the box, so that when the bulge is pushed down the paper will not be torn. The paper costs about 7 cents per pound.

Wrapping.

All apples should be wrapped in tissue paper. This helps to retain the moisture content of the apples and also makes a cushion between them. In case an apple should decay the paper also prevents the rot from spreading. Apples also pack more firmly when wrapped. Wrapping paper can be

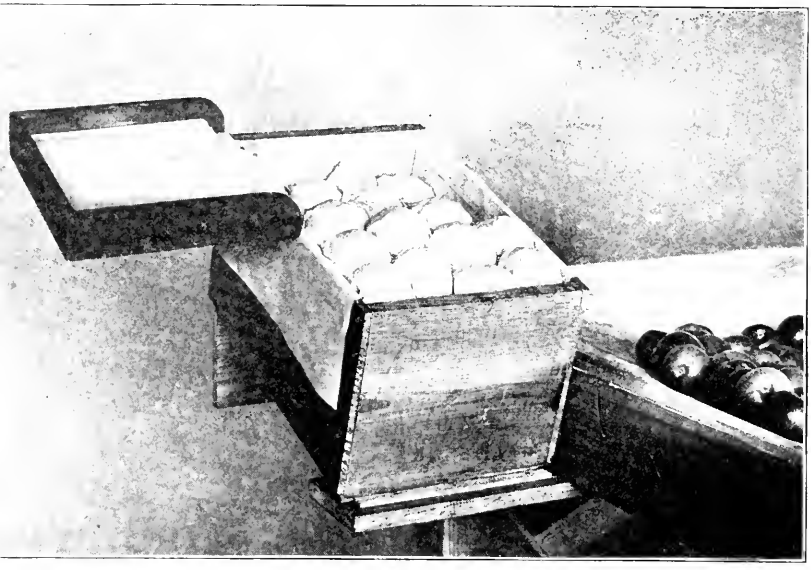


FIG. 4. — Box partially packed, showing construction and position of hod.

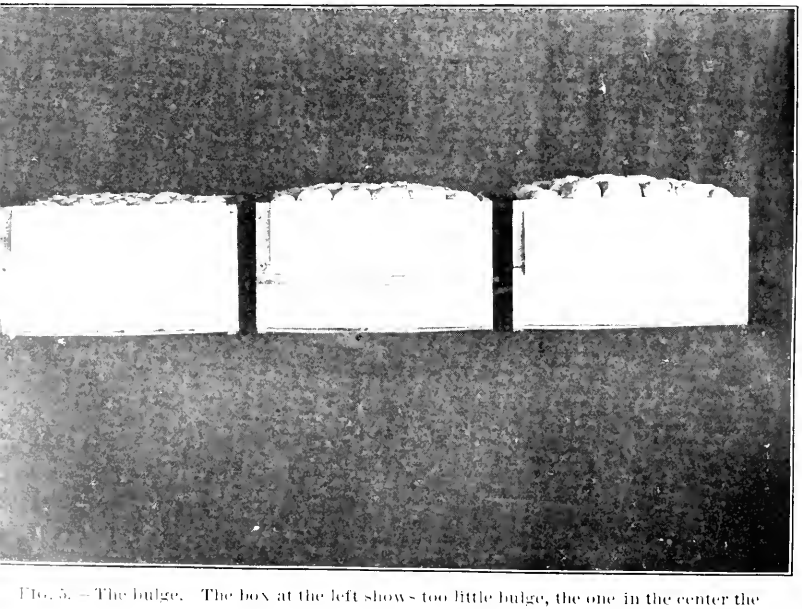


FIG. 5. — The bulge. The box at the left shows too little bulge, the one in the center the proper bulge, and the one at the right too much.

obtained either plain or printed. Oftentimes the large orchardists have their brand or trade name printed upon the wrapper. This makes it cost a little more, but it is a good form of advertising. The white tissue is the best, although different colors are used. It comes in different sizes, which are used according to the size of the apples. The common sizes are 9 by 9 inches, 10 by 10 inches and 11 by 11 inches. Supplies of the three sizes should be kept on hand; the 10 by 10 inch size, however, is most largely used.

Many beginners at apple packing have difficulty with the wrapping of the apple. Wrapping methods vary among different packers. The points sought for are speed and an attractive appearance when wrapped. The paper is taken with the left hand towards one corner. The apple is placed in the paper, blossom end down; the four loose corners are folded in; the left hand places the apple in the box. By placing the blossom end downward in the hand, the surplus loose corners are wrapped around the stem end, thus protecting the apples with which it may come in contact.

Layer papers are used in the top and bottom of the box inside of the lining paper; they are also used between the layers of apples, in order to raise the height of the pack when necessary. It comes in different colors and weights, but a medium weight, white, rough cardboard, 17½ by 11 inches for the Standard box and 19½ by 10 inches for the Special box, is the best.

A shelf should be made to put on the apple box to hold the wrapping paper, such as is seen in Fig. 4. Thumb-cuts should also be provided to put upon the thumb of the left hand for grasping the single sheet of wrapping paper.

Packing.

The packer is now ready for work. He stands in front of the box, with wrapping paper on the shelf and apples at his right upon the table. With his left hand he grasps a sheet of wrapping paper at the corner, while with his right he grasps a certain sized apple which he is about to pack. The experienced packer knows at a glance what pack he must

use to have every apple tight in the box, and also how many apples he will need to pack the box.

There are three systems of packing in use, the straight, the diagonal and the offset. The diagonal, however, is used almost entirely. It is the hardest to pack, but it is by far the most attractive and the most efficient. Apples in a square pack generally become bruised in shipment, because each apple is placed directly over the other. Apples may vary more in size in diagonal packing than in square packing; they also tend to bruise much less in this pack, because each apple rests in the space between two or four others. The offset pack presents more empty space to the critical purchaser when he takes off the side of the box to look at the apples; therefore it should be used only when necessary.

The size of an apple is always considered as the greatest distance from cheek to cheek, and not the distance from stem end to blossom end. A well-packed box of apples should always have a bulge of ¾ inch upon both top and bottom. The top and bottom bulged in this way act as springs to hold all the apples tightly. This bulge is most easily attained by selecting apples with a little greater diameter for use in the middle of each layer. As the box is packed this bulge will be about 1½ inches in the middle, but when the bottom is nailed on, the top of the box will spring out, thus making both top and bottom equal. (See Fig. 5 for illustration of bulge.) The pack should be but little in excess of the height of the box at the ends. This generally comes all right because of the size of the box and the kind of pack selected for the several sizes of apples. Apples which have a diameter of 2⅜ inches make a five tier pack of either 188, 198, 200 or 225; 2⅝ inches in diameter make a four and a half tier pack of either 138, 150, 163 or 175; 2⅞ inches in diameter make a four tier pack of either 113 or 125; 3⅛ inches in diameter make a three or two and a half tier pack of either 36, 48, 56, 64, 72 or 80. The number varies with the variety, caused by their different shapes and thicknesses. The regular Standard box is 10½ by 11½ by 18 inches, and can be used for nearly all of these packs.

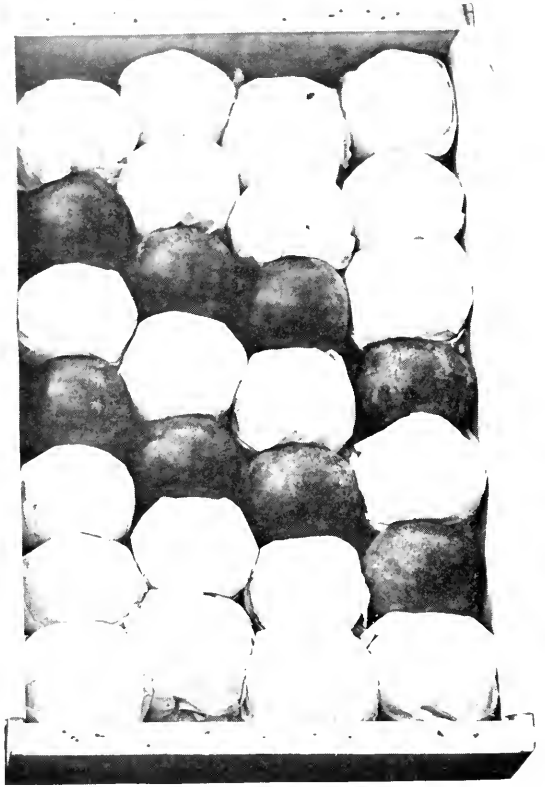


FIG. 6. — 112 pack (2-2 cheek).

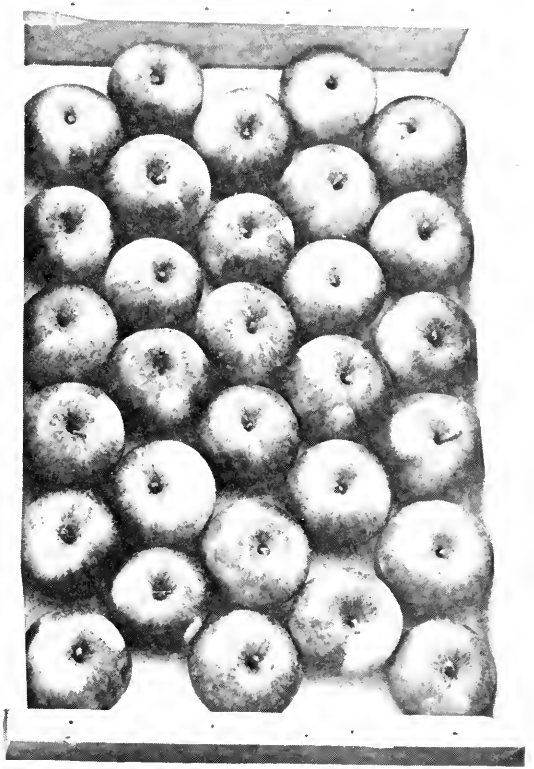


FIG. 7. — 150 pack (3-2 stem).

It is sometimes a hard question for beginners to decide when to use the different packs, such as the 4–4, 4–3, 3–3, 3–2 or the 2–2. This varies with the size of the apple being packed, the size of the box and the variety of apple. The 2–2 and 3–2 are the packs most in favor among fruit growers. It is advisable to pack the apples upon their cheeks (Fig. 6) whenever possible, as they present a much better appearance. A few of the varieties and sizes require stem-end packing (Fig. 7). Experience and long-continued practice will overcome most of the difficulties experienced by beginners in box packing.

In the 2–2 pack (Fig. 6), start by placing one apple in the lower left corner and another apple half way between the cheek of the first apple and the opposite side of the box. The next two apples are placed into the equal spaces formed by the first two apples. In Fig. 6 the first apple in the fourth row has slipped down. It should show a space between the apple and the end of the box. The operation of placing two apples in the cavities left by the last two apples should be continued until the top of the box is reached. The layer of apples should be pulled down towards the paper which will then leave sufficient space to insert two more apples. These last two apples will cause all the others to become firm in the box. If the apples are of such a size that layer papers are necessary to raise the height of the apples, a paper is inserted after the first layer is complete. The second layer in the box is packed in the same way, except that the first apple is placed in the lower right corner. This means that all the apples in this layer are placed in the pockets formed by the apples in the first layers, and that when the box is nailed no apple will be bearing the entire weight of any other apple. Each succeeding layer is packed in the same way, being careful that each layer is started so that the apples will be in the pockets formed by the apples of the preceding layer.

The 3–2 pack is very similar to the preceding 2–2 pack, except that three apples are used in alternate rows instead of two. This means that the 3–2 pack requires a much

smaller apple. Fig. 7 shows this method packed stem-end instead of cheek. This pack is started by placing one apple in each lower corner and one in the center of the space between these two apples. Two apples are next placed, partly filling the cavities formed by the three apples. These two apples leave three cavities which are filled by three apples, etc., until the first layer is completed. In starting the second layer, two apples are used, then three, etc., thus filling the small pockets formed by the apples in the lower layer.

The 4–4 pack is the square pack (see Fig. 8). The apples must be of such a size that four of them just fit into the box across the end. These are placed, and then four more, etc., until the layer is completed. The next three or four layers are packed in the same way, which means that every apple except those in the upper layer of the box must bear the entire weight of one or more apples above it upon its cheek. This invariably means a blemish upon the cheek, which immediately lowers the price.

The offset pack (see Fig. 8), generally a 3–3 pack, is started by placing three apples with their cheeks firmly together, with these firmly against the left side of the box. This will leave a space between the last apple and the right side of the box; start the next three apples in this cavity. Place two more against this first one in the same way, which will leave the cavity upon the left side. Continue this procedure until the layer is completed. The second layer is started from the right side, and the remaining layers alternate until the box is completed. In packing apples upon their cheeks always pack them with their stem ends pointing toward one of the ends of the box.

After the box is packed a layer paper is placed upon it, the ends of the lining paper which have been hanging loose on the side are folded over the apples, the box taken to the box press and the bottom nailed on. Box presses are upon the market and can be purchased very cheaply. Oftentimes they are made at home.

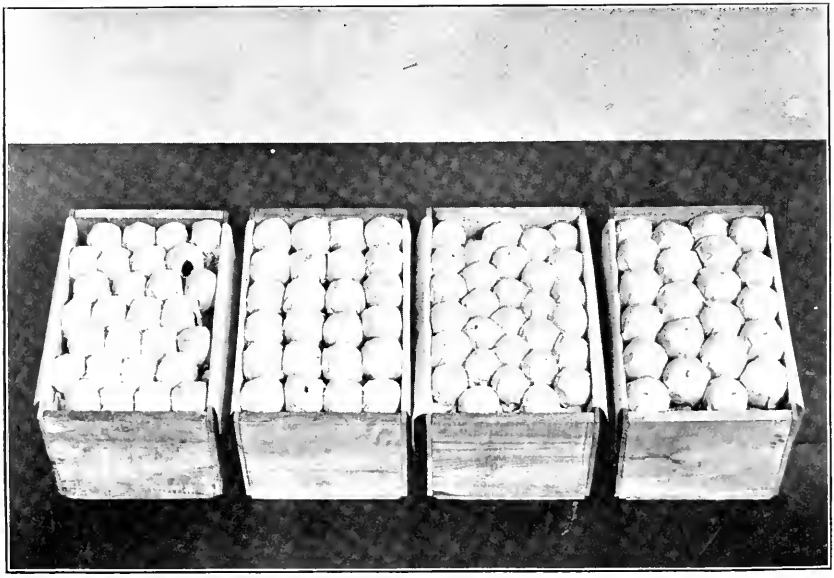
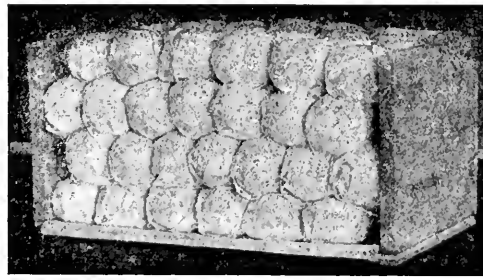


FIG. 8. — The different kinds of packs. Beginning at the left, (1) offset; (2) square; (3 and 4) diagonal.

Labeling.

Every grower who puts up fruit fit for box packing should have a label to paste upon the end of his apple boxes. The label should be stenciled with the class of fruit, such as "Fancy" or "Extra Fancy," in the upper left corner. The number of apples in the box should be placed in the upper right corner. The variety of apples can appropriately be placed between the two upper corners. Boxes when piled upon each other should always be placed upon their sides. They pile better and the fruit is not damaged by this method.

Other difficulties experienced by beginners at apple packing will be overcome by intelligent study and continued practice. A grower who uses the box package for marketing his strictly high-quality fruit ought to net a larger profit than if he marketed it in the large, bulky barrel. The box package has succeeded wonderfully with the progressive western fruit grower, and is also finding favor with the up-to-date eastern grower who does not make the mistake of using inferior grades.



ROOT AND CLEFT GRAFTING.[1]

H. D. HEMENWAY, NORTHAMPTON, MASS.

Grafting is the art of placing a portion of one plant upon another related plant in such a manner that the growing tissues of each coincide and union takes place. The plant grafted is the *stock*. The part grafted into the stock is called the *scion*. Grafting is practiced on many trees that do not come true from seed, such as apples, pears, etc. The fruit borne on grafted trees is the same variety as that from which the scion was taken.

Cleft grafting is practiced to obtain results from seedlings in the shortest possible time. It is also used to change the fruit upon any tree to a more desirable variety.

It is not as difficult to graft as many believe. A careful boy often obtains as good results as an experienced gardener.

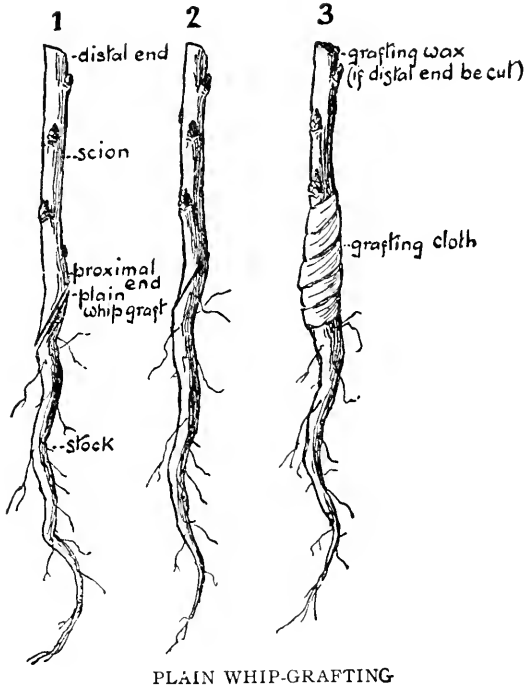
Root Grafting.

Root grafting, as the name implies, is the placing of a scion of the desired variety upon the roots of some other. Apple or pear seedlings one or two years old furnish good stocks. They can be purchased for about 1 cent each. The scions can often be gathered. They should be the short sprouts of the previous year's growth. They are best selected from thrifty trees on or near the ends of fully exposed branches. Avoid long sap sprouts with long spaces between the buds or nodes. Scions may be gathered at any time after the leaves drop, when not frozen, until the buds swell in the spring. If not used immediately, they should be kept covered with damp moss in a cool, moist place, to keep them fresh and plump. Varieties should always be marked with their names. The stocks, or roots, may be stored in the same

[1] Nature Leaflet No. 44, April 10, 1910.

manner and used at any time in winter. A common shoe knife, which may be purchased for 10 or 15 cents, makes an excellent knife for root grafting, when kept sharp. The stock and scion must be kept in place until they unite. For this purpose grafting cloth is perhaps the best means; it is easily made, as follows:—

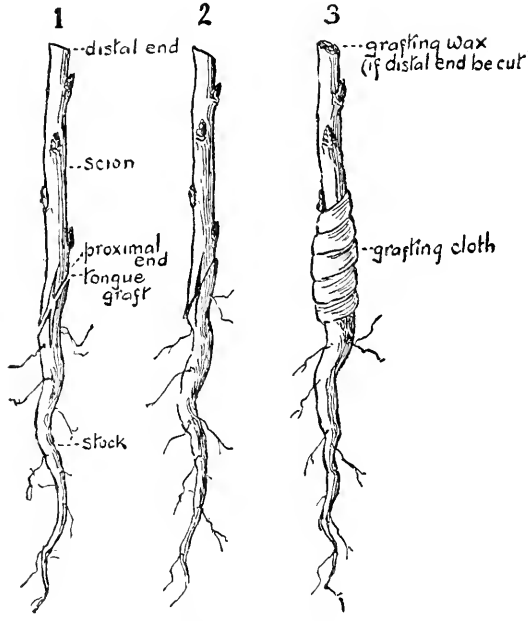
For grafting cloth, melt together over a slow fire 4 parts of unbleached resin and 1 part of beef tallow or raw linseed



PLAIN WHIP-GRAFTING

oil. Spread this evenly over cotton cloth with a brush or stick. Tack the cloth over a board or box. Keep it warm, so that the mixture may be spread evenly. When cool, roll and tie up. Keep in a cool, moist place until needed. When used, it should be cut in strips about ¼ inch wide. There are four simple methods of root grafting, viz., whip grafting, tongue grafting, saddle grafting and veneer grafting. In each case it is necessary to get the growing tissues, the cambium layers, to coincide; if they do not, they will fail to

unite. This growing tissue, or cambium layer, is just inside the inner bark. Before grafting, the tops of the seedlings should be removed, as the roots only are to be used. Thoroughly wash the roots, — this is very essential, in order to keep the knife sharp, — cut them into pieces 5 or 6 inches long; each piece more than ⅛ inch thick will make a root graft.



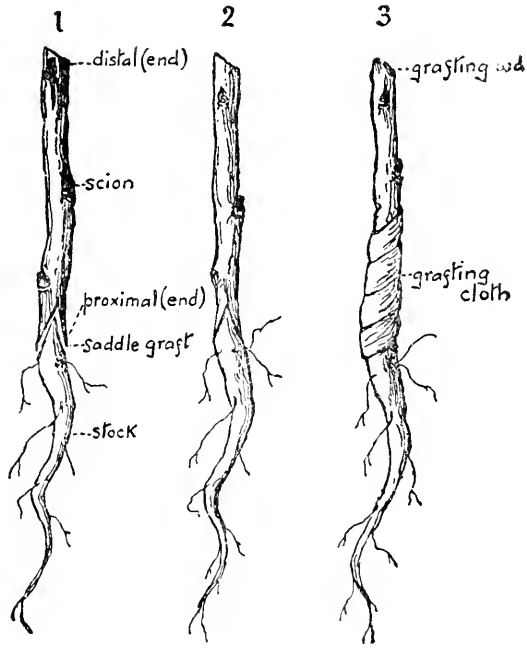
TONGUE-GRAFTING

Whip Grafting.

For plain whip grafting make long slanting cuts on the upper end of the root and the lower end of the scion, so that they just match each other. Place them so that the cambium layer of the stock and scion coincide, and bind firmly with grafting cloth cut in strips about ¼ inch wide. Begin winding well below the union, and continue spirally up over the union. The scions should not be over 4 inches long. This method is used on brittle woods, as raspberries and blackberries, as well as on apple and pear seedlings.

Tongue Grafting.

Make a clean, long slanting cut on the upper end of the stock. Select a scion about the same size, and make a similar cut on the lower end of it. Both cuts should be clean and smooth, and should match each other. Make a little tongue in each by cutting out a small wedge-shaped chip, as shown in the cut. Press stock and scion firmly together, so that the



SADDLE GRAFTING

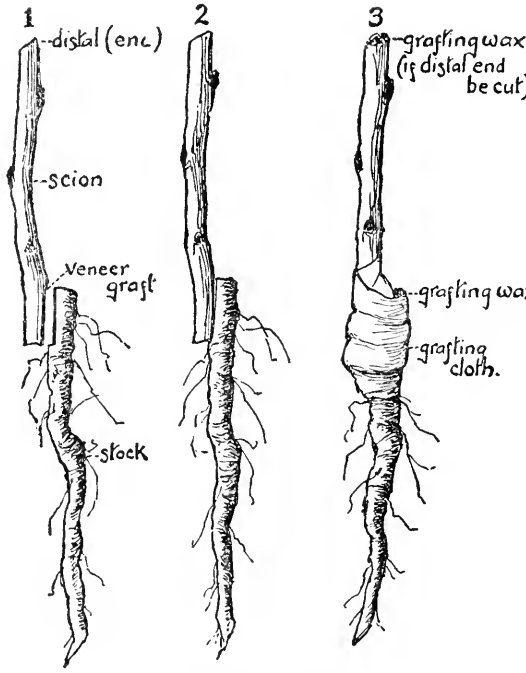
tongues dovetail. Be sure the inner bark of stock and scion coincide; if they do not fit exactly, take them apart and try until they do. If scion is smaller than the stock, it must be carried to one side. Bind firmly with warm grafting cloth ¼ inch wide, beginning well below the union, winding spirally until above the cut. This method is used with tough-wooded plants, as the apple. As the tongues hold stock and scion together firmly, it is a better method than plain whip grafting.

Saddle Grafting.

Make a clean slanting cut on each side of the upper end of the root, and a corresponding V-shaped cut on the scion. When these fit exactly, bind them together with grafting cloth.

Veneer Grafting.

Cut a shaving of bark from both the stock and scion, about 1 inch long. Make a short right-angular cut at the base of



VENEER GRAFTING

each. Bind firmly with grafting cloth, so that the cambium layers will coincide.

Approach grafting is similar to veneer grafting. The stock and scion are united, while both remain on their own roots. Usually one or both are potted plants. This is practiced on citrus fruits, Japanese maples, and plants that are more difficult to successfully graft.

All root grafts should be carefully marked and stored in damp moss, in a cool, moist cellar, until the ground is ready to plant them in spring. The distal end of the scion when cut should be covered with wax. The secret of success is to make clean cuts with a sharp knife, and be sure that the cambium layers coincide.

To plant Root Grafts.

Prepare the soil as for any crop, by spading or plowing and harrowing thoroughly. Stretch a line where the first row is desired. Put the spade down the full length of the blade under the line; move it back and forth, to increase the opening. Remove the spade, and press the root graft into the ground until the top is only one inch above the surface. Press the soil firmly about it with the heel. Continue to place root grafts under the line every 6 inches. The graft should be inserted into the soil well below the union, to encourage roots in the scion and to prevent the stock from sending up "suckers." In a small garden, root grafts may be planted in rows 2 feet apart; but if there is space enough to cultivate with a horse, the rows should be 3 to 4 feet apart.

Cleft Grafting.

Cleft grafting is practiced on the tops of trees which are more or less matured. Wild apple trees of good size are often grafted, so that they will produce desirable fruit. It should be practiced on branches not over 2 inches in diameter. It is best to graft only one-third or one-half of a tree in a single season, so as to have enough top to leaf out well. A saw, a pruning hook, a knife and a hammer are necessary, as well as scions and grafting wax.

With a clean, sharp saw remove the end of the branch to be grafted at a point where the stub will not be over 2 inches in diameter. Much care should be taken to prevent the bark from splitting down on one side when the branch is cut off.

Place the grafting hook so that the chisel part is over the center of the cut, and drive it down with the hammer, splitting the stub into two parts through the center. Remove the tool, and drive the wedge part into the end of the split stub,

so as to hold the edges open. Select a scion and make a double wedge-shaped cut on the lower end of it. Make it wedge-shaped lengthwise, so as to fit into the cleft; and wedge-shaped horizontally, so that the inside of the scion inserted in the cleft is almost cut away, while the outside which comes in contact with the cambium layer of the stub forms an arc of the original circle of the twig.

When the stub is 1 inch or less across, but one scion should be inserted. When the stub is two inches in diameter, place a scion in each edge of the cleft, so that the inner bark of the scion and of the stock will coincide. Remove the grafting hook. When the stub springs back, it will hold the scions firmly in place. All exposed surfaces should be well covered with grafting wax, to prevent evaporation. Let the wax cover the ruptured bark below where the scion is inserted, as well as the top of the cut. In the second season one of the branches should be removed, if both scions grow. If both were allowed to grow, a fork would be formed, which would weaken the tree. The scions should be wrapped in moist cloths, to prevent them from dying out. Cleft grafting is successfully done in New England only in the spring, when the buds are swelling. It is most successful on bright, warm days, free from cold or drying winds.

MASSACHUSETTS FRUIT TREES AND THEIR INSECT FOES.[1]

H. T. FERNALD, PH.D., AMHERST, MASS., STATE NURSERY INSPECTOR.

Massachusetts is a natural fruit-raising State. On her rugged hillsides flourish magnificent trees never set by man, while thrifty pear and plum orchards here and there attest the value of her climate and soil for fruit growing. The qualities of the Baldwin, Hubbardston, Sutton Beauty and Roxbury Russet apples, of the Clapp's Favorite pear, of the Crosby peach and of the Concord and Rogers' Hybrids among grapes, are known the world over, and all of these and many others originated in Massachusetts.

Civilization and fruit raising at first went almost hand in hand in this country. After making a clearing in the forest, building his log cabin and breaking ground for his crops, the settler rarely neglected to plant a few fruit trees near his home; and in time the better fruits occasionally appeared on his table, while the poorer sorts supplied cider and vinegar for his use.

But fruit raising was always a side issue. His markets were always for his hay, corn, potatoes and the products of his cattle, and with little time at his disposal it was these which received his attention and the fruit trees were neglected, as the only market for fruit was in his family and perhaps with a few of his neighbors; and it is probable that the one who most appreciated the fruit was the "Barefoot boy, with cheek of tan," who munched his apple as he drove the cows to pasture at early morn.

In time the farms began to run down, and the struggle to raise sufficient crops became more severe, thus concentrating all the farmer's energies in his special lines, and the fruit

[1] Agriculture of Massachusetts, 1907.

trees suffered still more from neglect. By this time it had become almost traditional that in order to obtain fruit all that is was necessary to do was to set out the trees and then let them alone. In consequence, when fruit came into demand for table use it found almost all the farmers of Massachusetts with nearly worthless trees, fruit averaging poor in quality, and with insects and fungi rampant. In addition, it found the farmer without a knowledge of proper methods of fruit culture, and devoting his energies to other crops. As a natural consequence, fruit raising in other parts of the country, where more up-to-date methods were promptly adopted when the demand came, has increased rapidly; while the people of Massachusetts with a few individual exceptions, have allowed their opportunity to pass rather than master modern methods of fruit growing and obtain their share of this rapidly increasing and profitable occupation.

The demand for first-class fruit is now greater than the supply, and the export trade is calling for larger shipments. Much of this fruit now comes from west of the Mississippi River, has been grown in climates less perfectly adapted to produce fine quality and keeping properties than is that of this State, and has been shipped long distances at freight rates much higher than would be the case here. Over half of the first-grade fruit in Boston markets to-day has come from the west, while Massachusetts supplies the lower grades at correspondingly lower prices.

Failure to raise the best fruit here has given the west its chance; and this has been taken advantage of, the finest grades attractively packed now selling in Boston markets for more than twice as much as home fruit. Only last year Hood River apples were selling at from $2.50 to $4 per box, the boxes holding about a bushel, and retailing at some places in this city at $1 a dozen; while the best home apples available were selling at $2.50 per barrel!

There is no reason why this condition should continue. Massachusetts can raise just as good fruit as Oregon, and at less cost. With much lower freights to pay, less risk of injury during transportation, excellent soil and climate, it is only necessary that fruit raising should be undertaken as

a business, on business principles, and with the determination to produce the very best fruit in existence, in order to establish a satisfactory market.

The difference in freight rates from points in this State to Boston, as compared with those from the west, is worthy of a moment's consideration. If a Kansas fruit raiser, for example, ships apples in carload lots to Boston for export, he pays from 25 to 35 cents per hundred pounds to the Mississippi River or to Chicago, and 30 or 35 cents more from there to Boston, his total freight being 60 or 70 cents per hundred pounds. The Massachusetts grower shipping in the same way would pay on the average 8 cents per hundred pounds, — a saving of nearly seven-eighths of the total shipping charges, as compared with the Kansas shipper.

It is high time for the farmers of Massachusetts to throw off the lethargy in which they have so long remained, and prepare themselves to occupy markets properly theirs, and which they can supply easier and better than can the residents of any other section of this country.

A recent editorial writer in the "Youth's Companion" has expressed his views upon this subject as follows: —

> The rapid development of the fruit-growing industry in this region is due to the great fertility of the soil, the intelligence and energy of the western farmers, and the co-operative organizations of growers. Poor fruit has been discouraged and almost eliminated. Packing is in boxes, with every apple wrapped separately, and warranted to be perfect. The number of apples which a box contains is printed plainly on the outside, and there is absolutely no "deaconing."
>
> These methods have enabled the western growers to realize a profit on apples and pears of $100 to $1,000 an acre. . . . There is no mystery about this remarkable development. It is due solely to intelligence, enterprise and hard work, and is just as much within reach of eastern growers as it was in the grasp of their western rivals. The lesson ought not to be lost upon eastern farmers who wish to retain such of their fruit market as still remains to them.

Even under present conditions, there are many persons in the State who derive three-quarters of their entire income from sales of their fruit. One such man, whose name would

be familiar to any of those present, recently admitted that his trees are growing in sod land, without fertilizing, pruning except at long intervals, spraying or care of any kind; that the fruit is shaken from the trees, roughly assorted, packed in the cheapest barrels obtainable, and marketed whenever it is most convenient. Yet he acknowledged that nearly all of his fair income came from this fruit. The San José scale had recently appeared in his orchard, and he had about decided to cut down his trees and go into some other occupation, rather than make the source from which he received most of his income his real business. If this be a fair sample of the way in which fruit growing is conducted in Massachusetts, it is no wonder that the larger part of the best export and New England trade is supplied from the west.

At the present time fruit growing has unusually attractive prospects in Massachusetts. The general distribution of the San José scale over the State absolutely requires regular and persistent treatment. Now, fruit trees are grown by three classes of people: those who make it their business; those who, though in other lines of agriculture, raise a little fruit; and those in commercial or professional occupations, who have fruit trees in their yards to supply their own needs. The first class will fight this insect foe, and get their fruit; but the farmer on other lines, after spraying once or twice, will usually give up treating his trees, as requiring too much time and trouble; while most of the third class, having no spraying apparatus to use and no knowledge how to use it, will probably try to hire the spraying done, and will generally find no one available to do it. In consequence, the trees thus left unprotected from this pest will die after a time, and the fruit raising in the State will be concentrated in the hands of the professional growers, and theirs will be the task of supplying the fruit now raised by the other two classes.

As the number of fruit trees around the houses of workers and grown by farmers as a side line only is now more than five times that of all those in the orchards of regular fruit growers, it is evident that the time is coming when fruit in

large quantities will be in demand to replace that which will be lost, and the man who prepares now to meet this demand will reap the benefit.

From what has been stated, however, it does not follow that fruit growing is a simple occupation. The successful grower must thoroughly understand what conditions of soil and elevation are best adapted to the varieties he attempts to raise; which varieties bring the best prices in the markets he proposes to use; what kinds of plant food and the proper amounts of these his trees need in order to enable them to do their best work; how to prune, fight his insect enemies and fungous foes; and, last but not least, how to gather, assort, pack and ship the fruit in such ways as will help it to look best, keep best and sell best. Such a man can make a success of fruit growing in Massachusetts; and a man who fails to measure up to an equivalent standard, in whatever occupation he may be, is a failure to just that degree. If it be in business, he is likely to assign; if in a profession, he soon drops out of sight; but if a poor farmer in any line he generally earns a living, scanty though it may be, for nature will sustain inefficient workmen where in any other occupation this would be impossible.

Let us now consider some of the foes the fruit grower will meet in Massachusetts, and how he must combat them if he is to produce crops which will bring the highest prices.

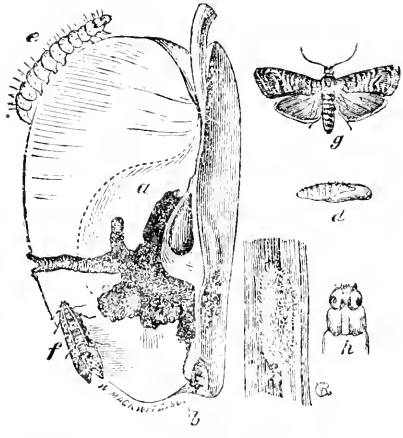
Codling Moth.

One of the most important pests of the apple in Massachusetts is the codling moth (*Carpocapsa pomonella* L.), a native of Europe, but which has taken kindly to new world conditions. The caterpillar, when through feeding in the apple in the fall, leaves the fruit and crawls down the tree till it finds some piece of loose bark beneath which it can make its way. Here it gnaws an oval cavity, which it lines with silk, and in this space it coils up to spend the winter. During this time woodpeckers are of great value to man by seeking for these caterpillars as they lie under the loose bark and feeding upon them. When spring comes, the caterpillar changes to a

pupa, and by the time the apple blossoms are falling the moth escapes from the pupa and begins to fly among the trees.

About a week after the petals fall, egg laying begins. The eggs are tiny white specks, placed singly, either on the fruit, its stem, or even on some leaf near by, and each moth may lay from 50 to 75 eggs. About a week later the eggs begin to hatch, and the little caterpillars crawl to the apples, if not already on them, and about three-quarters of them pass to the blossom end. Here they gnaw their way into the space between the sepals, and begin to feed. After a day or two each starts in toward the core, around and in which it feeds till nearly full grown. It now makes a tunnel toward the surface. Arriving there, it forms an exit hole which it keeps closed with silken threads mingled with excrement till it has finished feeding, when it leaves the apple and crawls down the trunk till it finds a suitable loose piece of bark beneath which to pupate.

Some of the caterpillars, — perhaps 25 per cent, — however, do not enter the apple at the blossom end, but at some scar on the surface, where a leaf rubs against the fruit, or elsewhere. For these after they have once entered the apple the history is the same, but the difference in the place where they enter makes a great difference in treatment necessary. In either case nearly a month is spent in the fruit, and the first caterpillars appear to finish feeding about the first of July. After these have gone to the trunk and pupated, two or three weeks are spent in this condition before the moth appears. Later caterpillars, however,



Codling moth: *a*, work of caterpillar; *b*, point of entrance; *d*, pupa; *e*, full-grown caterpillar; *f*, *g*, moth; *h*, head of caterpillar; *i*, cocoon.

which are not ready to leave the fruit before August, usually remain in the caterpillar stage under the bark till the following spring; while the moths from the early caterpillars go to the trees and lay their eggs for a second brood, which works in the fruit during the fall months. The caterpillars of this brood pay little attention to the blossom end of the apple, but enter anywhere, and often do not finish feeding until after the fruit has been gathered, and are accordingly carried into the bins or barrels where it is kept, and on leaving the apples form cocoons in any convenient crevice in which to spend the winter. How important this second brood is in Massachusetts is not known, and the subject is now being investigated.

The entire amount of loss caused by this pest is seldom appreciated, as many of the apples attacked by the first brood fall off early, not remaining long enough on the tree to show what the crop would be. But even of those which remain to be gathered nearly 40 per cent on an average are wormy, reducing their value at least one-third. Pears, too, are attacked by this pest, so that in the aggregate the loss is very great.

To prevent much of this loss, spraying may be made use of, and at the same time secure protection from various fungous diseases, such as scab and fruit spot. But, in order to be a success, the proper time must be chosen for the treatment. It has already been stated that a large majority of the caterpillars of the first brood enter the fruit at the blossom end, where nature has provided a little cup in and around which to place a supply of poison. For about a week after the petals have fallen the sepals which form the walls of this cup remain open, but after that time they draw together, thus closing the opening. Before this happens, the tree should be thoroughly sprayed in such a manner that as much of the spray as possible shall fall into and around this place, so that when the caterpillar comes, its first meal may be a poisoned one. The best spray to use for this purpose is Bordeaux mixture, to every barrel of which three pounds of commercial arsenate of lead have been added.

thus treating both insects and fungi at the same time. Repeating this treatment about the twentieth to the twenty-fifth of June is also of much assistance, and should not be omitted.

In this way most of the caterpillars entering the fruit through the blossom end can be destroyed. But about 25 per cent enter elsewhere, and for these other methods must be employed.

As a large number of the small apples which fall are infested, and once on the ground will soon be left by the caterpillars, it is important that these apples be picked up and destroyed, either by hand or by letting fowls or hogs run freely under the trees. For those caterpillars which leave the fruit before it falls it is well to scrape the trunks and large limbs of the trees about the middle of June, to remove all loose bark beneath which they might pupate, and tie a strip of burlap around the trunk. Beneath this strip the caterpillars will gather, and a weekly visit and the destruction of the caterpillars there, while not saving the fruit they fed on, will at least reduce the number of these insects, and be of value as a protection against later broods.

Spraying twice, burlapping and destroying early falling fruit are the protective measures to be adopted for this pest. Recent experiments in New Hampshire show an average profit per tree sprayed, over one not sprayed, of $1.25, while it cost less than 25 cents to spray a tree four times; and after deducting one tree's share of one-fifth of the cost of the apparatus used on a hundred trees, the net profit of a sprayed tree over one not sprayed was about 80 per cent.

These results have been tested in all parts of the country, and are but little better than the average; and if this be so, the question is no longer, "Can I afford to spray?" but "Can I afford not to spray?"

San José Scale.

Another and even more destructive enemy of the fruit grower is the San José scale (*Aspidiotus perniciosus* Comst.). Its extremely small size, its marvelously rapid increase in numbers, its covering of armor which makes destruction so difficult, and its variety of food plants, combine to render this a most dangerous foe. It lives not only on the bark, which it finally covers completely, but it spreads to the fruit, where it produces unsightly red spots, so injuring its appearance as to greatly reduce its value for sale.

This scale is now generally present in Massachusetts, and is rapidly becoming more abundant.

It is one of the most prolific insects known, the descendants of a single individual under favorable conditions having been calculated as numbering more than three billions in a single season; and as all of these obtain their food from the sap of the tree, it is not uncommon to see good-sized trees completely dried up as the result of their presence. They can be destroyed only by sprays which come in actual contact with their bodies, and strong enough to penetrate the armor which covers them; and sprays which can do this are not safe to use on the trees except during the winter months, while the trees are not growing. Yet a fruit raiser who understands the proper method of treatment has no fear of this pest; and to him, as Mr. J. H. Hale says, it is on the whole a blessing in disguise, for it means that this pest will destroy so many of the fruit trees which are not given proper care as to greatly increase his markets and improve his prices.

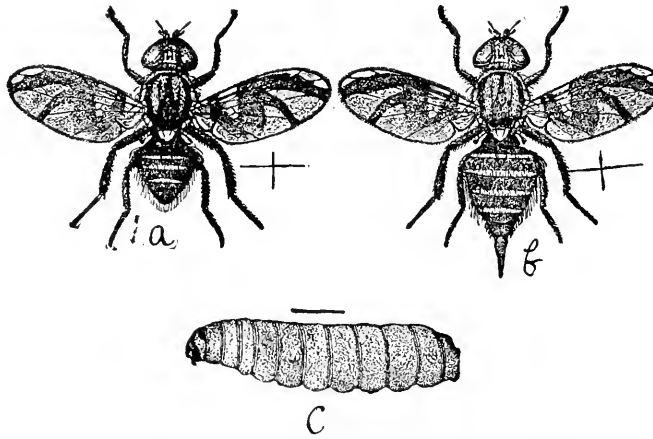
Oyster Shell and Scurfy Scales.

Two other scales are also frequently present in the orchard, and at times may cause trouble. The oyster-shell scale (*Lepidosaphes ulmi* L.), being larger than the San José scale, is more frequently noticed and feared by those not familiar with the subject. But this fear is unnecessary, for the oyster-shell increases slowly in numbers as compared with the other, and mild soap washes applied in June are sufficient

to hold it in check. The same is true of the scurfy scale (*Chionaspis furfura* Fitch), the dirty white color of which makes it very noticeable. Trees attacked by these scales must be treated, it is true, but two applications in June should be amply sufficient to prevent any loss from their ravages.

Apple Maggot or Railroad Worm.

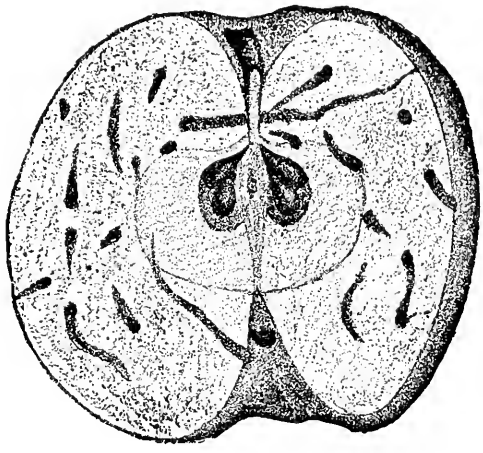
The apple maggot or railroad worm (*Rhagoletis pomonella* Walsh) is another pest which causes much trouble in Massachusetts. The adult is a fly, smaller than a house fly, with black bands on its wings, which lays its eggs just under the



Apple maggot: *a*, adult male fly; *b*, adult female fly; *c*, maggot; all much enlarged.

skin of the apple. This begins early in July and continues till late in September, different individuals appearing at different times during this period. The young maggots from these eggs tunnel in all directions through the fruit, the earlier tunnels healing and closing up, but later ones remaining open and turning brown, while the fruit becomes soft and worthless. When full grown these maggots leave the apple and enter the ground, where they pupate an inch or more below the surface. Sometimes they leave the apples after these have been gathered, and in such cases pupate on the bottom of the bin or barrel in which the fruit is stored.

The protected life of this pest makes it difficult to combat, the most exposed period being while it is in the pupal stage. The plan suggested for the codling moth, of gathering and destroying fallen fruit promptly, and of letting fowls or hogs run in the orchard, is also of value for the railroad worm, as many of the maggots in the fallen apples — those leaving it for the ground and those pupating in the ground — are quite certain to be found and eaten by these animals.



Apple, showing work of the maggot.

Apple-tree Borer.

All parts of trees are attacked by insects, and the apple tree is no exception to the rule. With the codling moth and railroad worm injuring the fruit, the scale insects sucking the sap from the branches and twigs and various other pests consuming the leaves, it would seem as though the trunk and roots at least should in fairness be exempt from injury; but this is not the case. The apple-tree borer (*Saperda candida* Fabr.) devotes its attention to the trunk near its base, and is an important foe, particularly in young trees. This beetle, which is strikingly marked and very noticeable, is rarely seen, being retiring in its habits. The eggs are laid here and there on the lower part of the trunk during the summer; the borers which hatch bore into the wood, where they make flat cavities just beneath the bark, which often cracks at such places, letting the "sawdust" out, and thus showing where the borers are. The following year the borer makes a regular tunnel into the wood of the tree, and finally gnaws out to the bark, only a thin layer of which it leaves in place.

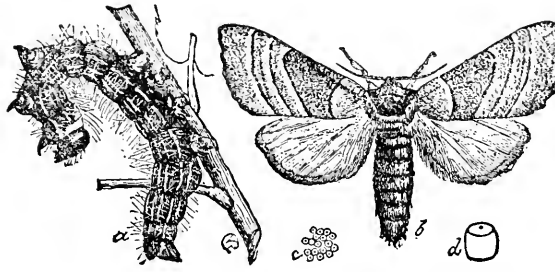
Having thus prepared a means of escape for itself, it goes back in its tunnel a short distance, turns so as to face outward, and changes to a pupa, from which the following June or July the beetle escapes, follows the tunnel to its end, and, gnawing away the thin layer of bark, begins its life outside the tree.

That this insect is capable of causing great damage is shown by the fact that neglected trees are often completely girdled by the tunnels of the borers, and are killed; and even those not so seriously affected have their bearing power and general vitality greatly reduced. Yet treatment for these insects is simple, and takes but little time. In order to carry out this treatment, it is first necessary to remove any borers already in the tree; and this should be done in October, by searching for "sawdust," and then locating and killing the borers either with a knife or a pointed wire. Each tree should then be protected by wire mosquito netting, placed around the trunk so that it will not touch the trunk except at the top, about two feet from the ground, where it should fit tightly enough to prevent the beetle from crawling down inside. The wire should form the surface of a cone, the trunk coming up through its center, while the lower edge of the wire should enter the ground. With wire so placed, and with no holes in it, the beetles are unable to reach the lower part of the trunks on which to lay their eggs; and rather than lay them higher up they will in most cases leave such trees, and, crossing the line fence, attack the unprotected trees of neighbors. Such a protection will not only keep out borers for several years before it gives out, but will protect the trees in winter from the attacks of mice and rabbits, while also permitting light and air to reach this portion of the trunk.

Plant Lice.

During the fall months the fruit grower frequently finds certain parts of the limbs of his fruit trees more or less covered with a white wool, beneath which investigation shows the presence of large numbers of small plant lice (*Schizoneura lanigera* Haus.). These lice suck the sap from the

tree, and locate, if possible, where the bark has been broken or rubbed, it being easier at such places to reach the sap than elsewhere. This insect is not usually a serious pest in Massachusetts; but as it also works on the roots and may do considerable injury there, its presence on the branches is an indication that the roots may also be suffering, and should be examined. To do this, the soil should be carefully removed till enough of the roots is exposed to determine their condition. If the lice are present, the earth should be removed down to the upper roots for a distance of two feet from the trunk in all directions, and this area well saturated



Yellow-necked apple-tree caterpillar: *a*, caterpillar, showing characteristic position when disturbed; *b*, adult moth; *c*, cluster of eggs, natural size; *d*, side view of one egg much enlarged.

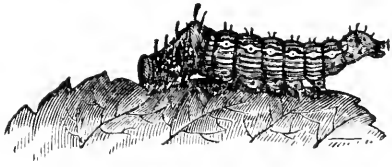
with 15 per cent kerosene emulsion. The earth should then be put back, and the emulsion left to work through the ground to the lice.

Yellow-necked Apple-tree Caterpillar.

In August and September caterpillars of various kinds feed on the apple leaves, often in clusters, and are quite conspicuous because of their bright colors. One of these is the yellow-necked apple-tree caterpillar (*Datana minstra* Dru). When disturbed this caterpillar lifts both ends of its body at right angles to its middle, assuming a very characteristic attitude. After feeding till full grown, the caterpillars enter the ground and pupate, the moths appearing the following summer.

Red-humped Apple-tree Caterpillar.

In some cases another kind of caterpillar having similar habits, and known as the red-humped apple-tree caterpillar (*Schizura concinna* S. & A.), is met with, also feeding in clusters. Of this, too, there is but one brood a year, the moths flying in midsummer.



Red-humped apple-tree caterpillar.

Such caterpillars as these cause much more apprehension than is necessary. Their habit of feeding in clusters makes it easy to remove them by hand; or if for any reason this is impossible, spraying the portion of the tree they are on with arsenate of lead will quickly destroy them. But the size of the clusters and the rapidity with which they will strip a limb are often the cause of much anxiety to fruit growers who are not familiar with them.

Moth of red-humped apple-tree caterpillar.

Bud Moth.

One of our abundant apple pests is the bud moth (*Spilonota ocellana* Schiff.). Though its work is generally little noticed, it blighted about 10 per cent of the fruit buds at Amherst last spring, besides many of the leaf buds, thus causing a large reduction of the crop, which was almost entirely unappreciated, the blossoms failing to develop.

The tiny moths of this insect measure less than an inch across the expanded wings. They appear in June and July, and lay their eggs on the leaves, generally singly. About a week later the eggs hatch, and the little caterpillars attack the leaves they are on, feeding on the epidermis of one side and the inside cells only, leaving the veins and other surface entire. Each caterpillar also forms for itself a little tube of silk, usually along the midrib of the leaf, and uses this as its home, leaving it to feed, but returning to it when disturbed. As the caterpillar grows, this tube is enlarged till it may become nearly an inch long.

Feeding thus, the caterpillar lives and grows till late in August or into September, the parts of the leaves which have been more or less skeletonized in this way turning brown and becoming noticeable. Late in September or in October, however, the caterpillar seems to realize that the leaf is no place on which to remain longer. It accordingly travels to a twig, where it seeks for some angle or corner, and here it encloses itself in a little web of silk in which to spend the winter.

When the buds begin to open in the spring, the caterpillars, now about half grown, leave their winter nests, being about a quarter of an inch long and dark brown in color. They pass to the leaf and flower buds, in which they feed, consuming the tender leaves or flower buds, and fastening them together with threads of silk. A caterpillar rarely eats an entire leaf or flower, but feeds for a time on one, then on another, thus blighting much more than it actually consumes. Sometimes it develops a burrowing habit, starting near the base of the bud and working down in the pith of the twig, causing the death of the entire tip of the shoot.

Those caterpillars which do not appear in spring till a little later select well-advanced leaves, the stems of which they partially cut off so that they wilt. Such leaves are then rolled up on one side and held by silk threads. In these the caterpillars live, and in feeding draw neighboring leaves close and fasten them together, thus constructing small nests.

The caterpillars feed for nearly two months in the spring before becoming full grown. When this condition has been attained, pupation takes place, either in a partially rolled up leaf, between two or three partially eaten leaves bound together with silk, or even on a leaf or twig, the cocoon in such cases being covered with the woolly growth natural to the smaller twigs or leaf stems. About ten days are spent in the pupal stage, and then the moth appears, and eggs are laid for another generation.

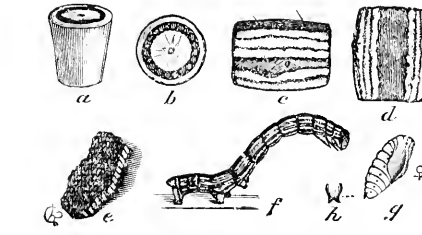
The importance of the bud moth as a pest has not been generally realized by most apple growers, as the estimates of the crop made are usually either from the abundance of the blossoms or from the newly set fruit, and both of these come after

the attacks of the bud moth have caused the blighting of the blossoms.

To destroy the codling moth, we should spray at such a time that the first meal of the tiny caterpillar shall be a poisoned one. Similarly, to destroy the bud moth the spray should be applied to the leaf and flower buds shortly before they open; and as this is also a proper time to spray for certain of the fungous diseases, besides aiding somewhat in the control of the plum curculio, which is now paying altogether too much attention to the apples, a spray of Bordeaux mixture and arsenate of lead, applied to the trees as soon as the buds are beginning to open well, is necessary. Later in the season the habits of the bud moth caterpillar are such as to make it almost impossible to reach them, and this early spraying is our only method of control which is of much value.

Canker Worm.

Whether the Prophet Joel, when he wrote, "That which the palmer-worm hath left, hath the locust eaten; and that which the locust hath left, hath the canker worm eaten; and that which the canker worm hath left, hath the caterpillar eaten," referred to the canker worm of modern times, is unknown; but there are many who can testify that at times the canker worm has left nothing for the caterpillar to take. Fortunately, the canker worms are rarely of much importance in orchards which are carefully watched, and even when abundant they can easily be held in check, because of certain peculiarities of their life and habits.



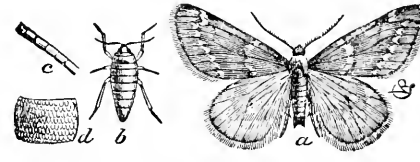
Fall canker worm: *a*, side view of single egg; *b*, top view of same; *e*, egg mass, natural size; *f*, full-grown caterpillar; *c*, *d*, *g*, *h*, structural details.

Both the fall and the spring canker worm are found in Massachusetts, the former being probably the more common, at least in the eastern part of the State. The caterpillar in both species is

what is commonly called an "inchworm;" in both it leaves the tree when through feeding, and changes to the adult moth in the ground; in both the female moth is without wings; in both the eggs are laid on the twigs of the trees; and finally, both the caterpillars feed at the same time of year. Here, however, the resemblance ends.

Fall Canker Worm.

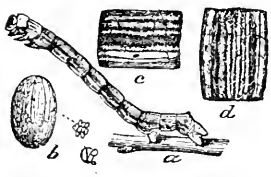
The fall canker worm (*Alsophila pometaria* Harr.) appears late in the fall, coming out of the ground; and the wingless females crawl up the trees to the smaller limbs, where the eggs are laid in clusters. In the spring these eggs hatch, producing tiny "inchworms," which feed on the leaves till full grown, this condition being reached in June. They then crawl down the tree or spin down a thread to the ground, where a few inches below the surface they pupate. Here they remain till the approach of cold weather, when the insects, now in the moth stage, leave the ground and pass to the trees to lay the eggs for the generation of the following year.



Fall canker worm: *a*, male moth; *b*, female moth; *c*, *d*, structural details.

Spring Canker Worm.

In the case of the spring canker worm (*Paleacrita vernata* Peck.) the moths do not appear in the fall, but during the first warm days in March and April; and, like the others, the females crawl up the trees to lay their eggs on the twigs, and it is possible that a cluster of freshly laid eggs of the spring canker worm may be placed close beside a cluster of eggs of the fall canker worm which have been there all winter. The eggs



Spring canker worm: *a*, full-grown caterpillar; *b*, enlarged egg, and part of a mass, natural size; *c*, *d*, structural details.

of both kinds will hatch at about the same time, however, and their feeding will also be completed at about the same period; but, while the spring canker worm will then remain in the ground till the following spring, the fall canker worm will spend but a few months there, the winter being passed in the egg on the twigs.

Spring canker worm: *a*, male moth; *b*, female moth; *c*, *d*, *e*, structural details.

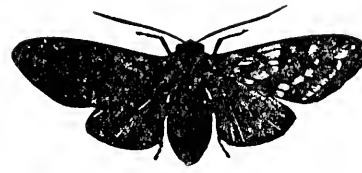
From the above it is evident that any treatment which will prevent the wingless female from ascending the tree to lay her eggs will be successful, and for this purpose sticky bands and metal deflectors are much used. It is essential that no space should be left through which the insect may crawl above the protector, and the bands must not be allowed to dry. For this last reason tar and printer's ink, which were formerly much used, are now being abandoned in favor of tree tanglefoot, while the metal deflectors, which are hard to fit closely to irregular trunks and frequently get out of order, besides being quite expensive, are also disappearing.

The time at which the band should be applied depends upon the species of canker worm for which it is used. As the fall canker worm moth crawls up the trees in October and November, the bands should be put on about the first of October and be kept sticky till about Thanksgiving time. For the spring canker worm they should be applied about the first of March and be kept in effective condition till the end of April.

In case the fruit grower is unaware of the presence of these insects until they have begun their feeding on the leaves, spraying with arsenate of lead will quickly check their ravages; and, as the spraying for the codling moth will have been recently made, both insects will be reached by the same application.

Hickory Tiger Moth.

During the present year the caterpillars of the hickory tiger moth (*Halisidota caryæ* Harr.) have been unusually abundant. Their contrasting colors attract attention against a background of green leaves, and their size when full grown is such that they can consume a considerable amount of food. They feed ordinarily on the hickory, walnut, elm and other shade and forest trees, but at times are quite abundant in orchards, particularly on the plum trees. The moths appear in June, but, as they fly only at night, are not often seen. The eggs are laid in clusters on the under side of the leaves, and the caterpillars at first feed together, but as they grow older scatter in different directions and often to other trees. They become full grown in September, and then seek for sheltered places, where they spin their cocoons in which to spend the winter and following spring till it is time for the moths to appear.



Hickory tiger moth.

The presence of the caterpillars of this insect is not often of any great importance; but when they become so abundant as to defoliate a tree to any great extent, it is well to check their ravages either by a little hand picking or by spraying with arsenate of lead, which will quickly destroy them.

Pear Psylla.

The San José scale, codling moth, canker worms, bud moth and several others of the insects already considered are as likely to be found on the pear as on the apple, but the pear psylla (*Psylla pyricola* Först.) appears to depend almost exclusively upon the pear for its food. This tiny insect, less than a sixteenth of an inch long, and without colors to make it conspicuous, may be abundant in a pear orchard long enough to make its presence seriously felt, and even to cause the death of the trees, without its presence being suspected

unless the owner is on the watch for it. It was probably brought to Connecticut from Europe on an importation of young pear trees in 1832, since which time it has spread everywhere through New England and as far west as Michigan and Illinois.

The insect passes the winter in the winged adult condition, hiding under loose pieces of bark, in crevices, or anywhere it can find protection. After a few warm days in spring the eggs are laid, chiefly near where the leaves of the previous year had been attached to the twigs, and in creases on the bark. The eggs, which are orange yellow at first, are attached to the tree by a short stalk, and are so small that eighty would need to be placed end to end to measure an inch.

The length of time spent in the egg is dependent upon the weather. If this be warm, the eggs may hatch in two weeks; but if it be cold, the young may not appear for over a month. When they do appear, however, they crawl to some suitable place and begin to suck the sap from the tree, seeming to prefer the angles between the leaf and fruit stems and the twigs to which these are attached; and as larger numbers appear later in the season they "overflow" from these places to the under side of the leaves and on the leaf stalks. While feeding, the young produce quantities of a sweetish, sticky fluid called "honey dew," which drops onto stems, leaves or the ground beneath the tree, and gradually dries. Ants, wasps and bees find this material much to their taste, and gather in large numbers to feed upon it. In some cases when the psylla is particularly abundant such quantities of honey dew are produced that it falls like a fine rain, and in any case when it dries it forms an ideal place in which a black, sooty fungus may grow, and this gradually turns such places black, and gives the leaves and twigs the appearance of having been covered with soot. This fungus does not itself attack the tree, but where it is present it and the honey dew close up many of the openings through which the tree obtains its air, and thus indirectly affect its health.

The young psyllas suck the juices from the tree, and molt several times during their growth as their skins become too

small, and after about a month at one of these molts the adult insect is produced. Egg laying for another brood now follows, and the eggs hatch in eight or ten days, because of the warmer weather which has now arrived. About a month later the adults of this brood appear, and we may have as many as four broods in Massachusetts before winter puts a stop to this process.

The effect of the feeding of these little pests upon the trees is to a large degree dependent upon their abundance. In general, trees attacked fail to make much new growth, but remain at a standstill. The quantity of fruit produced and its size are also determined to some extent in this way, while in severe cases the leaves turn yellow, the fruit drops from the trees when partly grown, and many of the buds die. In one case, where a pear orchard in the spring promised a yield of about twelve hundred barrels, the actual yield was less than a hundred.

Numerous methods for the control of this insect have been tested, but only one has given satisfaction, and this is kerosene emulsion. About the 15th or 20th of May, or as soon as the leaves are well expanded and the young have begun their work, one part of kerosene emulsion diluted with twenty-five parts of water, applied with a nozzle which will give a fine mist, has proved very effective against all the young psyllas it reaches; and when a thorough application has been made at this time, the later broods are so small that they may safely be neglected. Where this treatment can be given soon after a heavy rain, the results are better than is otherwise the case, the rain washing off much of the honey dew, which, when it is abundant, somewhat interferes with the best results of spraying in this way.

Peach Borer.

Every one who has attempted to raise peaches has had an unpleasant experience with the peach borer (*Sanninoidea exitiosa* Say); but few are aware that the adult of this borer is a pretty moth so closely resembling a wasp that De Geer wrote of it nearly a century and a half ago: "When I saw

the moth for the first time, I dared not take it with the naked hand, so sure was I that it was a wasp."

These moths begin to appear about the tenth of July in Massachusetts, but specimens are often observed as late as September, indicating that different individuals appear during quite a long period. They fly freely during the daytime, in this regard departing from the habits of most moths, and adopting those of the wasps they so closely resemble.

The eggs of the peach borer are laid during July, August, and perhaps in the early part of September, on the trunks of the trees. As a rule, they are laid singly and on the lower two feet, though in some cases they may be placed higher, and no particular place is selected for their deposition. They hatch in a week or ten days, and the borer at once works its way into the bark, but seems to try to reach the base of the tree for this purpose. During the fall it feeds on the inner bark till cold weather approaches, when it becomes quiet either where it fed or beneath a thin covering it prepares on the outside of the bark near the ground. In the spring feeding is resumed, and most of the borers become full grown in June. They then leave the tree, and at its base spin brown cocoons within which the borer changes to the moth, this change requiring about three weeks. At the end of this period the end of the cocoon is broken open and the moth escapes, leaving its empty case behind.

The work of the borer in the tree is very noticeable after a little time, quantities of gum being poured out from the wounds; and the presence of this gum at the base of the trunk or elsewhere is of itself sufficient to lead to the suspicion that borers are at work there. In such cases the gum should be scraped away, all splits or openings in the bark investigated with a knife, and any borers found in this way should of course be destroyed.

Various methods for protecting the trees from this pest have been tested with varying but usually unsatisfactory results, and the best treatments now known are cutting out the borers about the first of May, then mounding up the earth

around the trunk to the height of about eighteen inches early in June, and leaving this mound till the end of September.

In just what way this mounding prevents the attacks of the borer is unknown, but in such trees their numbers are greatly reduced, and when combined with cutting out in the spring excellent results are obtained.

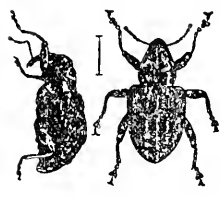
But peach trees should not be the only ones watched for this insect, as it also attacks plums and cherries; and these also should therefore be examined every spring, and any borers found in them be destroyed, to prevent the peach orchard being annually restocked with this pest.

Plum Curculio.

Every plant has its insect enemies, but, though the number of these differs with different plants, in each case one or two are of prime importance. It is probable that nine out of every ten fruit growers, if asked to name the most serious foes of the apple, pear, peach and plum respectively, would agree upon the San José scale; and after this would select the codling moth for the apple, the pear psylla for the pear, the borer for the peach and the curculio for the plum. Yet it is doubtful if more than two or three of the nine persons making this selection would know the adult plum curculio if they saw it. Its small size, its inconspicuous colors and its habits combine to aid it in escaping notice, but the work it does makes this pest an important one.

The plum curculio (*Conotrachelus nenuphar* Herbst.) is a small snout beetle, one of a group containing many important pests, among them being the cotton boll weevil of the south. It appears in early spring soon after the buds open, coming from the protected hiding places in which it has spent the winter months, and, flying to the plum trees, feeds to some extent upon the tender leaves while waiting for the fruit to grow. When this has taken place the beetles pass to the little plums, and here and there deposit their eggs. This process is at least suggestive of the exercise of some in-

telligence. The beetle, having selected the spot where an egg is to be placed, attacks the plum at that spot with its snout, working this in until a hole has been made, and at the bottom of the hole deposits an egg. This egg is very small and also very delicate, while the flesh of the plum at this time is very firm, and as the fruit grows rapidly the hole would soon close up and the egg would be crushed if the process ended at this point. The curculio appears to appreciate this, and to prevent such a result at once proceeds to cut a slit like a crescent in the plum close by the egg. The flesh of the fruit between the hole and the slit is in this way so far cut off from the remainder of the plum that instead of remaining hard it wilts and becomes soft, and in this way all pressure and consequent crushing of the egg is prevented. After an egg has thus been deposited and protected from destruction the beetle moves off to repeat the process elsewhere, each female laying from 50 to 100 eggs.



Plum curculio.

The eggs hatch in a week or so, and each little grub thus produced works into the plum till it reaches the stone, around which it feeds until it has reached its full size, which usually requires about three weeks. During this period the puncture and slit on the surface have nearly always become at least partly covered by gum which has escaped from these places, the gum accordingly marking where the curculio has been at work; while the feeding of the grub around the stone very often injures the plum so that it falls off at about this time.

This dropping of infested plums is very convenient for the grubs in them, for when these are full grown they generally find themselves on the ground with the fruit, which they now leave, working their way into the soil a short distance, where they pupate and after about a month reappear, now as the adult beetle. If the plum has not fallen the same thing happens, except that the grub falls alone instead of inside the fruit. How the adult beetles pass the fall is not known, but, as they are not noticed on the trees at this time except per-

haps for a few belated individuals of the first brood. it is not probable that they are doing much injury except where they puncture apples for food. When cold weather comes it seems certain that they find hiding places to spend the winter.

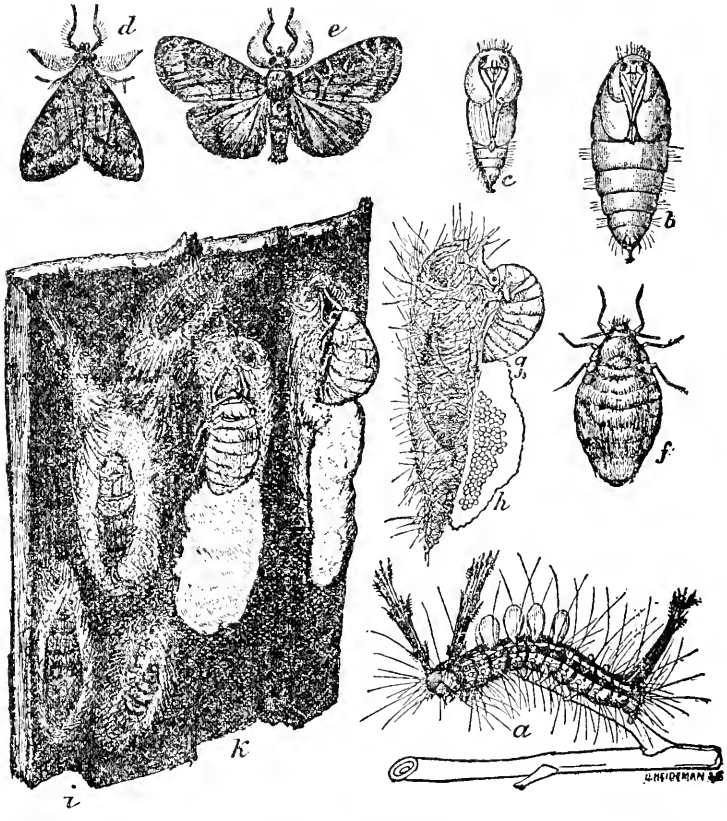
During years when these insects are abundant, 70, 80 or even 90 per cent of the plums may be destroyed or injured by their attacks. Not satisfied with this, they puncture cherries and apples also; and recently their work on the latter fruit has become so marked that the plum curculio is now considered quite an important apple pest. It lays its eggs in the fruit, causing many apples to fall off early, and the beetles which are produced in the summer also feed upon them, producing unsightly blemishes which seriously reduce their value.

No one method of treatment will suffice for this pest. Spraying with the arsenate of lead just before the blossoms open gives good results, as the leaves, upon which the beetles feed more or less while waiting for the fruit to form, will thus be covered with poison. In the case of the apple this treatment combined with Bordeaux mixture has already been advised for the bud moth, so it is not in reality an addition to the treatments. A second spraying after the blossoms fall should also be given, and has already been advised for the control of the codling moth; and the second spraying for this pest will also help control the curculio.

It is very possible, however, that these treatments may be only partially successful because of rainy weather, and it is often desirable to resort to the "curculio catcher." This is practically a large frame covered with white cloth, placed beneath the tree, which is then suddenly jarred. During the greater part of the day and even during the warm nights the curculios fly quite freely, but for some reason they are very sluggish early in the morning and about sunset. At such times they will fall from a jarred tree without taking flight, and may easily be gathered from the cloth beneath and crushed.

As many of the grubs fall to the ground in the fruit, and all of them enter the ground to pupate, fowls and hogs per-

mitted to run through the orchard, as was suggested for the apple maggot, will destroy large numbers of these insects; and spraying, jarring and the utilization of these animals will, taken together, be an effective check upon the ravages of the plum curculio.



White-marked tussock moth: *a*, caterpillar; *b*, female pupa; *c*, male pupa; *d*, male moth; *e*, same, wings spread; *f*, female moth; *g*, female moth on cocoon; *h*, egg mass with froth over it; *i*, cocoons on tree trunk; *k*, same, showing females and egg masses also; all slightly enlarged.

Tussock Moth.

The fruit grower who examines his trees during the winter months will frequently notice a dead leaf still adhering to some twig, and this should at once arouse his suspicions that insects are present. Sometimes the leaf is one which has for some reason retained its normal attachment to the

tree; but an examination will usually show that it has been fastened in its position by silk threads, and that a cluster of eggs is also present. If the eggs are in plain sight, they are probably those of the old tussock moth (*Notolophus antiquus* L.). If only a hard white crust shows, however, in which the eggs are concealed, this is an egg cluster of the white-marked tussock moth (*Hemerocampa leucostigma* S. & A.). Both of these insects are quite general feeders, but are often found on fruit trees; and their egg clusters are frequently mistaken for those of the gypsy moth.

White-marked Tussock Moth.

The eggs of the white-marked tussock moth are laid in the fall, often on twigs, but perhaps more frequently on the trunk or limbs of the tree on the old cocoons from which the female moths have escaped. The eggs are covered with a white froth which rapidly hardens, forming a crust which entirely conceals the eggs, but which is itself very conspicuous. The winter is passed in this condition, the eggs hatch in the spring, and the caterpillars feed upon the leaves until they are full grown, this condition being reached sometime about the middle or end of June. They now spin their cocoons on the trunk, limbs or twigs, and in this stage remain for two or three weeks, at the end of which time the moths escape.

The male moth is winged, and flies freely; but the female, being wingless, remains on the cocoon from which she escaped, and on this cocoon lays her eggs for a second brood, covering them with white froth, and dies upon the completion of this process.

The eggs thus laid soon hatch, and the caterpillars feed till the middle of August, when they also form cocoons, from which the second brood of moths escapes about the end of the month. Egg laying then follows as before, but these eggs do not hatch till the following spring. Frequently in Massachusetts these times of change come a little later, and the eggs laid in summer do not hatch until the following spring, giving us one brood a year instead of two.

Old Tussock Moth.

The life of the old tussock moth is so similar to this that it need not be outlined; but the caterpillar, though bearing the tufts or tussocks which have given these insects their name, is quite different, its color being more quiet and rendering the insect less noticeable.

Destruction of the egg masses by hand is generally easy as a method for the control of the tussock moths, and, as they remain on the trees from September until the following spring, there is plenty of time available for their removal. If the insects are first noticed while feeding, however, the sprays of the codling moth should prove entirely efficient to hold them in check, and it is only where neglect prevails that the tussock moths are of much importance for any length of time.

Summary.

Though eighteen insect enemies of our fruit trees have just been considered more or less in detail, these form but a small part of the total number of the foes the fruit grower has to meet. Nearly four hundred different kinds of pests may feed upon the apple, while the pear, plum, peach and the other fruit trees all have their share. That this alone should discourage the fruit grower is but natural, but a little consideration will show that each treatment is effective for several different insects. Bringing these together it becomes evident that for the apple spraying with arsenate of lead and Bordeaux mixture just before the blossoms open, again a little less than a week after they have fallen and again about two weeks later, should give a large measure of relief from most of the important pests except scale insects; while for these one winter wash of the lime and sulphur mixture thoroughly applied will be sufficient to check the San José scale, and a mild soap wash in June should accomplish the same result for the others. And if it still seems as though the odds are against the fruit grower in Massachusetts, we must remember that equally serious foes, most of them the

same, occur in the west, but do not prevent the man who means business from raising his fruit, shipping it to the east at high cost and selling it at high prices. The Kansas, Iowa and Oregon fruit growers have few advantages over those of Massachusetts; while the latter have home markets, cheap freights and a climate and soil not excelled anywhere in the world for this purpose. The real difference to-day is that the western fruit sold here and exported is produced by business men who are in this business for every cent it is worth, who apply business methods to every part of their work, and who propose to furnish the finest fruit for the highest prices. How long this shall continue depends entirely upon the ability, energy and enterprise of the Massachusetts farmer.

THE STORAGE OF APPLES.

F. C. SEARS, PROFESSOR OF POMOLOGY, MASSACHUSETTS AGRICULTURAL COLLEGE, AMHERST, MASS.

To any one who will study the orchard industry of New England to-day, it is very evident that few branches of the business stand in greater need of improvement than our storage facilities. We have made and are making great advances in the growing of apples; there has been a marked improvement in the packing of our apples (largely through the influence of the New England fruit shows); and our marketing methods are developing every year; but in storage facilities and methods there has been little advance and less study. The writer is glad to see that the State Board of Agriculture is disposed to begin a campaign for better storage. We surely need it.

The chief advantages of good storage facilities, looking at the problem from the standpoint of the growers, are: —

First, that it makes the orchardist relatively independent when it comes to selling his crop. If the buyer knows that the grower has no satisfactory place to store his apples, he will naturally hold back in the hope that the need of a prompt sale will lower the owner's notion of what his apples are worth. On the other hand, if both buyer and seller realize that the apples are safe, that there is no need of haste in disposing of them, the price is far more likely to be a reasonably profitable one to the man who grew the fruit. In fact, good storage facilities put the transaction on the ideal plane, — perfect equality of buyer and seller. If they can agree on a price, well and good; if not, the apples can stay where they are. This comfortable feeling of independence is worth to the orchardist all that the storage will cost, and he gets his additional price as a clear profit.

Second, better storage will, of course, keep the fruit in better condition, and it will therefore sell for more when it is disposed of.

Third, the consumer will be better pleased with what he gets and will be more likely to want another barrel. Every business man realizes that there is no advertisement like a pleased customer, and the difference between a crisp, juicy, well-kept apple and one which is simply *sound* must be appreciated. In the one case you want to eat another apple at once; in the other, you don't care how long you go without another!

And fourth, good storage delays the marketing of the apples and so improves the price. Baldwins, for example, are almost certain to be higher in December than they are in October, and higher in February than they are in December. Nothing is more demoralizing to prices than to have good stock forced into competition with the windfalls and other poor stuff which is pushed onto the market in the autumn.

In considering this question of the proper storage for apples we ought to keep in mind the fact that the ordinary function of a storage plant is to hold in check the ordinary life processes in the apple. These processes are always accelerated when the fruit is picked from the tree, and they end (so far as we are interested in them) when the apple becomes unpalatable. The very low temperature of the refrigerated room allows these life processes to proceed, but at the very lowest rate, and as the temperature rises the rate increases.

The ideal storage ought to have the following points emphasized: —

First, a relatively low temperature. So far as I am aware the exact temperature at which apples will freeze has not been determined, but it is probably somewhere below 28 degrees Fahrenheit. The ideal temperature for the storage of apples is probably from 30 to 32 degrees, but with good fruit very satisfactory results can be secured at 35 or 36 degrees.

Second, a constant temperature. Where the insulation of

the storage room is poor, the temperature, of course, rises and falls with the temperature of the outside air, and this is one of the chief objections to storing apples in ordinary cellars and rooms which are poorly insulated. The speaker once had experience with a storage room in which it was necessary to use an oil stove to keep the fruit from freezing during severe weather. As it was unsafe to keep this stove lighted at night, the temperature of the room would fall to nearly freezing by morning; then the stove would be started and the temperature would rise to nearly 60 degrees by night. The result was that the apples kept very poorly. The next year we put in furring strips along the walls and lined the room throughout with building paper, and the result was that with this improved insulation we could hold the temperature almost constant, even in severe weather, and our apples kept splendidly.

Third, the apple storage ought to have a relatively high degree of moisture. Just what this per cent is the speaker is not prepared to say. Mr. Madison Cooper, a recognized expert on such matters, gives 80 per cent as about right. What the speaker *does* know is, that in the Annapolis Valley, Nova Scotia, two growers who were especially successful in keeping their apples employed the following methods: one had a stream of water running through the storage room, and the other was in the habit of wetting down the storage-house floor (and even barrels in which Russets were stored) with the hose.

Fourth, the storage must be convenient for getting the fruit in and out. Few growers realize how much time is consumed in getting the apples into the storage, where they must be carried, one barrel at a time, down the cellar stairs. An elevator is usually the best method to use, though sometimes the barrels or boxes may be slid down an outside hatchway.

Fifth, the building must be reasonable in price. Just what constitutes a reasonable price of course varies. The cost will also vary with different localities, and the price that a grower can afford to pay and still make a profit will vary. But if an orchardist expects to store his apples in a

refrigerated building he can probably put up his own, if he is a large grower, cheaper than he can rent space in a commercial house. The usual price for the storage of a barrel of apples during the season is 40 to 50 cents. Assuming that a man is growing 1,000 barrels of apples he would pay $500 for storage, which is 5 per cent on $10,000. Now it is usually considered that a refrigerated plant can be put up for from $2.50 to $3.50 per barrel capacity, so that the man who is raising 1,000 barrels and putting them in cold storage is paying the interest on a plant that would store from 2,000 to 4,000 barrels.

Sixth and lastly, the plant must be operated cheaply. I propose to tell you what our college plant has cost. Others will vary of course, but to be profitable the plant *must* be reasonable in running expenses.

For our purpose this morning we may classify apple storage under three heads: —

1. What is ordinarily known as "frost-proof storage," where the temperature of the outside air is depended upon to bring the temperature of the room down to the desired point.

2. Refrigerated storage, in which the "cold" is produced by means of ammonia or some other gas.

3. Refrigerated storage, in which the "cold" is produced by ice.

The writer believes that all three of these systems are adapted to the fruit business, but especially the first and last; and as the college has recently installed a plant in which there is a combination of these two methods, it is proposed to spend a little time in discussing them.

The "frost-proof" section of our building includes three large rooms, with a combined capacity of some 2,000 barrels. The windows are equipped with heavy insulated shutters which may be easily closed when desired, and our method of handling the rooms is to start in the autumn and keep the windows open whenever the outside air is colder than that in the room. As soon as the outside temperature goes up the windows are promptly closed, and by careful attention to this plan the temperature may be forced down to a reason-

ably low point surprisingly early in the season. At the present time the temperature stands at 36 degrees in our large room, which is a good storage temperature, though of course not as good as 32 degrees; and it must be remembered that we have had relatively little cold weather this season during which the temperature in the room could be lowered. Last winter the temperature in this room on the 10th of January was 32 degrees, and it had risen only to 38 degrees on April 1. This is an extremely good record, and while it is *not* equal to a refrigerated room in which the temperature can be kept at 32 degrees without any variation at all, it certainly *does* keep apples well. For good, sound fruit of the late-keeping varieties, like the Baldwin and Spy, I believe that it has a distinct place of its own and a very useful place, and I believe, further, that any farm storage ought to include some rooms which are handled in this way, for it is, of course, much cheaper than refrigerated storage.

The balance of our rooms are refrigerated with what is known as the "gravity brine system," a patented method of refrigeration. For each room to be refrigerated there is located in the attic, or penthouse, a small vat or bunker lined with galvanized iron, in which is located a coil of pipes filled with a brine made by dissolving calcium chloride in water. This brine is made to test about 25 degrees on the Beaume scale, or about 4 pounds of the calcium chloride to 1 gallon of water. This makes a brine which will withstand a temperature of 10 degrees below zero without freezing. This coil of pipes in the vat (known technically as the "primary coil") is connected by two pipes (a "flow" and a "return") with a similar coil (known technically as the "secondary coil") in the room below, which is to be cooled. This secondary coil is hung from the ceiling of the room, either in a single section against one wall, in small rooms, or in several sections distributed through the room, in larger rooms. The flow of the brine in the pipes is controlled by suitable valves in the rooms to be refrigerated. When it is desired to cool one of the rooms, the connected bunker in the attic is filled with a mixture of broken ice and salt, using a coarse salt with particles the size of the end of one's little

finger. The ice is broken up in the ice room and hoisted to the attic in a large bucket holding some 400 or 500 pounds. This bucket, filled with ice, is then run along on a track (which extends the whole length of the penthouse) until it stands directly over the bunker to be filled, when it is tipped and the ice dumped into the bunker. Salt is then thrown in on top of this ice, another bucket of ice is put in, followed by more salt, and so on till the bunker is full. The amount of salt used varies with the temperature desired and with the outside temperature. It will ordinarily run about 5 to 8 quarts to each bucket of 400 pounds of ice. If at one icing 6 quarts of salt have been used and the temperature has not run quite low enough, more salt is used at the next icing. The temperature is also regulated by the valves located in the storage rooms which control the flow. If more "cold" is desired these valves are opened; if less, they are closed. With a little experience the system can be run very easily and very accurately. In our college plant the work is practically all done by the ordinary day laborer of the department. The foreman merely keeps track of the temperature from day to day, and gives directions as to the quantity of salt.

As to the working of the system, it is exactly the reverse of the ordinary hot-water heating system used in dwelling houses. In the latter the furnace is located in the cellar and heats the water, thereby rendering it lighter. This lightweight hot water then flows out through certain pipes and is replaced by the heavier cold water which comes down through other pipes from the rooms above, where it has been cooled off, or, in other words, where it has heated the air of the rooms. Now in this gravity-brine system the brine is cooled by the ice and salt in the bunkers and is thereby rendered heavier. It therefore flows down, and by its greater weight forces out the warmer brine in the secondary coils of the storage room, and is itself warmed up by absorbing the heat of the room and its contents. The frequency with which icing is required depends on the outside temperature, on the temperature desired in the rooms, and also on the frequency

with which new, and therefore warm, fruit is brought into the room. When the same fruit stands in the rooms for a long time it may not be necessary to ice more than once a week even in fairly warm weather. Where fruit is constantly being brought in and taken out again for shipment, it will usually be necessary to ice daily. On the other hand, it ought to be iced every day in warm weather (possibly twice a day in very warm weather) and every other day during autumn weather.

The great advantages of this system as thus far developed here at the college are the cheapness with which it can be run, requiring no high-priced engineers; the fact that any one of the rooms may be run without the others, thereby reducing the cost proportionately; the fact that there is no costly machinery to get out of order and cause large repair bills, and, most of all, the fact that it works satisfactorily, — that it "delivers the goods." Of course, it is especially adapted to those sections where natural ice may be secured.

The cost of ice will vary greatly according to the distance it has to be hauled, what the cost of labor is, and what, if anything, has to be paid for the ice. In filling our ice room at the college this year we put in approximately 250 tons, and the cost was as follows: —

Two men with double teams, eleven days, at $4.50 per day per team,	$99 00
Two men stowing ice, twelve days, at $1.75,	42 00
Ice,	28 00
Total,	$169 00

We have two refrigerated rooms of a capacity of 80 and 275 barrels, respectively, which we usually operate together. It takes two men from an hour and a half to two hours to ice these two tanks.

I want to close this paper with a short discussion of some of the factors which influence the keeping of apples in storage, for while a good storage house is very important, it must not be expected that it will take the place of care and proper methods in the growing and handling of the fruit.

1. I believe that by all means the most important single factor is the careful handling of the apples from the time they leave the tree until they are sent to the consumer. This would include, especially, care in picking, in packing and in handling the packages. In picking, the apples ought never to be tossed into the basket, and if they are poured into the box or barrel (which I believe ought not to be done with really choice fruit) the greatest care should be exercised to prevent bruising. In Hood River, Ore., I was told that they use galvanized pails for picking because the smooth, rigid surface does not bruise the apples, and because the picker who tosses the fruit into the pail can be located easily by the noise he makes. I believe that we might adopt the pail here to advantage. We certainly ought to banish the bag as a picking receptacle. In packing, the apples ought never to be handled roughly. The speaker recently saw one of our good orchardists packing apples in barrels. He had a packing table with a small opening at one end. A barrel was placed under this opening and the apples were allowed to drop from the table into the barrel. How many of them do you suppose escaped serious bruising? In one of our best orchard sections this autumn a large part of the fruit was bought by a dealer who used large slatted crates which held a barrel. The apples were hauled to the car in open barrels, the crates placed in position, and the apples poured into them like so many potatoes and the slatted cover nailed on. The speaker took the pains to examine one of these crates. On pressing one of the slats away from the fruit every apple which touched the corner of the slat was found to have a long bruise with the skin broken. These apples were going into storage and were eventually destined for the New York market. How well do you imagine they kept? And how much did they increase the demand for apples?

These are merely some isolated cases that have recently come to the speaker's notice. Hundreds more might be easily cited. This matter of careful handling has been dwelt upon because it is the all-important factor.

Some recent investigations by the United States Depart-

ment of Agriculture on oranges have shown that while fruit carefully picked and packed gave only 2 per cent of decay at the end of three weeks after arrival, that taken from the ordinary commercial picking and packing showed 16 per cent.

2. The second important factor is delay in getting the fruit into storage. This factor applies especially to fruit which is to go into refrigerated storage. As before suggested, the life processes are accelerated as soon as the fruit is picked *if* it remains at an ordinary temperature. It ought, therefore, to be hustled into the coldest storage available. If "frost-proof" storage is used the temperature ought to be brought down as rapidly as possible in the autumn, so as to be ready for the apples as they are picked. Of course this damage from delay is more serious when the autumn is warm. Powell states that Rhode Island Greenings, Kings and Suttons, picked September 15 and stored within three days, kept in good condition till March, while the same varieties handled in the same way, but not put in storage for two weeks, were badly decayed by January 1. Their commercial value was injured from 40 to 70 per cent by the delay.

3. Fungous diseases stand third among the factors influencing the keeping of apples. The most serious of these are the molds and apple scab which develop very rapidly under favorable temperature conditions. Molds cannot gain entrance to sound fruit and scab can, of course, be controlled by spraying. But we all know that it frequently *isn't,* so that these fungous troubles become a serious menace when either the conditions of the fruit or the storage are not good.

4. Maturity of the fruit when picked. There is no question but that this exercises a very decided influence on the keeping of apples but just what degree of maturity is best has not yet been determined. There is a very general impression that the longer apples are to be kept the greener they ought to be when picked, but this is certainly a mistake. As nearly as one can give a general rule, it is probably safe to say that apples will keep longest if picked when they are fully matured and well colored, but while they are still

firm in flesh. It would seem that it ought to be possible to tell beforehand the approximate date at which the different varieties of apples should be picked by knowing the mean temperature of the growing season, and our department is working on this problem at the present time.

5. There is no question that soil and cultural conditions exert a very profound influence on the keeping of apples. A light soil will give fruit of poorer keeping qualities than a heavier soil, and apples from a cultivated orchard are liable not to keep so well as the smaller and firmer fleshed apples from sod orchards.

6. The type of package used will certainly exercise a decided influence on the keeping of the apples. The writer believes that the ideal storage package is a tight bushel box with a tight cover, or so arranged that one box covers the one below it. When barrels are used in comparison with boxes it will almost always be found that the greater mass of fruit in the barrel, generating, as it does, more heat and having greater weight, will *not* keep as well as the same fruit in a box, and for apples the ventilated package is certainly not as good as the closed one.

7. Lastly, a wrap will certainly help to prolong the life of the apple. The speaker has frequently kept Baldwins in ordinary storage in prime condition up to May by wrapping each apple in paper.

There are still many storage problems left to solve, — what type of storage shall it be; shall it be located in the orchard section or in the city; shall it be a large central plant or smaller ones on the farm? But this much is settled definitely in the speaker's mind, that some type of modern storage, at least part of it refrigerated, is a prime necessity if our orchard men are to get the most out of their crops.

Mr. Trull. I know we have all enjoyed the paper from the attention I have seen you give it. Professor Sears will be glad to answer any questions.

Mr. Abner Towne. Would it be practicable for a neighborhood or a community to unite and have a common storage plant?

Professor SEARS. That is a point which I neglected to touch upon. It is the practicable solution of this question, where you have a neighborhood with a common interest. When in any section there are a number of men interested, we ought to get some type of storage plant started. It is only the large growers who can afford to establish such a plant individually.

Mr. WILFRID WHEELER. I would like to inquire about a style of storage which I think is of importance. This is what you might call ordinary ice-house storage. There are several modifications of this, and the most common one that I have in mind is where the ice chamber is high up in the air and a good-sized room is located directly under it; there is another type where the storage room is built inside the ice house and ice packed all around it. I have several of these types in mind, and I think they make a fairly good sort of storage. I would like to ask Professor Sears what he thinks of that type of house.

Professor SEARS. Mr. Chairman, I am glad that Mr. Wheeler raised that question. I had a little personal experience with one, the type where you have ice storage overhead. I think it is all right and will give pretty good storage facilities; but from my experience, which is rather limited, it is rather hard on the ice supply. We had one at the college and the ice usually gave out about the time we needed it the most. If a man had a better type of building and more ice he would get around that difficulty. I think it is a little wasteful of ice, but there is no question about its being efficient if you have a good building, and I presume that if one had his own ice pond, and the ice wasn't costing much, it would be very satisfactory.

Mr. WHEELER. Would you break up the ice in the tank of your storage house or just put in the whole cake?

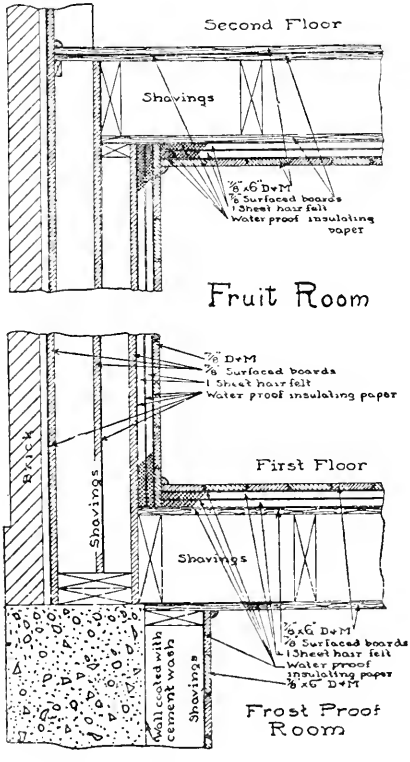
Professor SEARS. Break it up; this has to be done in order to get the salt in through the ice and produce the proper amount of cold.

Mr. WHEELER. Is the temperature lower when the apples are in barrels than when they are loose? Will they freeze quicker loose than in barrels?

Professor Sears. They would freeze more quickly loose simply because the cold air can get at them more quickly. I suppose that if you put in too much salt and get the room too cold the loose apples would freeze much more quickly than those in the barrels, simply owing to this fact, — the barrel is quite a protection because it doesn't allow the air to circulate quite so freely. I think in that connection all fruits, certainly all apples, should be stored in tight packages. I don't believe in the ventilated packages.

Mr. Munroe Morse. Do you have separate bunkers for each room, or are all the rooms supplied from one bunker?

Professor Sears. We have six of these bunkers and each has its coil of pipe, and that coil is connected with a separate room, one bunker and one pipe for each of the six rooms.



DETAIL OF INSULATION

The above diagram shows the type of construction of the walls of the refrigerated rooms. The walls of other parts of the building are much less complicated.

Mr. H. L. Frost. Should the storage room be below the ground?

Professor Sears. If you can get it below the ground the temperature will fluctuate much more slowly, and it is very desirable so far as insulation is concerned. The 10th of January last year broke all records outside, and the temperature in the underground room I refer to then stood at just 32; we kept it closed, and it rose gradually to 38 on the 1st of April. It took it all that time to rise from 32 to 38. If it had been above ground it would have risen much more rapidly, even with the best of insulation.

Dr. H. J. Wheeler. I would like to ask the speaker whether the use of a wrapping paper which was impervious might not be better than a wrapper which is very porous as it would prevent the evaporation of moisture?

Professor Sears. We have not taken up that matter. The wrapper is largely for holding moisture in the apple, and I should suppose that if something impervious, like an oiled wrapper, were used, it would be better than ordinary paper, as it would hold the moisture better.

Dr. H. J. Wheeler. I wish you could get your chemist to study the skins of apples exposed to the sun and those not exposed, in order to ascertain what the difference is. It is a most remarkable difference.

Mr. Frost. Doesn't the question of moisture have something to do with it?

Professor Sears. If you have plenty of moisture the open package would be all right if you kept the room moist enough. The conditions are controlled with the closed package, however, a good deal better than they can be controlled over the entire room.

Mr. C. P. Greenwood. Will a perfectly sound apple be injured by contact with rotten apples?

Professor Sears. I think it would depend on what was causing the rot. If it were merely a breaking down, a physical change, going on in the rotten apple, I shouldn't think it would hurt. It would hurt the taste, of course. But if it were being destroyed by mold then the germs of that mold would be very likely to get on the other.

Mr. Greenwood. I heard a fruit grower say some time ago that he didn't believe a perfectly sound apple was injured by a rotten one touching it.

Professor Sears. Perhaps not if you have a perfectly sound apple without a break or weak place on the surface, as mold or disease probably wouldn't get in. The flavor would probably be tainted, as it is in the case of a partly decayed apple.

Mr. F. A. Russell. I would like to ask if in the construction of a cold-storage plant it would be economical or advisa-

ble to construct a building large enough to hold other things, vegetables, say, in conjunction with the fruit, so that you could store everything that you raised, beets and onions and parsnips and cabbages, in the same building?

Professor SEARS. That would depend altogether on the circumstances. If a neighborhood were growing all these different things and were keeping them there I think it would be very desirable to have them provided for in the building. We have both in our storage building, but there is only one door between the two compartments and that is kept locked. Care must be taken that the odors don't get from the vegetables into the fruit compartment. This is a danger which can be easily avoided, and I think it is a very satisfactory arrangement, because you can put up your vegetable storage a good deal cheaper if you combine the two than by making it a separate storage.

Mr. JOHN P. BOWDITCH. How much would the investment be to build such a cold-storage plant as the one you have described?

Professor SEARS. The figures I mentioned run all the way from $1.50 to $5 per barrel capacity of the storage; and the general opinion seems to be that about $2.50 is the average cost per barrel. Perhaps if you strike an average of about $3 per barrel you will have it, so that if you want to put up a 1,000-barrel plant it will cost you, complete, about $3,000.

Mr. R. H. RACE. I had an old ice chute on my farm. It was 16 feet long and 20 inches wide inside, of 1½-inch oak slats, 3 inches wide, bolted to cross slats, the bolts being set in so that they wouldn't interfere with the ice. The idea came to me that this could be used in putting barrels of apples into the cellar. I cut a square piece out of an old bran sack, slipped it over the barrel and drew it up with an old strap below the two top hoops, so they wouldn't break open when they were sliding down. I then got two pairs of ice tongs and gave one to each man, and they carried the apples in there just as fast as they could slide them down. It was a very simple arrangement, and I put in 200 barrels of apples in short order. There was no inconvenience, dis-

comfort or damage to either the apples or to the men, and when we took the apples out I used the same device; I took a pair of ice tongs, put a rope through one handle and attached it to the other. I slipped the tongs over the head of the barrel and hitched a horse on with just the right length rope; out came the barrel without bruising anybody's fingers. This is a very simple device which I just stumbled onto and thought I would give it to you.

Mr. G. D. Forrestall. Apples will stand a much lower temperature if wrapped in paper than they will without it, and will keep better. I speak of this for home use, as we cannot all have cold storage.

Mr. Wheeler. I think the question in regard to combining storage that will take in fruits and vegetables is worthy of further discussion. I have often seen the time when asparagus, held back for three or four days, would bring double what it does when there is a glut in the market, and I believe we should have a central storage plant wherever there is a large enough crop in any section to warrant it. I think these central storage plants should be constructed and perhaps run by the farmers themselves. I believe it is perfectly feasible to use the same one for both fruits and vegetables, and I think that farmers should co-operatively build just such storage plants.

Mr. J. J. Erwin. Would such a cold-storage plant be suitable for keeping milk?

Professor Sears. We haven't used it for milk. I don't see any reason why it shouldn't, though. It is all right for anything that wants cold. I don't see why there should be the slightest objection to storing asparagus in the small room, as there is no offensive odor.

Secretary Ellsworth. I think that the farm which is doing a considerable business in a variety of crops can well afford to have a cold-storage plant. There are times in the summer when there seems to be a glut of certain varieties of vegetables, like tomatoes, cucumbers or asparagus, when if they could be held for a few days the farmer could get a great increase in the price. And as for apples, Gravensteins

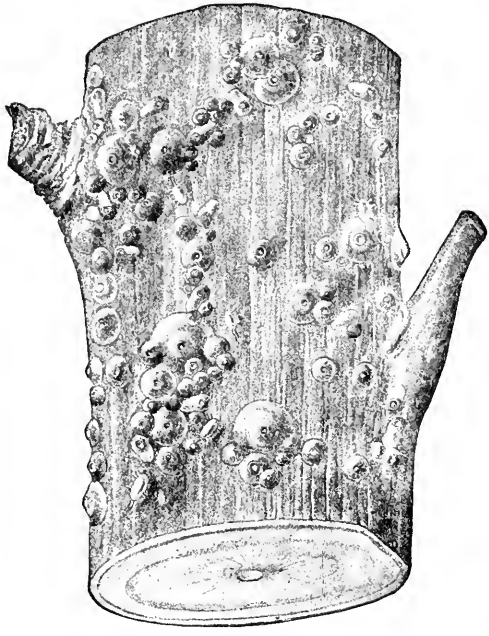
that were selling perhaps this year for 75 cents and $1 a bushel, a little later were selling for one-third more, and I don't know but for double that amount. I know that the added profit would easily pay the interest on the investment.

Mr. G. F. Morse. Would it not be valuable for Bartlett pears? They are a quick-ripening, quick-softening pear, and I should think it would be just as valuable for them as it would for apples. I believe that it could be profitably used for both pears and peaches. In the early part of September, when the Elbertas come along, if a man could hold back a week he would undoubtedly double the price; this could also be done with pears, and especially with Bartletts. It doesn't make any difference what a man is selling, if he can hold back for a few days, say a week to two weeks, he will often double the price received and sometimes even more. Cold storage helps out the other fellow who has not such facilities, also, in preventing a glut on the market. If every grower were equipped with a plant, prices would be better and the fruit season would last longer for the consumer.

THREE COMMON SCALE INSECTS.[1]

H. T. FERNALD, PH.D., STATE NURSERY INSPECTOR, AMHERST, MASS.

Fruit growers often find scale insects (formerly called bark lice) on their trees, and of these there are three kinds which are abundant in Massachusetts. These are known as the San José scale, the oyster-shell scale and the scurfy scale.



Different stages of the San José scale, enlarged five times. (From Virginia State Crop Pest Commission Bulletin, 1904.)

The San José Scale.

This pest, which is the most destructive scale we have, is now generally distributed in the State.

The scale is round (circular) in outline, or nearly so, and when full grown is about as large as a small pin head, highest in the middle and grayish-brown in color. The young are born alive, beginning about the middle of June, and are produced at intervals of two or three days for about a month before the parent dies. The young are very small, yellow, and crawl about for a time till they find a satisfactory place on which to settle. During this time they may crawl on to the feet of some larger insect

[1] Nature Leaflet No. 33, March 31, 1911.

or bird, and thus be carried to some other tree, where they may crawl off and infest that tree, or they may be blown by gusts of wind on to trees near by. When ready to settle down, they work their beaks into the bark till they reach the sap upon which they feed, then begin to produce waxy, white threads on their backs. These threads soon mat together, forming a circular white scale, and to this are added molted skins as the insect grows. These skins and the action of the weather turn the scale gray or blackish, so that young scales may often show black, white and gray, arranged more or less in concentric rings, though they are so small that this can be seen only under a magnifying glass. In a month or less from the time they were born these young have become mature and in their turn are producing young, and there is accordingly an almost continuous production of young from the middle of June till cold weather begins, the process in Massachusetts usually ending before the first of December. At this time there will be scale insects of all ages on the trees, but all the adults and young scales die during the winter, leaving only those which are half or two-thirds grown. The early spring months are used by these in completing their growth, the adult condition being reached and reproduction beginning, as already stated, about the middle of June.

Treatment.

This pest can be successfully treated only during the winter months. Many different methods have been used, but most of these are either worthless or too expensive to be available.

Trees nearly dead can probably be saved by treatment; but this does not usually pay, it takes the trees so long to recover. In most cases it is better to destroy such trees.

Where treatment is advisable miscible oils and the lime-sulphur wash are now much in favor for this purpose.

Lime-sulphur Wash. — This may be made where it is to be applied, or can be purchased ready made. Apparently the home-made material is slightly the better, but this is often offset by the inconvenience or impossibility of preparing it where it is to be used.

Several formulas have been given for making the wash but there seems to be little difference in the results. One good formula is: —

Lime,	20 pounds.
Sulphur,	18 pounds.
Water,	48 gallons.

As spraying is usually done with barrel pumps holding about 50 gallons, this formula is prepared to fill such a barrel.

The lime used should be the best stone lime, freshly burned, and as little slaked by standing as possible. Finishing lime gives excellent results.

The sulphur should be either flowers of sulphur or sulphur flour; stick sulphur will not do. These materials should be prepared in an iron kettle holding at least 30 or 40 gallons, as follows: Place 6 or 8 gallons of water in the kettle, start a fire under it, and slake the lime, getting this as fine as possible in the slaking. When this is well under way gradually add the sulphur, stirring it in well, and keep the fire going to continue the heat begun by the slaking lime. Boil the mixture, adding water as may be needed from time to time, till the color of the liquid becomes dark orange-red. This should take from forty minutes to an hour, the longer boiling seeming to bring more of the sulphur into solution and leaving less sediment at the bottom of the kettle. When the boiling is completed strain the liquid into the spray pump barrel, using a strainer of copper wire of at least 20 threads to the inch, and add any water necessary to make the 48 gallons, and spray. The cooking is sometimes done in barrels by the use of steam led into them, but for some reason this often fails to give as good results as the use of a fire.

If for any reason this home-made wash cannot be made use of, numerous ready-made lime-sulphur washes are on the market, and can be used with quite satisfactory results.

A concentrated home-made lime-sulphur wash is now being used to quite an extent. The method of making, keeping and diluting this for application can hardly be given within the limits of this paper.

Miscible Oils. — Many orchardists are now using miscible oils — often wrongly called soluble oils — instead of the lime-sulphur wash. A satisfactory miscible oil can be made by the person desiring to use it, but the trouble and time necessary are so great that this is not often done, and the oil is generally purchased, ready for use on dilution with water.

A number of different miscible oils are now on the market, and most of them can be expected to give very good results when not too much diluted and when thoroughly applied. Where the scale is abundant the dilution should not be more than one part of oil to fourteen parts of water, though in order to reduce the cost, directions accompanying these materials often direct that one part of oil be mixed with twenty of water. This generally makes the spray too weak to be sufficiently effective.

General Spraying Directions.

In spraying for scale insects thorough work is necessary if satisfactory results are expected. Only those scales actually reached by the spray will be killed, and a very few left on a tree will be sufficient to heavily restock it by the following fall. Formerly a very fine misty spray was considered the best for the work, less of the material being wasted. At the present time the tendency is to use a coarser nozzle, thus making it possible to drive the spray with more force, and also to cover the trees more rapidly with the same thoroughness as that given by the other nozzle. By spraying in this way the loss of material is more than made up by the saving of time and of wages to the men doing the work.

Spraying for the San José scale should be done during the winter months, while the trees are leafless and dormant. It should not be done after the buds have opened in the spring sufficiently to show a green color (or white, in the case of the blossom buds), as the spray is so strong that injury may then result.

Many orchardists are now spraying one winter with the lime-sulphur wash and the following winter with one of the

miscible oils, believing that by an alternation of the two materials better results are obtained. Whatever the material used may be, the spraying should be thorough, and every part of the tree covered with the spray. If windy weather prevents good work, it is often possible to spray one side of the trees and complete the treatment at some later time.

Sometimes summer treatment seems advisable on trees badly affected. In such cases either of the above materials can be made use of, though they should be diluted much more than for winter use.

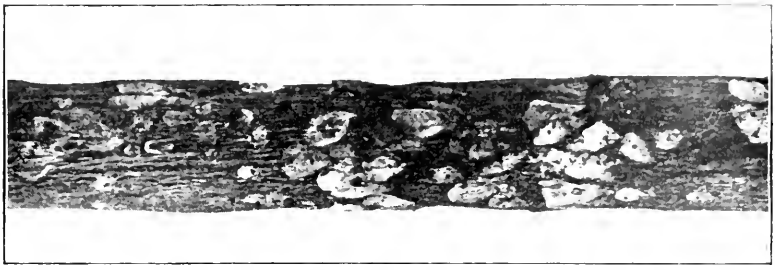
Many other trees besides fruit trees and many shrubs are attacked by the San José scale, but the treatment for these is the same as that given above.

The Oyster-shell Scale.

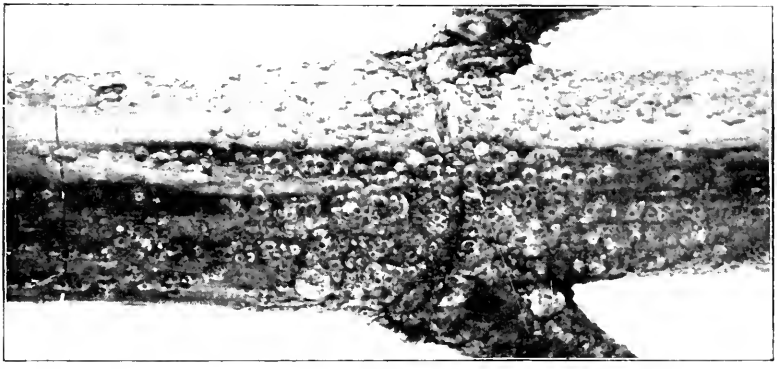
This common pest on apple, pear, ash, poplar and willow trees and lilac bushes is much larger than the San José scale, and is of different form, being long, rather pointed at one end and broader and rounded at the other, and may be curved along its length, the form as a whole suggesting that of an oyster shell, which has given it its name. It is brown or dull gray in color, this last shade being the most common on the ash, willow and lilac.

The life history of this scale is so different from that of the San José scale that the treatment for it is also very different.

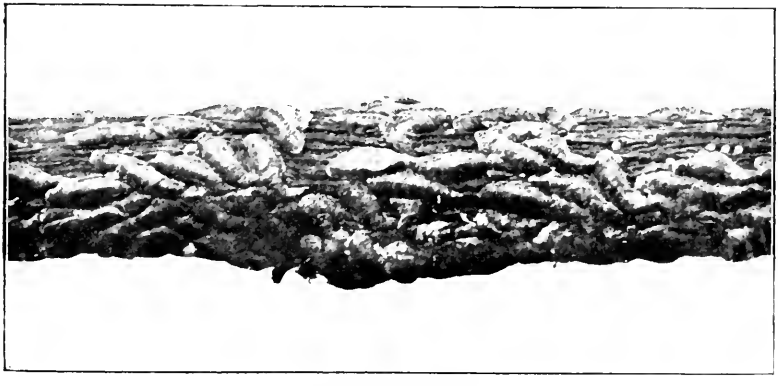
The winter is passed by this insect in the egg. At this time the parent insect which produced the scale lies dead under the pointed end of the scale, and the rest of the space is occupied by from twenty to a hundred tiny whitish eggs. These hatch about the first of June, and the young, which are whitish-yellow, and closely resemble the young of the San José scale, push out from beneath the parent scale and crawl about, seeking for a place to settle and feed. When this has been found a scale begins to form over the back of the insect, and by October it has become fully grown, has laid its eggs behind it under its scale and has died. These eggs pass the winter and hatch the following June.



The Scurfy Scale.



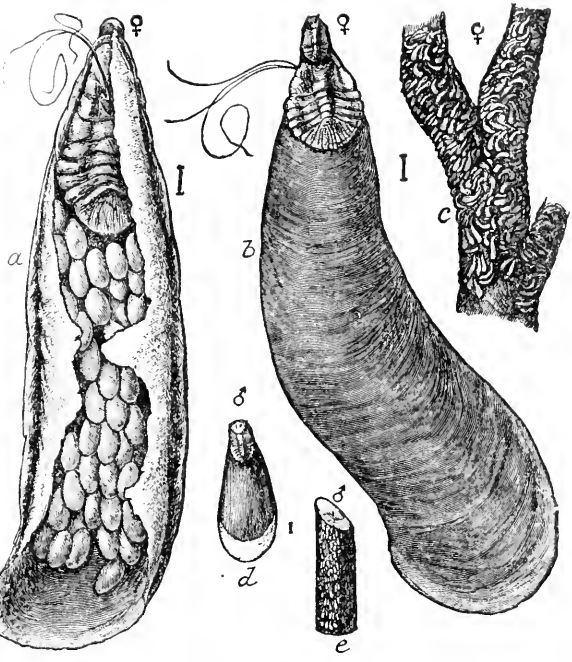
The San José Scale.



The Oyster-shell Scale.

THREE COMMON ORCHARD SCALES (TWICE NATURAL SIZE).

From this it is evident that there is but one brood of these insects each year. Farther south there are two broods a year, and it is possible that there may be two in Massachusetts, in some cases, but, if so, it is unusual.



Oyster-shell scale: *a*, under side of female scale, showing eggs; *b*, upper side of same, both much enlarged; *c*, female scales on a branch, natural size; *d*, male scale much enlarged; *e*, male scales on branch, natural size. The fine lines to the right of *a*, *b* and *d* show the real length of the scales. (Howard, United States Department Agriculture, Yearbook, 1894.)

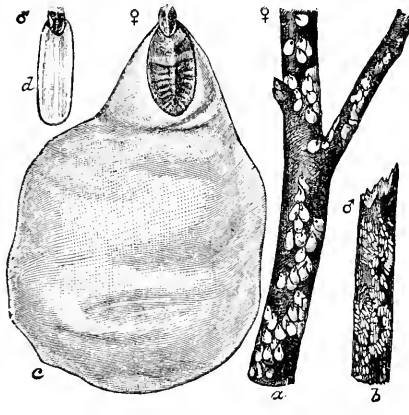
Treatment.

As the eggs of these scales all hatch about the first of June, this fact may be taken advantage of in the treatment. The crawling young are entirely unprotected by any scale, are soft-bodied, and can be killed by spraying with kerosene emulsion or with whale-oil soap, if taken at the right time. The only difficulty is that in order to be destroyed each one must be touched by the spray, and they are very small. This means that the spraying must be thorough.

Whale-oil Soap. — Whale-oil soap, 1 pound; water, 4 or 5

gallons. Spray thoroughly about the first of June, according to whether the season is early or late, and repeat in from ten days to two weeks. This second application will be likely to reach some which were missed the first time, and also any which had not hatched when the first treatment was given.

Kerosene Emulsion. — Hard soap shaved fine, ½ pound; water, 1 gallon; kerosene, 2 gallons. Dissolve the soap in boiling water, then remove from the fire and pour it into the kerosene and churn with a spray pump, turning the nozzle back into the mixture; continue this till the mixture changes first to a creamy, then to a soft, butter-like mass. This will keep for some time. Use 1 part of this mixed with 9 parts of water to spray. If the water used is hard, the emulsion may not form unless borax or soda be added to make the water soft.



Scurfy scale: *a*, female, *b*, male scales, natural size, on twigs; *c*, female scale, much enlarged; *d*, male scale, much enlarged. (Howard, United States Department Agriculture, Yearbook, 1894.)

The Scurfy Scale.

This scale, which is also very common on apple and pear trees, is about as long as the oyster-shell scale, but is broader, rather pear-shaped, and white or grayish-white in color. Its life history is about the same as that of the oyster-shell scale, but the eggs are purple, as are also the crawling young. The treatment is the same as for the oyster-shell scale, and should be applied at the same time.

PLANT LICE OR APHIDS.[1]

H. T. FERNALD, PH.D., STATE NURSERY INSPECTOR, AMHERST, MASS.

There are more than three hundred kinds of plant lice known in this country, feeding on nearly all our common plants, shrubs and trees, and the injury they cause is often serious. They begin their work early in spring, often before the plants they are upon have gotten well started, and, increasing in numbers with great rapidity, do a great deal of damage almost before it is realized that they are present.

Twig of apple, showing plant lice. (About natural size.)

Among the more important plant lice which concern the fruit grower and farmer are the woolly apple louse, so noticeable along scars of the limbs of apple trees in the fall, because of the white woolly threads it forms; the green apple louse; the black louse on plum and cherry; the cabbage louse; the currant louse; the rose louse; the pea-vine louse; and during the spring of 1903 the elm louse and maple louse.

The life history of some species of these insects is quite

[1] Nature Leaflet No. 18, Nov. 1, 1906.

different from that of others, so that only general statements for the group as a whole can be made.

As a rule, plant lice pass the winter in the egg stage, the eggs being attached to the stem or twigs of the food plant. In the spring the eggs hatch, and the tiny aphids, which are green, brown or black, soft-bodied, wingless forms, with six legs, begin to feed, sucking the juices from the twigs or leaves. This is done by means of a pointed beak, the tip of which is pushed through the bark or epidermis till it reaches the sap. In the course of a few days each little aphid becomes adult, and begins to produce living young at the rate of three or four nearly every day. These in their turn feed, grow and reproduce, and in this way many generations appear during the summer. One or more of these generations may develop wings and pass to other plants, in this way spreading over the entire region. In the fall the last generation does not produce living young, but lays eggs instead, and these winter over, hatching the following spring.

The rapidity with which plant lice increase is of importance, as but a short time is required after the first individuals appear for a plant to swarm with them; and when this occurs, treatment becomes more difficult. This is because in many cases the effect of their feeding is to cause the leaves on which they are to curl, thus protecting the lice so that they cannot be reached by a spray.

Plant lice produce a sweet, sticky fluid, known as honey-dew, from two small tubes on the upper side of the body, and ants are very fond of this, visiting the lice and gathering it from them. If the honey-dew falls on the leaves and twigs, it makes them sticky, and it is sometimes produced so abundantly as to fall to the ground with a pattering sound like rain. This substance forms an excellent place for the growth of fungus, which turns the honey-dew black, and accounts for leaves and twigs having a smutty appearance, particularly in the late fall and early spring.

Treatment.

As plant lice suck plant juices, no poison like Paris green or arsenate of lead is of the slightest value, and something that will destroy these insects by touching them is necessary. Such a substance is kerosene emulsion, which kills by covering the body of the insect with a thin film of oil, and suffocating it. In order to obtain good results with this material, however, it is necessary to touch every individual, which it is exceedingly difficult to do, even when the insects are not protected by the curling of the leaves, because of their small size. To treat for plant lice successfully, therefore, spraying should be begun as soon as the lice appear; and, as most of them are on the underside of the leaves, the spray should be directed upward, to reach as many as possible.

Of the many ways of making kerosene emulsion, the following is probably the best: —

½ pound of hard soap, shaved fine.
1 gallon soft water.
2 gallons kerosene.

Dissolve the soap in the water, which should be boiling; remove from the fire and pour it into the kerosene while hot. Churn this with a spray pump till it changes to a creamy, then to a soft, butter-like mass. Keep this as a stock, using one part in nine of water. If the water is hard, add a little soda or borax before churning.

In some cases a strong stream of cold water thrown from a hose upon an infested plant is quite effective, knocking off and killing the lice; and sometimes spraying with very strong soap suds is also successful.

In the case of the pea-vine louse it is difficult to reach the insects by spraying, and here the best practice is to follow along the rows on a hot day with a branch from an evergreen tree, and switch the lice off the vines onto the ground, which can be easily and rapidly done. A cultivator should then follow along the rows, and, by loosening the hot dry soil in this way the lice will be dried up and die before they can return to the plants from which they were switched off.

APPLE DISEASES.

GEO. E. STONE, PH.D., BOTANIST, MASSACHUSETTS STATE BOARD OF AGRICULTURE, AMHERST, MASS.

The unusual interest now being shown in the renovating and planting of orchards has stimulated a desire on the part of the orchardist to know something of the different diseases affecting trees. For a long time before this the apple industry had been on the decline, and thousands of neglected apple trees could be found in the State bearing inferior fruit and affected with innumerable troubles foreign to well-cared-for orchards.

For years we have been observing different orchards, with particular reference to diseases and the results obtained from the systematic use of lime and sulphur and arsenate of lead. With the advent of the new interest in orcharding, and the consequent renovation of old trees and extensive pruning, spraying, cultivating and fertilizing, diseases have become much less prevalent.

A few years ago it was the practice to spray apple trees six or seven times a season, without much regard to whether it was necessary or not; but pruning and cultivation, etc., are fully as important as spraying, which should be done only with some definite object in mind. It is true that progress in the successful management of orchards has often been hindered by a too liberal practice of spraying at the sacrifice of other methods, and to-day many growers are obtaining good results with only two or three sprayings.

The experience and skill of intensive farmers have been of great aid in determining the cause of and methods for controlling certain diseases, and it has been demonstrated that many factors other than spraying help to produce healthy

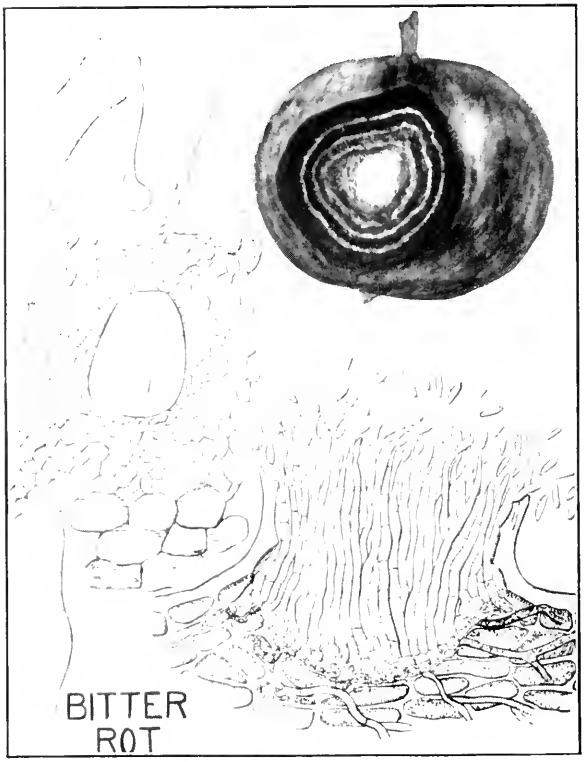


FIG. 1. — Bitter rot of apple.

crops. There are a number of fungous diseases occurring on the apple, some of which are parasitic; others follow mechanical injuries, and still others come about from various causes. The number of diseases affecting our cultivated crops is constantly increasing, most of them being introduced from other regions through commercial activities. Some apple diseases have been with us for many years, but just how long it is hard to learn in many cases, although some of the early works on fungi do not refer to them. The early agricultural and horticultural references are also very meager, and the identity of the disease is often left in doubt.

Some of the diseases affecting the apple in Massachusetts are given below.

Rots.

There are a number of fungi causing apple rots, and those found on the apple in this State are given below. In some sections of the country these rots cause an enormous amount of damage during the summer months, especially in warm, sultry, rainy weather. They are not serious here, usually being found on apples lying on the ground which have been bruised or are in an over-ripe condition, and also on those under poor storage conditions.

Bitter Rot (Glomorella rufomaculans (Berk.) Spaudl. and von Sch.).

This rot (Fig. 1) has been known in this region for many years, and almost invariably attacks the apple on the ground or in storage, although some early varieties are occasionally affected to a slight extent on the tree, especially during warm, muggy weather. It is more serious in the west and south, where it causes an enormous amount of injury to apples.

The disease is characterized by dark-colored areas on the surface of the apple, which later contain minute, dark-colored pustules. These pustules contain smaller and more slender and light-colored spores than those of the *Sphæropsis* rot, described below. This as a rule constitutes only about 5 or 10 per cent of the apple rots in this section, although in

1912 it was the most common of all. As already stated, it is much more serious in warm sections, and its unusual prevalence on fruit lying on the ground or in storage the past season was apparently due to the fact that the season was so warm.

According to our experience this rot hardly deserves treatment by spraying, since it makes its appearance so late and is confined to fruit that has been picked. Care should be taken to avoid all bruising in picking, and to secure the best possible storage conditions.

Black Rot (Sphæropsis Malorum Pk.).

This is usually the most common rot of apples in storage and on the ground, and we have never seen it attacking fruit on the tree in this State. It is quite similar to the preceding in appearance. The principal naked-eye characteristic distinguishing it from other rots is the absence of concentric growth of the fruiting bodies. The spores are borne in little pustules, resembling those of the bitter rot, but are larger and darker colored.

Sphæropsis is associated with one of our common cankers, and in all probability is responsible for most of our apple leaf spots. As an economic factor this rot is of little importance in this State and does not warrant spraying treatment.

Fruit Mold or Brown Rot (Sclerotinia fructigena (Pers.) Schroet.).

This fungus is responsible for the brown rot of the peach and plum, and also occurs on apples, especially on those which are over-ripe, affected by frost, etc. The light-colored fruiting bodies of the fungus may be seen on the surface, and resemble a mold. This rot is of no economic importance in this State.

Fruit Mold (Penicillium sp.).

Some apple rots are associated with our common green mold, *Penicillium,* and other organisms, such as yeast, are sometimes present, which give a characteristic ferment odor.

European Apple Canker (Nectria ditissima Tul.).

This canker (Fig. 4) is usually characterized by ugly scars, due to the distortion of the tissue by the fungus named above. It is less common than the preceding canker, except on neglected trees, where it sometimes does much injury. Our earliest New England literature refers to canker on apple trees, and it is not unlikely that this is the one meant. In most cases it seems to follow injuries from various causes. Where the disease is severe it should be pruned out.

Nectria Canker (Nectria cinnabarina (Tode) Fr.).

This fungus (Fig. 5) is responsible for a canker which is characterized by the production of numerous cinnamon-colored pustules on the bark of dead wood. It is occasionally seen on apple trees, but more commonly on winterkilled branches of maples, horse chestnuts, etc. So far as our observations go, this is invariably a dead wood fungus following injuries of different types. The fungus penetrates the bark and wood and gives rise to discolored areas of the woody tissue.

Blight Canker.

A canker of rare occurrence with us has been described by Dr. H. H. Whetzel (Fig. 6). It is caused by the apple and pear blight organism, and occurs most frequently on young, smooth bark trees and on water sprouts. The diseased areas are smooth, sunken and brown in color, and there is no formation of pustules. The freshly affected tissues are usually watery, and in older cases cracking of the bark occurs. More often infection is confined to the bark, causing no injury to the wood. It is believed that only a small percentage of this canker lives through the winter to serve as a source of infection the following year, and that insects play some part in the work of infection. Another source of infection is the pruning knife.

FIG. 4. — Showing European canker (*Nectria ditissima*).

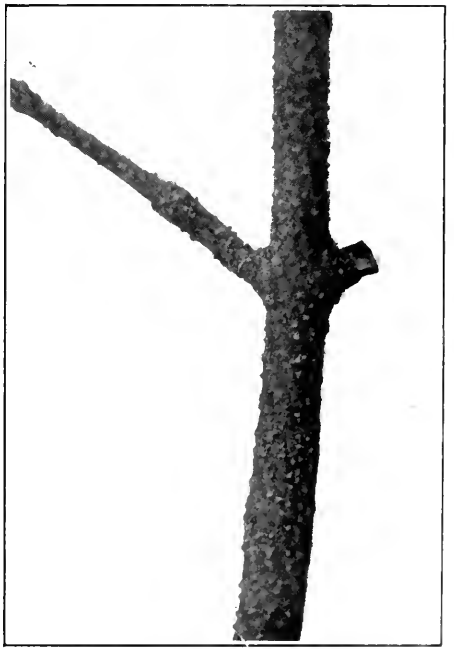


FIG. 5. — Showing canker (*Nectria cinnabarina*) on dead twigs.

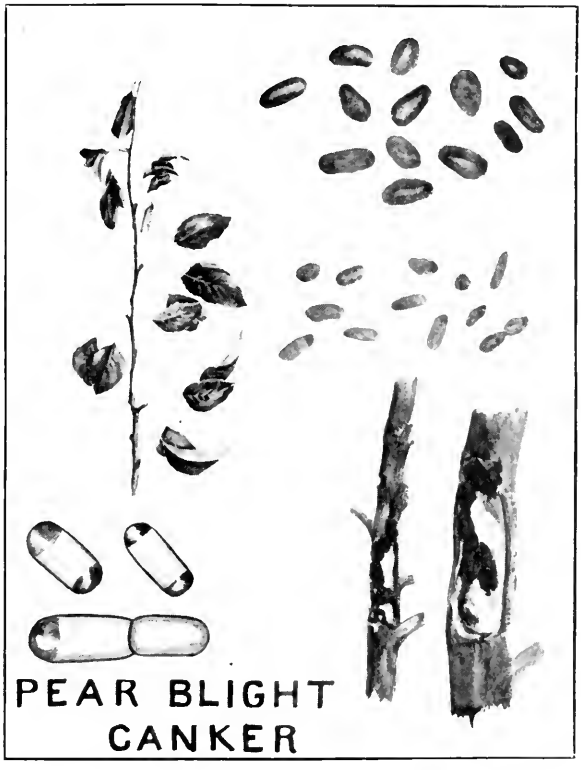


FIG. 6. — Pear blight canker.

Blister Canker (*Nummularia discreta Tul.*)

A form of canker caused by the above-named fungus has been observed in apple-growing regions of the Mississippi valley, but never in our section. This canker is characterized by a black, rough, more or less charred appearance of the bark on the older parts of the tree. On the surface of the diseased areas may be seen circular dots or fruiting bodies which are regarded as the most characteristic feature of the disease. We have recently seen a few apple trees in this section which seem to show the symptoms of this canker, but the specific fungus was not observed. It is believed to be a wound fungus.

Apple Rust (Gymnosporangium macropus Lk.).

This species of fungus is believed to be the principal cause of the apple rust in our section, one of the stages being found on the pear and quince. It is also believed to produce the so-called cedar apple on our common pasture juniper (*Juniperus virginiana*). Its appearance during the past few years has seemed to coincide with a general epidemic of rust throughout the country, and although it had been unusually rare on apples for many years in Massachusetts up to the past three or four years, since then it has often been found on foliage, and sometimes on the fruit. It is more common on neglected trees than in a scientifically managed orchard.

All rusts are difficult to control by spraying, but besides the general treatment which apple trees should receive each year, sanitary methods of culture should be practiced.

Apple Scab (Venturia Pomi (Fr.) Wint.).

A disease known as apple scab has been present in Massachusetts for many years, affecting both the leaves and fruit and occasionally the twigs of several varieties of apple trees, — in this State, more particularly the light-colored varieties. Fortunately, the disease seldom assumes a severe form here. It is more commonly found on the foliage than on the fruit, especially in unsprayed, neglected orchards. It is character-

ized on both the leaves and fruit by dark-colored or olivaceous spots, giving, as the name indicates, a scabby appearance to the fruit and leaves.

Treatment with lime and sulphur in the spring, in the dormant period, according to our observations, holds the fungus in check. Other fungicides also control it.

Pink Mold or Pink Rot (Cephalothecium roseum Cda.).

Since 1902 a pink mold has been known to be associated with apple scab, although it has caused little or no trouble in this region. As the name implies, it is of a pinkish color and is confined to the scabby spots on the fruit, developing over the surface of the scab. Although the fungus has been present for some time in this region on dead wood, etc., it was supposed to be perfectly harmless until 1902, when it was discovered as an accompaniment of the scab. It causes much more injury elsewhere than here, and is more severe in moist seasons.

Any treatment which will control the scab is applicable to this mold.

Leaf Blight (Sphæropsis Malorum Pk.).

It is generally believed at the present time, from the results of experiments, that the above-named fungus is the cause of the so-called leaf spots of the apple, although they were formerly attributed to other fungi, known as *Phyllosticta Pyrina* Sacc. and *P. limitata* Pk. These two species of *Phyllosticta* are now considered merely accompaniments of the leaf spot, occurring only in the later stages of the disease. The foliage of most neglected apple trees develops these spots, and the disease is sometimes severe enough to affect the growth of the tree. The fungi associated with the leaf spots, however, are easily controlled by spraying with lime and sulphur in the spring before the buds open, and therefore are of minor importance in well-cared-for orchards. Many orchards go through the season without a spot as a result of spraying with lime and sulphur in the dormant period of the tree.

Sooty Blotch or Fly Speck (Phyllachora pomigena (Schw.) Sacc.).

A fungous growth known as sooty blotch or fly speck has been common for many years, occurring on the surface of apples. With us it affects Greenings more commonly, sometimes discoloring the fruit to quite an extent. It was formerly believed that there were two species of fungi, — one causing the blotch, the other fly speck, — but it is now generally recognized that one species of fungus causes both. Both of these forms occur on the surface of the fruit and do not penetrate the cuticle, and they can easily be removed by washing.

Sooty blotch forms large, irregular, olive-brown areas on the fruit, while fly speck occurs as minute dark-colored dots scattered over the surface. The trouble appears to be more abundant in the shade and where there is considerable moisture. The fungus does not injure the fruit other than to affect its market value, and it can usually be controlled by spraying late in the season with Bordeaux mixture.

Apple Blight, Fire Blight, Twig Blight, etc. (Bacillus amylovorus (Burr.) DeToni.).

This blight has been common for many years on apples, pears and quinces, and is often severe in some parts of the United States. It is caused by a minute organism (bacillus), and it is generally recognized that infection takes place at the period of pollination. The blight is characterized by a blackening and shriveling of parts of the twigs or branches, and the leaves droop and turn brown, but do not fall. The organisms under certain conditions multiply very rapidly in the nectaries of the flower, and are readily transferred to other flowers by bees. From the nectaries the bacteria gain entrance to the tissues of the small branches, causing them to collapse. In most cases direct infection probably occurs by means of insects, abrasions, etc. The blight organism also occasionally causes what is termed blight canker. The

blight is not so serious in our section on the apple as on the pear and quince.

The principal methods of control consist in pruning out the infected limbs, at least a few inches below the affected region. Fall and winter pruning is considered better than summer pruning, since the affected parts may be more readily found, whereas in summer the disease may be spreading rapidly and all of it may not be eradicated. In all cases of pruning, antiseptic methods should be employed, such as sterilizing with formalin or some other substance the tools used in pruning, or treating the cut surfaces with creosote, etc.

Powdery Mildew (Erysiphe Polygoni DC.).

This mildew is seldom found on apples in this section. It occurs on nursery stock in some regions, where it causes more or less injury in the form of a mildew effect on the upper surface of the leaf.

Crown Gall.

Crown gall (Fig. 7) has caused vexation and worry to many fruit growers for the past few years, although the amount of actual injury done is somewhat problematical. For a few years considerable infected apple stock came into our State from outside, but for the past four or five years orchardists have been more particular about their material, and cleaner stock has been obtainable. There are only a few instances where trees have been so severely affected as to die, but one never knows when complications may set in and result in loss.

There are many forms of galls affecting plants, but practically all have a similar distorting effect on the tissue, which may seriously interfere with the vital processes of the plant. Eel worm galls, which are similar in appearance to those found on the apple tree roots, cause little injury to tomatoes and cucumbers, but are very injurious to roses, violets and melons, and in the south, various other crops, including some trees, are affected.

There is much difference of opinion as to the effect of crown

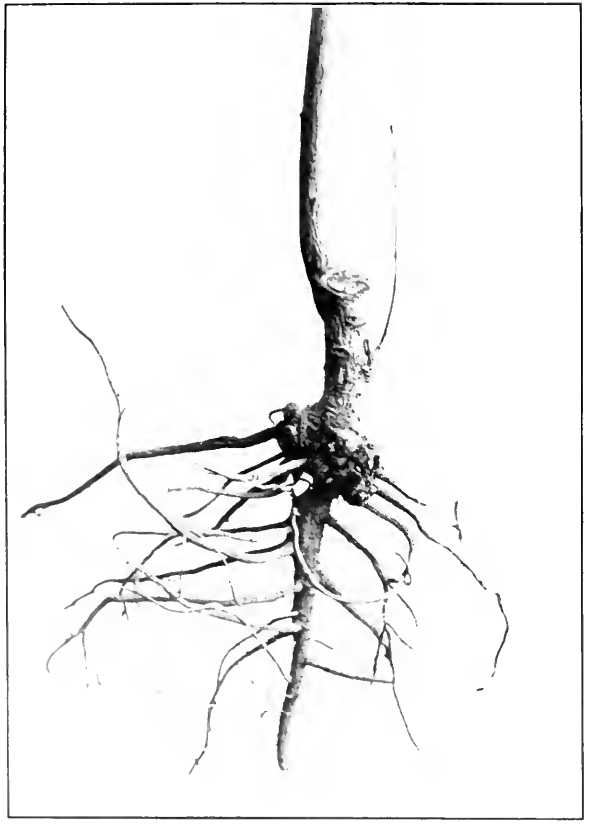


FIG. 7. — Crown gall of apple.

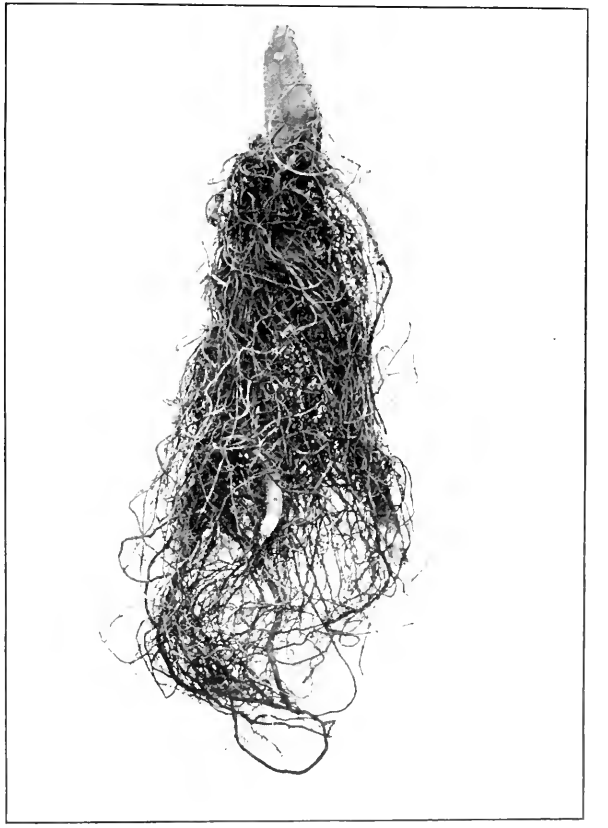


FIG. 8. — Hairy root.

gall on apple trees, which appears to be more injurious in the warmer parts of the country. Nevertheless, no orchardist should accept material affected by this disease.

While the specific bacterial organism has been isolated, and many cross inoculations made, there is yet much to be learned concerning the relation of a particular type of gall to another. Extensive investigations made by Smith and Townsend seem to indicate that the organisms causing crown gall on the raspberry and apple are similar, yet our raspberry has had galls for years, while apple trees have been free from them until comparatively recently. Crown gall was not observed here until certain infected stock was obtained from outside the State. Where infected stock has been planted and cultivated, the disease spreads from one field to another, and seedlings raised on soil which was formerly free from the organism become infected. It is possible that much of our infected stock already planted will pull through and develop into bearing trees; but it is a wise precaution to secure clean trees when planting.

Crown gall, as its name implies, is characterized by a gall formation near the crown, which causes a distortion of the tissue, and in very severe cases it interferes with the function of the plant to such an extent that death results.

Hairy root (Fig. 8), which is characterized by the abnormal production of roots, giving a hairy effect, appears to be a similar trouble, although it is much less common with us.

Baldwin Spot or Fruit Pit.

This spot, which has been known by several names, has been present in Massachusetts since 1898 at least, and has been confined, to our knowledge, to the Baldwin in this section. It is characterized by small spots or indentations on the surface of the fruit, ranging from 2 to 4 millimeters or more in diameter, which are scarcely perceptible to one not acquainted with the disease. The spots are usually so insignificant that expert judges of fruit have been known to place premiums at fruit shows on apples badly affected with this trouble. In cutting open an affected fruit, numerous

brown areas may be seen extending quite deeply into the tissue, which give it a bitter taste.

The cause of this spot is not known. Some years ago we tried to associate it with meteorological conditions, and interviewed many fruit growers in regard to its appearance in different seasons, but we were unable to establish any definite relationship, although the spot seemed to be more common after extremely dry periods. The disease is apparently of a functional nature, since spraying has no effect on it.

Baldwin Fruit Spot (Cylindrosporium Pomi Brooks).

This disease (Fig. 9) is characterized by spots very similar in many ways to those caused by the Baldwin spot or fruit pit, and has only been observed on apples in this State for three or four years. Only recently an experienced fruit grower, in describing this spot before a number of orchard specialists, found none of his audience familiar with it.

The spots are larger and more distinct, and the indentation is usually lacking, so that as a rule there is little excuse for confusing it with the old Baldwin spot. It attacks several varieties of apples, differing in this respect from the Baldwin spot previously noted. This disease is caused by a fungus (*Cylindrosporium Pomi* Brooks) and is much more severe here than the Baldwin spot, but like this it extends below the surface and turns the tissue a reddish brown. According to Dr. Brooks of the New Hampshire station, who has given it much attention, it first appears about the middle of August. The spots develop about two weeks before harvesting, during periods of dampness. The fungus gains entrance to the fruit in July or early August, and is said to be controlled by spraying with Bordeaux mixture, applications being made in June or early in July. From the general appearance of this spot one might surmise that it was the old Baldwin spot attacked by a fungus which has modified its appearance somewhat, although it occurs, as has been said, on a much larger number of varieties.

An inspection for the last three years of some of the best orchards in the State has revealed only a few affected apples

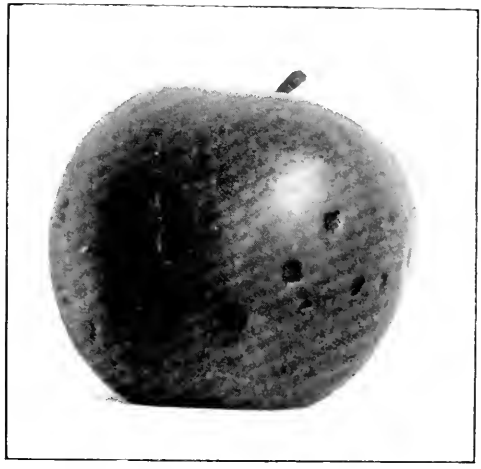


FIG. 9.—Showing Baldwin fruit spot (*Cylindrosporium*) on apple.

on each tree, although on individual trees in some orchards we have seen 50 per cent. of the apples diseased, and in many cases no spotting at all was seen. The trees which were so badly affected were old ones which had recently been cultivated and fertilized, and the manager attributed the outbreak to the application of nitrogenous fertilizers and the recent renovation of the orchard. Another successful orchard manager gave damp periods following drought as the cause. For five years we have been having severe droughts in the summer, followed by rains in the fall, and this spot has made its appearance during this period.

Winterkilling.

Winterkilling often occurs below the surface of the ground as well as above. During the cold winter of 1903–04 many apple trees were seriously injured, both above and below, in some States whole orchards being wiped out. Such injury is not always associated with cold weather, much depending on the condition of the tissue before the tree enters the winter.

The causes underlying winter injury are severe cold, when the frost penetrates to great depths; sudden and severe cold following prolonged warm periods in the fall; general low vitality, caused by lack of food; insect or fungous attacks; lack of moisture and organic matter in the soil; lack of snow covering; location in exposed situations, etc. Any condition which favors a soft growth and immaturity of the wood, whether from too much moisture or too heavy manuring and fertilizing, tends to produce winterkilling, as does also absence of sufficient sunlight. Trees growing where they receive the overflow from cesspools, etc., have been known to winterkill when others near by would not. Piling dirt three or four inches high around the base of young trees in winter often causes injury similar to winterkilling in nature, and tarred paper has the same effect.

Barnyard manure used as a mulching helps to prevent injury from winterkilling, and even sod is a great protection.

Frost Cracks.

Frost cracks are sometimes found disfiguring and injuring fruit trees by splitting the bark and wood of the limbs. In some cases they open only one-half inch or so, while in severe cases they may be three or four inches wide. They occur usually during sudden reductions in winter temperature. Extreme cold has a similar effect on the tissue to drying or shrinking, by causing a withdrawal of water from the cell walls, thus rupturing the tissue, and while the cracks sometimes heal over, they more often do not. They open wide in winter, and their opening and closing are affected by various meteorological conditions.

Frost cracks are very difficult to treat, but we have found that the best way to handle them is to paint the inner surfaces of the cracks with coal tar or paint in winter when they open up. Then in spring or summer, when the cracks close, staples of one-half or five-eighth inch iron, with prongs three or four inches long and pointed ends, may be driven into the trees after boring a hole with an auger. The staples should be painted and the bark cut away underneath, so that they may be driven in flush with the wood, when they will heal over and disappear.

Frost Blisters.

Occasionally during the past ten years we have observed a spotting on apple leaves caused by injury from spring frosts, and during the summer of 1902 considerable defoliation resulted, as much as 30 per cent. of the leaves falling from certain trees in July and August. The trouble was in general confined to the sections where the spring frost was most severe.

This frost injury occurs just as the leaves are unfolding, the frost rupturing the tender epidermal cells on the under side of the leaves. As the leaves develop, conspicuous, irregular spots may be found on the upper surface, corresponding in a general way to the ruptured areas on the under

side of the leaves. The heavy loss of water from the leaves following this injury causes them to deteriorate and fall off in large quantities.

Treating Cavities.

No tree is so often found with cavities as the apple, and perhaps none will thrive with so much decay of the heartwood, etc., as this species. The principal cause of the decay is poor pruning and lack of antiseptic treatment of wounds. When long stubs are left after pruning, the decay works into the heartwood and a cavity results. These long stubs never heal over, since the healing surface is not in direct communication with the flow of plastic substances. Large wounds, if not painted, will decay even if the branches are cut close.

Apple trees will live and thrive for many years, even when the heartwood of the trunk is completely destroyed, since the sapwood appears to be immune to most of the organisms causing decay. Modern tree surgery methods, however, can be used to good advantage on apple trees. A cavity should first have a thorough cleaning, followed by treatment with creosote, and should then either be filled with cement, or the orifice of the cavity tinned over or covered with some other suitable material.

Effects of Drought.

It often happens that in a wet spring trees will produce more foliage than they can support throughout the summer, especially if a severe drought occurs, resulting in a premature loss of foliage. The ideal moisture conditions for fruit trees consist in having a plentiful supply of moisture during the growth and early ripening of the fruit, with a bright and relatively dry period, characteristic of Indian summer, for the maturity. If there is too little moisture in summer the fruit is likely to be small; on the other hand, a dry summer followed by heavy fall rains affects the quality of the fruit and the ripening of the tissue, and is conducive to winterkilling. As already noted, it may also have some effect on the occurrence of the Baldwin spot.

Sun Scald.

This is a common type of injury, especially to the apple, pear, peach and plum, and is more likely to affect nonripened wood. It is much more common on neglected apple trees, and a few years ago was quite prevalent in the State, particularly on the lower branches, which were secluded from the light. Sun scald is characterized by a sunken, blackened appearance of the bark. Anything which prevents the wood from ripening makes the tree more susceptible to this trouble, and canker often follows it.

A similar trouble is known as collar rot, to which certain varieties of apples are particularly susceptible. This attacks the base of the tree, and is characterized by the death and abnormal appearance of the outer bark.

Storage Burns.

A storage burn of the apple which causes discolored spots, and which is undoubtedly a climatic trouble, occurs occasionally. This was unusually common during the fall of 1912, and one large shipment of Massachusetts apples to Europe was ruined in transit by the burn.

There are undoubtedly a number of causes responsible for storage burns, such as lack of light, too much soil moisture, etc., when the fruit is ripening, also warm periods such as were common during the past fall and winter (1912–13).

Spraying Injury.

Most of the spray injuries in our region result from unfavorable climatic conditions preceding or during the time of spraying, although some are due to the unusual susceptibility of certain varieties, and others to improperly prepared spray material. Peach and plum trees, for example, are injured by customary strengths of the Bordeaux mixture, and we have seen plum trees defoliated by spraying with arsenate of lead. It is possible to cause injury with almost any insecticide or fungicide under certain conditions,

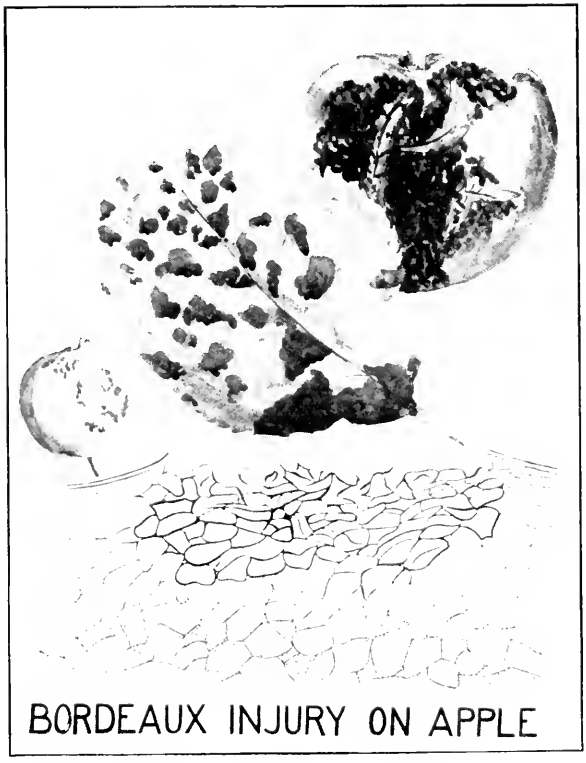


FIG. 10. — Bordeaux injury on apple.

and this is also true of fumigation. Many of our oil sprays have been known to injure apple and even shade trees when in the dormant condition, and judgment must be used in applying them. Even kerosene can sometimes be sprayed on certain plants without injury, although at other times it may kill the plant. Kerosene used directly or diluted with water is dangerous to many trees, as are various other oils.

Bordeaux mixture, even when properly prepared, causes burning to fruit trees under certain conditions (Fig. 10). In the south such injuries are more common than with us, but even here russeting of the fruit sometimes occurs from Bordeaux, as well as burning of the foliage. Meteorological conditions are responsible for some of the injury from spraying; for instance, spraying during cloudy periods, when the foliage and wood are not properly matured; and spraying mixtures left on the foliage in solution for a long or short period cause injury. Therefore, trees sprayed in the sunshine, when the solution quickly dries on the foliage, are less likely to burn. There are also many other factors which enter into burning of the foliage and russeting of the fruit, such as soil moisture.

Sunlight as a Factor in Apple Orchards.

No factor has a more important bearing on vegetation than sunlight. Through its action on foliage, plants obtain most of their food from the air, and tissue is rendered less susceptible to disease, since the physiological effect is to inhibit growth and render tissue more resistant. Aside from the necessity of pruning apple trees to make them low headed to facilitate picking the fruit, pruning is very important from the disease standpoint. Proper pruning and thinning give light a chance to reach all the branches, fruit and foliage, and thus modify the tissue and make it more resistant. Light is also important in preventing sun scald, winterkilling and other troubles.

A few years ago sun scald was quite common on neglected apple trees in our State. The most notable feature connected with the injury was the fact that it was confined to the shaded

limbs and branches where the light was more or less excluded, and was very rare on thinned trees. On the other hand, too intense light may cause injury to tender growths when shaded, as when young trees are suddenly stripped of their foliage by insects, or where too rapid growth results from severe pruning, followed by cultivation and fertilization. Sun scald is occasionally found on the larger limbs of trees which have been more or less shaded, and therefore receive too much light from severe pruning. A well-thinned tree is likely to be less affected by different diseases, and the danger from burning of various kinds is lessened.

Undoubtedly much of the spraying injury to fruit and foliage is associated with lack of light and other climatic factors, and the injury from fumigation has a relation to light intensity and moisture. There is much evidence to show that the practice of pruning apple trees is of much importance in controlling certain troubles.

BORDEAUX MIXTURE.[1]

GEORGE E. STONE, PH.D., AMHERST, BOTANIST, MASSACHUSETTS STATE BOARD OF AGRICULTURE.

The object of spraying is to protect plants from the ravages of fungous and insect pests. Spraying constitutes a preventive rather than a cure for diseases, which implies that it should be done before injurious pests make their appearance, or in the case of certain insects, before they do any damage. Spraying is a form of insurance, there always being a possibility that more or less disaster will result from pests; hence, a return from this kind of protection generally follows.

Some crops are especially susceptible to damage from insects and fungi, and need protection every year; while others suffer only now and then, and are frequently productive without spraying. Even where severe loss is occasionally experienced from pests, it pays to practice systematically methods of prevention.

As an all-round fungicide for foliage the Bordeaux mixture still stands first, and in certain cases it is unsurpassed. There is, however, considerable difference in the quality of Bordeaux mixture, due to variations in methods of preparing it. To obtain the best results with this mixture, it is essential to have it properly prepared.

Preparing Bordeaux Mixture.

In preparing Bordeaux mixture, nothing but the freshest quick-lime should be used. Air-slaked lime is unsatisfactory, and should be avoided. Better results can be obtained from the lump than from the fine, broken-up material which

[1] Nature Leaflet No. 17, Aug. 7, 1907.

is likely to be more or less affected by the air, and does not slake as well.

Masons who are familiar with the use of lime utilize the whole contents of a barrel for ordinary purposes. When, however, it is necessary to prepare whitewash or finishing material for plastering, they select nothing but the freshest and finest lumps to slake. By this practice they obtain a pure white, thoroughly slaked, pasty substance, fairly free from grit.

Particular attention should also be paid to the matter of slaking the lime, inasmuch as a novice cannot do this properly. When the requisite amount of lime has been weighed out, place it in a tub and add water cautiously, and only in sufficient amounts to insure thorough slaking. It should not be allowed to become too dry, neither should it be deluged with water. Lime slakes best when just enough water is added to develop intense heat, which renders the process active. When very small quantities of lime are to be slaked, better results can be obtained by using hot water as a starter. It is not desirable to stir the lime more than necessary when slaking. If large quantities of Bordeaux are used, a stock of slaked lime of the consistency of paste can be made, which always should be covered with water, to prevent becoming gritty.

The copper sulphate or blue vitriol is dissolved in hot or cold water, using either a wooden or earthen vessel. The proper mixing of the two solutions is important. In mixing, it is best to dilute both the copper and lime with water, so when combined they will make the required amount. Strain the lime, and mix the two solutions quickly and thoroughly together in a separate barrel.

If the amount of lime is insufficient, there is danger of burning tender foliage. In order to obviate this, the mixture can be tested with a knife blade or with ferro-cyanide of potassium (1 ounce to 5 or 6 ounces of water). If the amount of lime is insufficient, copper will be deposited on the knife blade, while a deep brownish-red color will be imparted to the mixture when ferro-cyanide of potassium is

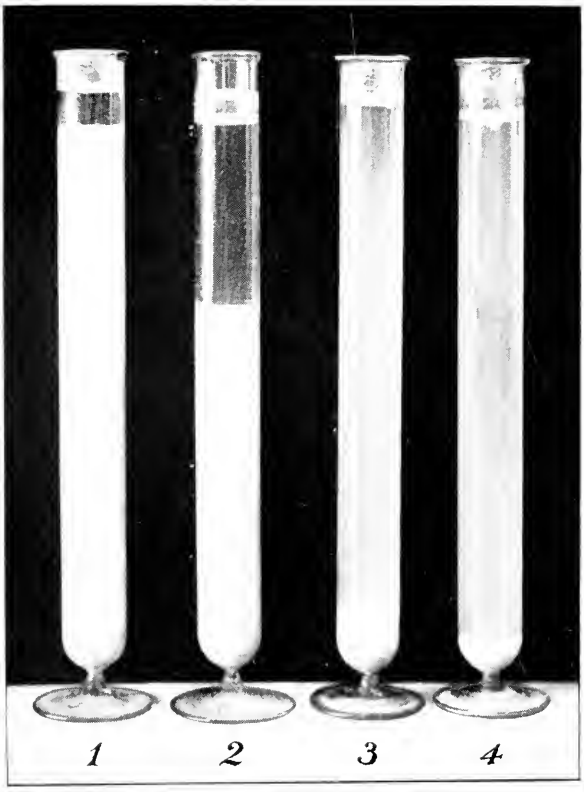


Illustration showing the degree of settling in properly and improperly made Bordeaux mixture. 1. Bordeaux mixture properly made by mixing diluted lime and copper sulfate together in a separate vessel twenty-four hours after the copper and lime have been prepared. 2. Mixture made by combining freshly made copper sulfate and lime solutions. 3. Dissolved copper solution poured into lime water while warm. 4. Freshly prepared lime water poured into the copper solution while warm. Nos. 1 and 2 photographed three-and one-half hours after mixture was placed in cylinders and shaken; Nos. 3 and 4 photographed fifteen minutes after being placed in cylinders and shaken.

added.[1] Lime should be added until neither reaction occurs. A slight excess of lime, however, is desirable.

The following precautions should be observed: never mix the concentrated solutions together and then dilute, or never mix the two together while warm. The properly prepared mixture should be fine in texture, and very slow to settle. (See illustration.) The Bordeaux mixture is the best when first prepared, and it is hardly advisable to use it when more than a few months old.

One of the standard mixtures is as follows: —

4 pounds copper sulphate (blue vitriol).
4 pounds of lime (unslaked).
25 gallons of water.

This is known as the 4–4–25 formula, the half-strength mixture being 4–4–50; other formulas frequently used are 6–4–25 or 50, 2–2–50, 3–6–50, 3–9–50, etc., the weaker mixtures being useful for tender foliage, such as the peach.

Spraying Methods.

One of the frequent drawbacks in not obtaining the best results from spraying is due to the methods employed in applying the spray. Quite often sufficient attention is not given to spraying those parts of the plants which become affected. Then, again, the time to apply the spray is not always well chosen, and considerable depends upon the manner in which the spray is applied to the plant. The essential feature in a spray is fineness, which is determined by the type of nozzle employed and the pressure behind it. A pump capable of maintaining 100 pounds pressure is better than one with a limited capacity of 40 or 50 pounds; and a spray from a nozzle with 100 pounds pressure back of it is quite different from one obtained by 25 pounds pressure.

Fig. 2 shows some typical results obtained by different nozzles with a pump maintaining an approximate pressure

[1] A simple test for excess of lime can be made as follows: put a little of the mixture in a flat dish and blow into it for half a minute. If an excess of lime is present, a thin coating of carbonate of lime will be formed upon the surface, caused by the chemical action of the carbonic acid in the breath upon the lime.

of 120 pounds, or 8 atmospheres. The finest spray is that given by the atomizer, a simple tin hand appliance limited in its use to small plants at close range. Next to the atomizer comes the spray produced by the Ware nozzle, followed by the Vermorel, Bordeaux and one-fourth-inch nozzle. The latter nozzle deposits the spray in large spots, and the Bordeaux nozzle with a three-thirty-second-inch aperture does the same to a less extent. Neither of these nozzles as used in this experiment is applicable to good work under low pressure. The Bordeaux nozzle, however, can be modified so as to produce a finer spray than that shown in the figure.

At the present day the Ware and Vermorel types of nozzle are not so generally used as the Mystry, Friend and Tiger types. The Ware, which was devised for spraying the foliage of large trees at close range, is now supplanted by coarse nozzles with apertures varying from one-eighth to five-sixteenths inches, to be used with high pressure. These will throw the spray considerable distances, and break up into a fine mist.

The Bordeaux nozzle is still much used for the spraying of fruit trees, especially for lime and sulphur spraying. The remarkable results obtained by coarse-nozzle, high-pressure spraying for gypsy and brown-tail moths and elm-leaf beetle open up the question whether this kind of spraying cannot be more extensively used for other kinds of work.

SPRAY CALENDAR FOR APPLES.

COMPILED IN OFFICE OF STATE BOARD OF AGRICULTURE BY ERWIN H. FORBUSH, SECOND CLERK.

[General importance of sprayings is indicated by size of type.]

WHAT TO SPRAY FOR.	When to spray (in Proper Succession).	What to use.
1. San José and other scale pests, and as a general sanitary measure.[1]	**While trees are dormant (from November to March).**	**Concentrated lime-sulphur (home boiled preparation for extensive operations, but commercial mixture for medium and small orchards), or miscible oils.**
2. SCAB, CURCULIO, BUD MOTH, ETC.	JUST AFTER LEAF BUDS BURST AND BEFORE BLOSSOM BUDS OPEN.	BORDEAUX MIXTURE (4-4-50), TO WHICH HAS BEEN ADDED 3 POUNDS OF ARSENATE OF LEAD TO 50 GALLONS, OR DILUTE LIME-SULPHUR AND ARSENATE OF LEAD APPLIED SEPARATELY.
3. Codling moth, canker worm, and other leaf feeding insects.[1]	**As soon after the petals fall as possible, surely within ten days, so that the calyx can be filled with the poison before it closes up.**	**Bordeaux mixture (1-2-50), to which should be added from 3 to 4 pounds of arsenate of lead to each 50 gallons.**
4. Curculio, scab, blotch, rust, etc.	From two to three weeks after the blossoms fall.	Same as No. 3.
5. Codling moth, scab, brown rot, etc.	June 25 to July 5, . .	Same as No. 3. (Where fungous diseases are very prevalent the Bordeaux will prove more efficacious than the lime-sulphur.)
6. Bitter rot, apple blotch, black rot, brown rot.[2]	July 25 to August 1, . .	Bordeaux mixture (3-3-50), to which 2 to 3 pounds of arsenate of lead have been added.

[1] The two most important sprayings. In many cases these may be all that are necessary.

[2] This spraying needed only where fungous diseases or insect pests are extremely numerous and troublesome. In this section of the country this is useful in the control of apple blotch only.

In regard to the above table it may be well to discuss briefly some of the directions therein given, and to give some further instructions for the benefit of those who may be starting in the business of orcharding. It will be noted that sprays Nos. 1 and 3 are designated as the most important.

In some cases, perhaps, these may be all that are actually needed.

The first is for the San José scale, that insidious pest whose presence is oftentimes unnoticed until the vitality of the tree is much impaired. Other scales, such as the scurfy and the oyster-shell, which are not as bad as the San José, may possibly be partially controlled by this spraying. This must be applied while the leaves are off the trees and before the buds begin to swell in the spring. It should not be done on a day which is cold enough to freeze the solution as it is applied to the tree, however, and a quiet day should be selected, so as to cover the tree thoroughly from all sides. The covering of every part of the tree is very essential to good results, as this insect does not move about, and the caustic spray *must* touch each scale in order to properly accomplish its object, and if only a very few of the scales are left they will be sufficient to repopulate the tree by the following fall. There are two kinds of insects, those which feed on the foliage of a plant and those which suck the plant juices. A poison spray applied to the foliage destroys the former, while it requires either a caustic solution which will destroy the insect or the scale which covers it, or a dust which will close up the breathing pores of the sucking insect which has no protective scale. The lime-sulphur is the most generally used, and is probably the best caustic spray to use for this pest, although some authorities are very emphatic in their claims as to the superiority of the miscible oils, claiming that they spread with greater facility and so are more likely to cover every portion of the tree.

For all spraying operations the best nozzle is the disc type, with a rather large chamber and a large hole which will not clog, of which type the Friend nozzle is as good as any. A factor which may save a lot of bother is a long-shanked coupling with two raised rings for the hose. This will obviate any danger of the uncoupling of the hose while in use.

The most damaging insect to the fruit itself is the codling moth, or "apple worm," as it is commonly called. The spraying numbered 3 is the one which is of the greatest importance in combating this pest. This *must* be done while

the calyx of the apple is turned upward, so as to fill it with the poison, as this is the place at which the larvæ enter the fruit. This object may be attained by spraying at any time within ten days after the blossoms fall. A fine, forcible spray is required, and a spraying tower is desirable in order to spray *downward* into the highest calyx cups on the tree.

These two sprayings are by far the most important. Next to these comes No. 5, for the caterpillars of the codling moth, which feed on the leaves before attacking the fruit, and this spraying will generally control it.

The other sprayings scheduled in the calendar are to be used when especial care is desired for the production of extra fancy fruit, and when insect pests or fungous diseases are unusually prevalent.

In regard to the comparative value of lime-sulphur and Bordeaux mixture as a fungicide, it may be said that the Bordeaux is generally recognized as a more efficient fungicide, but some are using a weak solution of lime-sulphur on apple trees to eliminate any possible injury to the fruit, such as is attributed to the Bordeaux when used at too great strength when the apples are young and tender. A weak lime-sulphur solution, say 1 gallon concentrated solution to 50 gallons of water, may be substituted for the Bordeaux, but in this case the arsenate of lead should not be mixed with the lime-sulphur, but should be applied as a separate spray.

Pruning is quite an important factor in connection with spraying operations. The present day demand calls for a low-headed tree, some even going so far as to say that it does not pay to harvest an apple over 15 feet from the ground. The advantage of low-headed trees, however, will be very apparent to all, not only in the harvesting of the crop but as an aid to efficient spraying, as a low tree can be more economically and completely covered with the spray material than a tree which shoots way up in the air. Pruning should be done *before* spraying, also, as the chance to do efficient work with the spray pump is much greater.

A power spraying outfit can be economically used only in extensive operations. For ordinary use in the small and

medium sized orchard the barrel pump, mounted on a wagon or truck to which a tower may be attached, will be found as good an outfit as any.

The main facts to be remembered in spraying operations are: proper preparation of materials, adequate means of application, proper time of application, thoroughness in applying. On proper spraying, to a large degree, depends the health of the tree and the quality and appearance of the fruit.

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For ready identification the titles of bound volumes are quoted. Prices were obtained from the United States Catalogue and Cumulative Book Index published by the H. W. Wilson Company, Minneapolis, Minn., and New York, N. Y. Such publications are obtainable through almost any dealer in books. Readers must not send money or orders for this literature to this office, as we cannot supply them.

At the end of this bibliography is a list of the experiment stations mentioned, with their location and directors, for the benefit of those desiring to send for these bulletins. In the following list, in referring to books, the title is first given, then the author, followed by the date of publication and the price; in the case of bulletins, the title is first given, then the source of the bulletin, followed by its number, the author and the year in which it was issued.

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Arkansas: Fayetteville, M. Nelson.
Colorado: Fort Collins, C. P. Gillette.
Connecticut: State Station, New Haven, Storrs Station, Storrs, E. H. Jenkins.
Delaware: Newark, H. Hayward.
Georgia: Experiment, R. J. H. DeLoach.
Idaho: Moscow, W. L. Carlyle.
Illinois: Urbana, E. Davenport.
Indiana: La Fayette, A. Goss.
Iowa: Ames, C. F. Curtiss.
Kansas: Manhattan, W. M. Jardine.
Maine: Orono, C. D. Woods.
Maryland: College Park, H. J. Patterson.
Massachusetts: Amherst, W. P. Brooks.
Michigan: East Lansing, R. S. Shaw.

Minnesota: University Farm, St. Paul. A. F. Woods.
Missouri: College Station, Columbia, F. B. Mumford; Fruit Station, Mountain Grove, Paul Evans.
Montana: Bozeman, F. B. Linfield.
Nebraska: Lincoln, E. A. Burnett.
Nevada: Reno, S. P. Doten.
New Hampshire: Durham, J. C. Kendall.
New Jersey: New Brunswick, J. G. Lipman.
New Mexico: State College, Fabian Garcia.
New York: State Station, Geneva, W. H. Jordan; Cornell Station, Ithaca, W. A. Stocking, Jr.
North Carolina: College Station, West Raleigh, State Station, Raleigh, B. W. Kilgore.
Ohio: Wooster, C. E. Thorne.
Oregon: Corvallis, J. Withycombe.
Pennsylvania: State College, R. L. Watts.
Rhode Island: Kingston, B. L. Hartwell.
South Carolina: Clemson College, J. N. Harper.
South Dakota: Brookings, J. W. Wilson.
Vermont: Burlington, J. L. Hills.
Virginia: Blacksburg, S. W. Fletcher; Norfolk, Truck Station, T. C. Johnson.
Washington: Pullman, I. D. Cardiff.
West Virginia: Morgantown, E. D. Sanderson.
Wisconsin: Madison, H. L. Russell.

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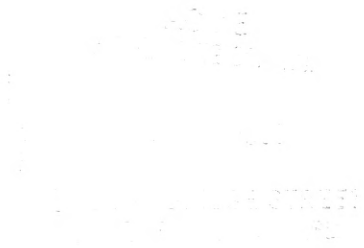
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