The Evaporation of Prunes

By

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THE EVAPORATION OF PRUNES

INTRODUCTION

During the summer of 1911 the Division of Horticulture conducted a prune survey of the State. This survey covered nine counties and involved a study of seven hundred prune orchards. It revealed the fact that there was great variation in the methods and types of buildings used in the evaporation of prunes.

Standardization. Since 1911 very little progress has been made in standardizing prunes.* The only standard used in the State at the present time for prunes is that of weight, which is based upon the number of prunes to the pound. Just previous to the European war Austria had detailed certain scientists to make a study of the prune and deter-

Fig. 1. A PICKING CREW. The pickers work on hands and knees, picking into buckets which are then emptied into orchard lug boxes to be hauled to the evaporator.

mine whether or not it was possible through chemical studies to standardize the product and give the output a better rating in the world's markets. Whether or not these studies are being conducted during the war, we do not know. California is making supreme efforts to standardize its fruit output, and it has passed some excellent standardization laws. For example, with oranges, the 8 to 1 standard is being generally accepted. With the grapes a sugar standard is required. The California prune growers, wide awake to the needs of the hour, are making efforts to improve the products which they offer the world's markets.

*There has been a tendency, however, in building evaporators to shorten the tunnels materially, a practice which we have been advising for a number of years. It is a step in the right direction.
We of the Northwest should do much more than we have done in the past along these lines. What do we mean by standardizing the prune? Simply adopting a degree of excellence which it must attain in order to be marketable. This will mean that the buildings used and the methods employed, will in all cases be essentially alike. We must first make a more careful study of the inter-relation of temperatures, air circulation, humidity of the atmosphere, and the influence of such factors on fruit, in whatever condition it may be. It will mean that we should make a serious attempt to find out what equipment and buildings will enable us to have the best control of heated air in such a way as to turn out high-class products.

The Oregon Experiment Station has sensed this problem for a number of years. Immediately following our survey we inaugurated some investigations with the evaporation of prunes. Mr. F. R. Brown, a member of our staff at that time, was detailed as field agent and carried out the work cooperatively with a number of growers. Unfortunately, two years ago appropriations for the Experiment Station were discontinued, and the problem had to be conducted on a very small scale. We have, however, done something with the problem. Mr. A. F. Barss has given some attention to this work. During the last session of the legislature a small appropriation was obtained and we are now attacking the problem again. We are erecting a building which will be provided with appliances for the evaporation of fruits, and thus we shall have conditions absolutely under our control, and should be able to aid materially in standardization work.

Purpose of Bulletin. We are issuing this publication at this time since we believe that we have made some observations which will be of aid to all prune growers, but most especially to those engaged in prune evaporation for the first time. There are a large number of

Fig. 2. AN INEXPENSIVE HAND GRADING MACHINE. The prunes pass from the hopper onto a vibrating screen through the openings in which they fall into small bins below.
men who will dry prunes for the first time during the next two years. These men may lower the standard of our product, or they may materially raise it.

Prune growers should study very carefully the cost of producing and evaporating prunes and should conduct their business as economically as is advisable for the production of a high-grade product. Frequently, for over a period of five years, fruit will produce unusually high profits. At such times growers become extravagant, careless in their methods, and are not ready to meet periods of depression or lower prices.

The cost of evaporation should be analyzed and brought down to the lowest cost possible so that our Oregon growers may meet competition from any source.

Fig. 3. AN EFFICIENT POWER DIPPING AND TRAYING MACHINE. This kind is used quite extensively in the larger evaporators. The open trough makes sorting convenient.

HARVESTING

In order to have a high-grade evaporated product, it is essential that the fresh product also be of a high grade. It is impossible to take inferior prunes and so evaporate them as to make a first-class product. Much of the quality of the product, therefore, will depend upon the time of harvesting and the methods employed. Too many growers have formed the habit of allowing many pickers to shake the trees; or of sending some unusually strong man, no matter how careless he may be, through the orchard to do the shaking. This practice results in the harvesting of a large amount of unripe fruit.

Shaking. There seems to be no common practice followed among all growers in harvesting. Some refrain entirely from shaking until the last picking with the idea of harvesting only the ripe fruit. While there is much merit in this system, it has the drawback of allowing a
considerable amount of fruit to become overripe. The tendency seems to be to pick the smaller plantings more frequently than the larger ones. This is due to the impossibility at times of getting over large areas frequently.

The most common practice followed is that of three pickings, shaking the trees for the last two. It must be borne in mind, however, that the finest prunes are secured where it is possible to pick the fruit frequently. In this way one is more likely to secure only ripe fruit. Our survey showed us that the average time of maturity for Italian prunes over a period of years in the Willamette Valley was from September 10 to October 5. In recent years, however, there has been a tendency on the part of a large number of growers to start the harvesting unusually early, generally from the first to the sixth of September, or about ten days in advance of the normal season. This tendency has been brought about by the feeling that the early harvesting might mean less damage from rains later in the season. This early harvesting, however, has necessitated a great deal of shaking. While we do not recommend doing away with shaking entirely, we do advocate delaying the season to the point where a very gentle shake before each picking will supply plenty of fruit. If growers organize their work so as to pick frequently, and there is during the period a moderate amount of wind, practically no shaking will be needed until late in the season.

**Picking Too Early.** The season of 1912 should have taught many growers an important lesson. The harvesting that year was started early and at the end of the season after most of the growers had re-

![A DIPPING AND TRAYING CREW AT WORK. For a hand outfit this type is very satisfactory.](image-url)
sorted to very vigorous shaking or clubbing, there were still many prunes scattered throughout the trees. A majority of the pickers had finished their work by September 25, which is 10 days in advance of a normal season. A number of orchards were visited on October 2 and the trees examined for fruit. Not a single prune was found still hanging to the trees, although there were many on the ground, indicating that they could not be shaken off at the last picking. Clearly the crop of 1912 was harvested too early and the loss to the growers of Oregon amounted to thousands of dollars.

As fruit matures many chemical changes take place as regards tannin, acids, starches, and sugar. The sugar accumulates very rapidly during the last few days of maturity. Sugar is very desirable in the

![Fig. 5. A REINFORCED CONCRETE HOT-AIR CHAMBER. Note numerous cold air intakes close to the ground. A brick-arch furnace, lined with fire-brick, furnishes heat for evaporator and also, by means of coils in the furnace, heats the water for dipping.](image)

![Fig. 6. THE "DUTCHMAN." A separate furnace is often used for heating water for the dipping tank. The fire can thus easily be regulated without affecting the rest of the evaporator.](image)

Italian prune. It means maturity of fruit and heavier fruit, a greater percentage of dried fruit secured from fresh fruit, a shortening of the evaporation period, and the production of a much more desirable product.

While we did not conduct chemical analyses on such a scale that we can regard our results as at all conclusive, nevertheless those we did conduct indicated that the increase in sugar content was very rapid during the last few days of ripening. From the time the prunes are shaken off until they drop naturally, if not shaken, the increase is 1.6% of their total weight. This increase in weight is practically all sugar and would mean that about 11% of the sugar content has accumulated in that short time. Some studies to determine the differences in specific
gravity in prunes in these investigations indicated very rapid increase in weight during the last few days before the prunes dropped. The prunes which dropped naturally had a specific gravity of .0283 higher than those which were shaken off. During the season of 1913 we used a brine solution of 1.0905 density. With this solution one could very easily separate the prunes which were shaken from the trees from those which dropped naturally.

**Losses from Premature Picking.** Premature harvesting, then, seems to be the greatest cause of loss in the evaporation of prunes. Unfortunately this premature harvesting and great loss has been encouraged by the fact that some packers offer a premium for early delivery. Other growers, fearing rainy weather, practice this early harvesting. Weather records, however, show that rain is as likely to occur early in the month as it is later. Often, if harvesting is delayed, the early rains will cease and good weather will prevail during the remainder of the season. This was true during the seasons of 1911 and 1914. During the season of 1914 the majority of growers were well under way in their harvesting by September 6. In our experimental plots, however, we did not start our picking until September 11 and then obtained only 4.22% of the crop in the picking. Results showed that had we waited five or ten days longer we should have gained more, as that portion of the orchard on which picking was begun September 11 was not completely harvested until September 20.

During the year 1913 we were able to secure some observations in a twenty-acre Italian prune orchard where the owner was harvesting his crop rather early. By harvesting the fruit from a few trees after they dropped naturally, as compared with fruit he was shaking vigor-
ously from the trees, we were able to get a good index of his loss in weight. Using the weight of the dried fruit as a basis, we found that he lost 6% of the total weight of his crop by harvesting too early. In addition to this, the immature prunes dried away more than the ripe ones. This resulted in an additional loss of 6% in his crop, making a total loss of 12%, or a monetary loss of $15.00 a ton due to too early harvesting.

Extensive shaking experiments which we carried on during this same season proved that the prunes which dropped naturally in the fruit harvesting, dried 3% heavier than those shaken off. The gain in weight of the finished product for the season was 6.05%, giving us a total of 9.25%, or $13.87 a ton.

In obtaining these results we assumed that the cost of harvesting was the same in both cases. It must be remembered, however, that it costs from $1.00 to $2.00 a ton to shake green fruit from the trees. This would mean that from $3.00 to $6.00 for each ton of dried fruit must be added to the cost of harvesting, where shaking is employed. By watching the fruit carefully one can determine the proper time of harvesting.

The ideal prune for evaporating is one which is mature, (that is, fully ripe), which drops naturally, is plump, and has a golden yellow flesh. If the prune is shriveled at the stem, has a fibrous dark-colored flesh, or shows a tendency to become mushy, it will mean that the prune has poor drying qualities. The ideal prune will make a sweet, flavored product, and will give as high as 25 pounds of dried fruit to 60 pounds of fresh. Prunes of the second type will give only about 19 pounds of dried fruit to every 60 pounds of fresh, and are dark colored, sour, and tough. Undoubtedly the question of the production of prunes,
so as to have them mature early and have desirable characteristics, is one which needs much study and perhaps extensive experimental observations.

**Sorting the Prunes.** A few of the growers sort out all the decayed prunes at the time the fruit is trayed, but a greater number of the growers depend upon the pickers to gather up only good, sound prunes. We have observed both systems, tried out on an extensive scale, from the point of view of economy. For a number of years we have been convinced that there is a distinct advantage in having the pickers gather everything, the rotten, undesirable fruit being sorted out before it is trayed. With such a system there is very little poor fruit to bother the pickers after the first picking, while if this is not done, the decayed fruit is constantly accumulating, thus making the picking more difficult and disagreeable. With either system, some sorting will need to be done in the evaporator, and it is well to have some one man in the evaporator responsible for all the sorting, in order that more uniform and satisfactory results may be obtained. This can perhaps be more economically done by emptying the prunes on endless belts, which carry them past the sorter to the dipping machine.

**Brown-rot Infection.** There is one very good argument against mixing decayed fruit with sound fruit and that is the danger of infection from brown rot. Most of the rotten prunes are attacked by a fungous disease known as brown rot (*Sclerotina fructigena*). This disease will spread very rapidly from decayed fruit to sound fruit whenever conditions are suitable and often the loss from such sources is very great after the prunes have been delivered to the evaporator and have been allowed to

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**Fig. 9.** THE WILLIAM FRYER EVAPORATOR. One of the largest evaporators in the State. This shows the advantage of building on a side hill so that the proper height can be obtained for the hot-air chamber and at the same time have the receiving room not too high for convenient unloading. Note the high ventilators.
stand around in a warm, moist atmosphere for a considerable length of time. It would be well if there was some system whereby these rotten prunes could be removed from the orchard, and thus prevent them serving as a menace to future crops.

**Picking Up Prunes.** Prunes are picked from the ground (Fig. 1) and placed in lug boxes which will hold about 60 pounds. The price paid the pickers ranges from 5 to 10 cents a box, depending on the season, crop, etc. From 30 to 40 boxes is considered a fair amount for ten hours work under normal conditions. There are times when many pickers far exceed this average, due to very favorable conditions. It is desirable after the fruit has been placed in the lug boxes to have it removed to the evaporator as soon as possible.

**Yield of Fruit.** The question is often asked as to how many pounds of dried prunes one should expect to the acre. This is an extremely hard question to answer. The condition of the fruit (that is, the degree of its maturity, weather conditions, methods of drying, age and vitality of the orchard, etc., all exert an influence. At the time we made our survey of 700 orchards we found this kind of information very difficult to secure. The range of yields was wide. One might naturally expect this, owing to the fact that the orchards differed widely; many of them...
were very old, while others were just coming into bearing. By checking up with packers, as well as with growers, we were able to strike a pretty fair average. The maximum yield reported was 8,000 pounds of dried fruit to the acre. There were a large number of reports exceeding 4,000 pounds an acre. The minimum yield reported was 500 pounds. The average yield of the bearing orchards was about 2,800 pounds of dried fruit to the acre.

**PREPARING FRUIT FOR EVAPORATION**

It is very desirable to evaporate the fruit as soon as possible after harvesting. Unfortunately, fruit is sometimes carried to the evaporator and forced to remain in the boxes for several days before it can be placed on the trays. This always means a serious loss. The brown rot, if present in such boxes, will tend to spread rapidly. There is considerable humidity in the atmosphere around the prune evaporators and the temperature will often range from 90 to 115 degrees. This condition is especially favorable for the spread of fungus, and the loss from this source at times is very high. Again, these conditions encourage the fermentation of sugars in the fruit; our observations revealed a considerable amount of such fermentation. Fermentation always means a loss of sugar and a final loss of weight in the dried fruit, as well as deterioration in quality. The sooner the prunes can be placed in the trays, the less danger there is of loss.

**Grading.** From observations we have been able to make and from experiments we have conducted, we are inclined to believe that it would pay to grade the prunes before they are placed on the trays for evaporation. The greater the variation in size and ripeness of prunes, the
greater will be the percentage of dobies. The percentage of dobies is also increased by premature harvesting. Under normal conditions the percentage of dobies, due to unevenness in size, is about 3%, but may run as high as 8%. In addition to this, the dipping in lye also seems to encourage uneven drying. It would seem wise, therefore, to practice grading, dividing the prunes into at least three sizes. (Fig. 2). While such grading can be done by hand, and is being done by hand by many growers, we wish to call attention to the fact that it is possible to purchase machines on the market that can be adjusted to peaches, prunes, apricots, and even cherries. These machines, which can be purchased at prices ranging from $50 to $100, have a capacity of from 25 to 50 tons.

Where prunes are ungraded, the general tendency is to overdry the small and overripe prunes in order to avoid sorting. By spreading the fruits of the same size on a tray, they tend to evaporate in about the same length of time. This would materially reduce the amount of checking and would hasten drying, as it would relieve many of the trays sooner. It would permit, also, at the same time, the elimination of worthless fruit, such as decayed fruit, which often takes up too much tray space. By actual observations 6% of the tray space is occupied by fruits which are either partly or entirely rotten. This is where poor sorting and no hand grading is practiced.

**DIPPING**

There seems to be a great difference of opinion among the growers concerning the question of dipping. We find that some prunes are dipped in hot lye water, some in boiling water, some in cold water, and some are dried without even dipping. Yet all these men are able to market their crop at standard prices.

Where lye is used, the average strength is one pound of lye to from thirty to fifty gallons of water. The cost of dipping in lye will vary tremendously according to whether the work is done by hand or by machinery. During our survey we found that, on the whole, machine dipping could be done at from 70 to 85 cents a ton, the hand dipping costing materially more. With a modern power machine, (Fig. 2), four men can sort the bad prunes, dip, and tray from 500 to 600 boxes in ten hours. The cost of this entire operation would vary to a certain extent, but would average about one cent a tray. In the smaller evaporators, where a small tonnage is handled, the regular drying crew would be able to do the traying during spare time. In such cases the depreciation for each tray would be greater than if the machine were running to its full capacity. Even then, however, the cost of traying would probably be less than with any other method. In our experimental work, one man did the dipping by hand, two men spread the fruit on the trays, and two did some sorting and stacking the trayed fruit on trucks. (Fig. 4). The figures in Table I are of interest concerning the difference in cost of the two methods.
Table I. Cost of Dipping and Traying

<table>
<thead>
<tr>
<th>Method</th>
<th>Cost per tray</th>
<th>Cost per pound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine dipped</td>
<td>$0.011</td>
<td>$0.000314</td>
</tr>
<tr>
<td>Hand dipped and spread in water</td>
<td>.023</td>
<td>.000770</td>
</tr>
<tr>
<td>Additional cost due to hand dipping</td>
<td>.012</td>
<td>.000456</td>
</tr>
<tr>
<td>per ton of dried</td>
<td></td>
<td>$2.78</td>
</tr>
</tbody>
</table>

Cost of Drying Per Ton of Dried Fruit

<table>
<thead>
<tr>
<th>Method</th>
<th>Cost per ton of dried fruit</th>
<th>Cost of Drying Per Ton of Dried Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine dipped</td>
<td>$21.80</td>
<td></td>
</tr>
<tr>
<td>Hand dipped and spread in water</td>
<td>26.06</td>
<td></td>
</tr>
<tr>
<td>Increase in cost of drying due to hand dipping</td>
<td>$4.26</td>
<td></td>
</tr>
<tr>
<td>Increase in cost of traying due to hand dipping</td>
<td>2.73</td>
<td></td>
</tr>
<tr>
<td>Total increase in cost</td>
<td>$6.99</td>
<td></td>
</tr>
<tr>
<td>Received from sale of rotten prunes</td>
<td>2.70</td>
<td></td>
</tr>
<tr>
<td>Net loss per ton due to hand dipping</td>
<td>$4.29</td>
<td></td>
</tr>
</tbody>
</table>

With hand dipping there seems to be a tendency for more decayed fruit to get on the trays than is true with machine dipping. By the hand method an entire box is handled at a time, while with the machine and endless belt method the prunes are separately exposed to view both in the feeding trough and as they are carried up into the dipping tank. There is also a tendency not to fill the trays to their entire capacity, the average being only 86 percent. This would mean that about 20 percent of the trays are either empty or occupied with worthless fruit.

The chief advantage to be gained from the use of lye is the shortening of the time required for evaporation. General practice, as well as our experiments, would bear out this idea. This difference at times is considerable, as shown in Table II.

Table II. Effect of Lye in the Dipping Process

<table>
<thead>
<tr>
<th>Dipped in lye</th>
<th>Weight fresh lbs.</th>
<th>Weight dry lbs.</th>
<th>No. lbs. dried fruit per bu.</th>
<th>Drying time, hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prunes grown on upland</td>
<td>427</td>
<td>151</td>
<td>21.27</td>
<td>36.</td>
</tr>
<tr>
<td>Prunes grown on upland, green</td>
<td>488</td>
<td>140</td>
<td>19.17</td>
<td>38.</td>
</tr>
<tr>
<td>Prunes grown on lowland</td>
<td>490</td>
<td>169</td>
<td>20.36</td>
<td>37.</td>
</tr>
<tr>
<td>Prunes from lowland, partly dried on ground</td>
<td>444</td>
<td>150</td>
<td>20.27</td>
<td>43.</td>
</tr>
<tr>
<td>Total Average</td>
<td>1799</td>
<td>608</td>
<td>20.27</td>
<td>38.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dipped in boiling water</th>
<th>Weight fresh lbs.</th>
<th>Weight dry lbs.</th>
<th>No. lbs. dried fruit per bu.</th>
<th>Drying time, hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prunes grown on upland</td>
<td>491</td>
<td>176</td>
<td>21.46</td>
<td>42.</td>
</tr>
<tr>
<td>Prunes grown on upland, green</td>
<td>439</td>
<td>143</td>
<td>19.80</td>
<td>45.</td>
</tr>
<tr>
<td>Prunes grown on lowland</td>
<td>495</td>
<td>151</td>
<td>19.27</td>
<td>45.33</td>
</tr>
<tr>
<td>Prunes grown on lowland partly dried on ground</td>
<td>266</td>
<td>99</td>
<td>22.33</td>
<td>43.</td>
</tr>
<tr>
<td>Total Average</td>
<td>1691</td>
<td>569</td>
<td>20.66</td>
<td>43.8</td>
</tr>
</tbody>
</table>
As is readily seen it required 5.3 hours more to dry the unlyed fruit than it did the lyed. The one mistake made, however, by the strong advocates of lye, is that the shortness of drying time is the main factor considered. This will be discussed more thoroughly under the heading, Evaporation.

**Lye-checking.** Dipping the prunes in lye generally means a considerable loss in weight. From experiments we have been able to conduct we have found this loss to be about 2%. Another point which calls for careful study is that not all prunes in any single lot will be checked by the same strength of solution. Ripe prunes will check more easily than green prunes. It naturally follows, therefore, that under the present methods of harvesting, some prunes will be checked more than others, and we shall find that either the ripe prunes will be checked too much, or else the green ones will not be checked at all. This, of course, is another argument in favor of grading. It is interesting to note that those prunes which would normally dry more quickly without the checking are the ones always checked. On the other hand, if there were many prunes left unchecked, it would be those that would dry more slowly without checking. Should the lye solution be made strong enough to check the green fruit, the riper fruit would be so badly checked that the same relative difference in drying would obtain. On the other hand, lye-checked prunes tend to dry more unevenly than those dipped for cleansing purposes only.

**Sanitary Rinsing.** Another disadvantage connected with dipping is the question of sanitation. It is very doubtful if, under any method of dipping, there is sufficient accumulation of alkali to be in any way injurious to health. From some chemical tests which were made, however, we found that often the rinsing water was as strong in lye as the dipping solution. To overcome this it would be well to have the prunes pass through a second rinsing vat. The ideal way, however, and the one which every prune evaporator should attempt to adopt, would be to install a water system so that rinsing vats would have a flowing stream of water. Where this cannot be done both the dipping and rinsing vats should be frequently emptied and thoroughly cleaned. We should all aim to maintain the best sanitation possible. Clean, sweet, wholesome fruit is the only kind which will build up a permanent reputation. No other kind will give us a good, permanent standing in the business world.

**Boiling Water.** Some growers have tried the boiling water and claim they cannot secure results. We know it is possible, however, to secure splendid results with boiling water, as demonstrated in our own experiments and also by our observations with a number of growers who are turning out a good, first-class product. Investigations have shown that occasionally where men have claimed to use boiling water, they have simply used hot, or even merely warm water. This would not tend to check the fruit as would the boiling water.

To those growers who prefer to use lye, we can say that no serious objection can be raised to the practice, if cleanliness is observed and an abundance of good rinsing water is always supplied.
BLEACHING

Bleaching is not practiced generally. In fact, it seems to be in disfavor. About the only prunes which are bleached are the Silvers. The methods practiced are identical with those used in sulfuring other fruits. Before drying, the fruit is placed in a closed compartment, in the bottom of which is a small amount of burning sulfur, and thus exposed to the fumes for only a few minutes. The time, however, will vary according to the amount of sulfur burning, and the cubical contents of the bleaching box.

EVAPORATION OF THE FRUIT

In the evaporation of prunes, certain terms are generally used which may not be well understood by growers who are engaging in the work for the first time. A brief definition of these terms will probably prove helpful to such people. “Drying time” is figured from the time the fruit is placed in the heating chamber to the time it is removed as dried fruit. “Weight per bushel” refers to the number of pounds of dried fruit from sixty pounds of fresh prunes. “Size” refers to the number of dried prunes it takes to make a pound, such as 30-40’s, 40-50’s, etc. “Dying percentage” is the relative amount of dried fruit that is obtained from a given amount of fresh fruit. “Dobbies” are prunes which dry more slowly than most of the fruit on the tray and have to be re-dried. “Bloaters” are prunes which puff up until the skin becomes very tight so that they often explode and are worthless, examination showing that nothing is left but skin and pit. They are apt to have a burned or scorched flavor. “Dripping” refers to an accumulation of thick sirup which oozes from the fruit during the process of evaporation, generally caused by using unripe fruit and by improper methods of evaporation. Too high a temperature at certain stages of evaporation may be partly responsible. Poor ventilation is also a factor. “Sweating” refers to the placing of prunes in piles or bins and allowing them to remain until the entire mass has a uniform moisture content. “Sugaring” refers to the accumulation of a white or sugary substance on the outside of the fruit. “Frogs” are cured prunes which are very much misshapen, probably due to the fruit being unripe. “Processing” refers to the steaming of the prunes just before they are packed in the boxes for market. It is a cleansing, softening process and facilitates proper packing.

Buildings for Evaporating Prunes. No hard fixed rules can be formulated which will apply in detail to all buildings used for the evaporation of prunes. Every grower must study his own evaporator carefully, so that he may know under what conditions he can secure certain temperatures, certain air circulation, and a combination of factors which will turn out a high-grade fruit. What might apply to one building might not to another. There are certain fundamental principles, however, that apply to all buildings. For instance, lack of ventilation or air circulation would have the same effect regardless of where the prunes are dried. The use of abnormally low, or abnormally high temperatures would have the same influence in any building, as far as the type of product turned out is concerned. Prunes require a great deal of air, which should move at the rate of at least 600 feet a minute. They should have a starting temperature of about 130 to 145 degrees,
and a finishing temperature not higher than 160 degrees. A high humidity should prevail until the fruit is thoroughly heated, then the humidity should be gradually decreased until it is a little less than the percentage of moisture desired in the finished product. It is well to have the tunnels thoroughly heated before the fruit is introduced. Some growers claim that they start prunes at as low a temperature as 90 to 115 degrees. We doubt, however, the wisdom of such a practice, for with such temperatures rapid fermentation of fruit may take place, which means a loss of sugar and a deterioration of the product. Certain molds may form at the lower temperature and brown rot can work under such conditions. We have not carried on sufficient experimental work to state arbitrarily just what temperatures are always best, but our results do show, and our observations with many growers indicate, that the temperatures we have advised produce splendid results. It must be remembered that warm air will absorb more moisture than cold air; that if you have a large volume of hot, dry air, moisture that is given off from the fruit will be absorbed very rapidly. Just how much moisture the air can hold and still be of value in prune drying, is a subject needing much investigation. Many tunnels are so long that the air when it reaches the ends of the tunnels is practically valueless for evaporating purposes, as it is practically saturated with moisture, and giving out moisture rapidly into the air tends to cool it and thus reduce the moisture-holding capacity. As the prunes are nearing the time when they are ready to be taken from the trays, they gradually become hot. If, however, they are allowed to become too hot before they are really finished, the cells may rupture and leak, and dripping will take place.

**Thermometers.** Much of the poor work in the evaporation of prunes is due to the fact that the grower is using a poor thermometer. Cheap thermometers should not be used in prune evaporation. It would pay all growers to use some self-recording thermometer which would record the temperature during the entire twenty-four hours. Such a thermometer will easily indicate what happens when the night worker goes to sleep, and will be an aid in explaining many of the poor results obtained.

**Air circulation** is extremely important. Good air circulation and proper ventilation must prevail at all times. It is possible to have too rapid circulation and to have the ventilators draw out the air too quickly. For example, in evaporating vegetables, it is very desirable to have the air move rapidly at a relatively low temperature of about 140 degrees. These results are obtained by blowing air over steam pipes and causing it to move rapidly over the vegetables. Some fresh fruits should be dried in this same way. The aim is to have the product when finished resemble, as much as possible, the undried product. With prunes, however, the aim is entirely different. We are really after a cured fruit. While it may be desirable so to handle the evaporator that a high-class product may be turned out in the shortest time, yet we must not make the mistake of attempting to evaporate the prunes so rapidly that an inferior product is the result. Certain changes are taking place in the prune during the process of evaporation. Sugar is forming rapidly and will do so unless the temperature is forced too high on the one hand, or allowed to remain too low, on the other. It is very important to have all the factors influencing drying under the complete control of the
Operator and influenced as little as possible by outside conditions and climatic changes.

Weather exerts a marked influence on the weight of the fruit obtained from each bushel and on the drying percentage. The influence of weather is well shown in Table III.

**Table III. Weight of Fruit as Influenced by Climatic Conditions**

<table>
<thead>
<tr>
<th>Year</th>
<th>Weight per bushel</th>
<th>Drying percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1911—Rainy</td>
<td>17.00 lbs.</td>
<td>28.83%</td>
</tr>
<tr>
<td>1912—Dry</td>
<td>19.89 lbs.</td>
<td>33.15%</td>
</tr>
<tr>
<td>1913—Dry</td>
<td>20.80 lbs.</td>
<td>33.85%</td>
</tr>
<tr>
<td>Maximum in experimental work for 1913</td>
<td>24.40 lbs.</td>
<td>40.07%</td>
</tr>
<tr>
<td>1914—Rainy</td>
<td>17.05 lbs.</td>
<td>28.41%</td>
</tr>
<tr>
<td>Maximum in experimental work for 1914</td>
<td>20.25 lbs.</td>
<td>33.76%</td>
</tr>
<tr>
<td>Average for rainy weather</td>
<td>17.02 lbs.</td>
<td>28.37%</td>
</tr>
<tr>
<td>Average for dry weather</td>
<td>20.09 lbs.</td>
<td>33.49%</td>
</tr>
<tr>
<td>Loss due to rainy weather</td>
<td>3.07 lbs.</td>
<td>5.12%</td>
</tr>
</tbody>
</table>

The seasons of 1911 and 1914 were much alike. They were both rainy at the beginning of the season and strong southwest winds prevailed. Such conditions are unfavorable to the evaporation of prunes. During the seasons of 1912 and 1913, however, almost ideal climatic conditions prevailed for good evaporation. The average sugar content for 1913 was 15.28% and that of 1914, 12.45%. This will account for some of the difference in weight of prunes, the remaining difference probably being due to weather conditions. From our investigations extending over a number of years, we find that there is a loss ranging from 5% to 9% in the drying percentage due to unfavorable weather conditions. If climatic conditions had been such that the prunes had thoroughly matured, having a very high sugar content, less time would have been required to dry, there being a high drying percentage. This is one reason why Petites dry more quickly than Italians; another reason is because they are a smaller fruit. Investigations will show that some years prunes contain much more moisture than others, are less mature and contain less sugar, and therefore require a longer drying time.

**Moisture Content.** The question is often asked as to how much moisture prunes should contain after they are evaporated. In our experimental work we have accepted 17% to 18% as the proper moisture content. In some cases it has run as high as 22% without any apparent injury to the keeping quality of the prunes. It is desirable to have as high a moisture content as is compatible with good keeping qualities. As a rule, the prunes having the higher moisture content seem to have the better quality. It is to the interest of the growers that the best quality of prunes possible be placed on the market. The moisture must be dried out to a point where the prunes will keep well, but a point higher than that is undesirable both from the point of view of the quality of the fruit and from the point of view of profit to the growers. Table IV shows the effect of the drying time on the average weight per bushel secured in some of our prunes used in experiments.
The figures given in Table IV were taken from data collected over a period of two years and represent the number of trials in each case. The gradual decrease of the drying percentage as time increases is probably a true indication of what may be expected with evaporation methods commonly practiced. Where prunes are dried very slowly, they have a tendency to take on a dull, unattractive appearance, and during the season of 1914 mold appeared on such fruit. With such prunes the temperature had probably been kept altogether too low.

**Drying Time Important.** There seems to be very little change in the drying percentage until the drying time becomes abnormally long. There is, however, a marked difference in the appearance, texture, and flavor of the fruit. These seem to be better where the drying time is relatively short, and less favorable where the drying time is increased. It must constantly be borne in mind, however, that shortening the drying time will not always give a higher drying percentage; for if a dry, parching heat is used from start to finish, the prunes will have a distinctly tough skin, glossy, black color, but will dry away badly. The drying time seems to be of very little importance except to show the presence or absence of ideal conditions. If all conditions are favorable for good evaporation, the process will be fairly rapid and the drying time relatively short. If the drying time is abnormally long, the operator should know that either his methods are not the best, or else the building is faulty in construction.

There seems to be little change in the appearance of the prunes during the last six or eight hours of drying. As the amount of moisture in the fruit becomes less, the amount evaporated in a given time also becomes less and the air is not cooled as rapidly as was true when the prunes were giving out lots of moisture. The greatest loss of moisture seems to occur when the humidity of the air is between 10% and 15%. Finishing the product in a high, dry, parching temperature, seems to produce a less desirable fruit.

**Economies Possible.** The air at the lower or finishing end of the tunnels is practically dry at all times. A slight increase in humidity was observed when the weather was clear and warm, over that noted when cold, rainy weather prevailed. A greater difference prevailed, however, at the upper or starting end, where during clear, warm weather, the humidity of the air was about 30%, but during cold, rainy weather the average was about 15% to 20% and at times ran as low as 5%. These facts become important when we consider the importance of returning some of the heated air, passing it over the fruit a second time. By mixing some outside air with that already heated to 135 degrees and passing this mixture over the furnace, the humidity could be controlled and the amount of heat required lessened.
When air is taken in the furnace pit at a temperature of 45 to 70 degrees, which commonly occurs during the period of evaporation, a large amount of heat is required to raise the temperature to 160 degrees. Since the air passes off at the upper end at a temperature of 120 to 140 degrees, a large amount of heat is lost. The removal of moisture from the air by condensation is doubly expensive in that the cost of cooling is added to that of reheating air from a low to a high temperature. If, by the use of forced air currents, the greater part of the air could be returned to the furnace pit at a temperature of 120 degrees or better, much of the cost of heating could be reduced. Possibly methods will be evolved, some time, so that much of the heat which is now entirely lost can be used.

As soon as the prunes are finished they should be removed from the trays while still warm, the dobies should be re-trayed and redried. The prunes are then taken to the bins or piles to cure until sold or ready for processing.

**PROCESSING**

We are not attempting in this bulletin to handle in detail the processing of prunes. We are interested, however, in some of the problems which the packers are facing in the processing of prunes. These problems will be investigated during the coming season.

**BUILDINGS AND EQUIPMENT**

In the back of this bulletin will be found sketches and suggestions for those desiring to build evaporators. We desire, however, to give some general suggestions at this time to those who are planning to erect these buildings, or for those who may be considering remodeling. We have visited a large number of prune driers and shall be glad to give lists of names and addresses to those who care to visit buildings of certain types. In fact, if more of the prune growers would visit their neighbors, or make trips to other prune sections, they would often learn much of value to them in their work.

**Equipment.** Only a small amount of equipment is necessary for the evaporation of prunes. Some type of dipper should be in all buildings. To get the best results some arrangement must be made for keeping the water boiling hot. Coils are sometimes placed in one of the furnaces (Fig. 5) for such purpose, or a special brick furnace (Fig. 6) with coils is arranged solely to produce large quantities of boiling water. To those who do not have mechanical dippers we would suggest that they look into the possibilities of such machines. There are several on the market doing very efficient work. (Fig. 3). There are several very unique dippers (Fig. 7) that could probably be copied, if one desired to use them. Well-built tanks which can be cleansed easily should be installed adjacent to the dippers. Some of the mechanical dippers need no additional tanks as the dipping and rinsing are done with the same operation.

Trucks can be used to splendid advantage in delivering trays to desired points. In some cases mechanical contrivances for the return of trays have been worked out and seem to be fairly satisfactory.
For heating purposes brick ovens, furnaces or so-called hop stoves are used. The hop stoves are increasing in favor. It has been found difficult to build brick ovens which will stand the heat. Not enough attention has been given to stove pipes and chimneys. In many cases the stoves are required to heat too great an area and in others not sufficient space is allowed. Wherever a furnace needs a forced draft, or it is necessary to keep the dampers constantly open, it is an indication that the stove is being over loaded. Sufficient heat should be secured by running a moderate fire. If the stove is over heated much heat is lost through the chimney, there is greater danger of burning out the pipes, and greater danger from fires. Each stove should be placed in a separate pit, so that only one unit of the evaporator may be used if desired. Numerous cold-air intakes should be arranged on the outside of the furnace pit (Fig. 5), so that cold air can be brought in below the pipes. It is better to have too many of these intakes than too few, as one can easily close the ones that are desired. Large stove pipes with little reduction in diameter from the furnace to the flue are desired. The building should be provided with a large chimney having a good damper.

The building should be so constructed that the fruit always moves in one direction. Avoid steep stairs if possible. (Fig. 8). Inclines can be used to splendid advantage and should often take the place of steps. Side-hill houses have much merit (Figs. 9, 13, and 23), as the fruit can be brought up on the upper side and taken out on the lower. Where large quantities of prunes are to be handled, a store house at a considerable distance from the evaporator is desirable, so that in case of fire though the evaporator may be lost, the crop may be saved.
Costs. The cost of the building should be very carefully studied. One man may have a building representing only $1,000 for every ton daily capacity. Another man's building may represent $2,000 for the same capacity and yet may not be superior to the other building in any respect. The building should be well built. The outside walls should be of such a nature as to prevent the tunnels or stacks from drafts of cold air or sudden changes of wind. The furnace pits should be constructed of reinforced concrete (Fig. 5), or similar fireproof material. Tunnel walls and partitions should be double walled with dead air spaces. The top of the tunnels should have a layer of building paper between the two thicknesses of boards. Strive for a simple, economical, substantial building.

Two Types of Driers. We may divide prune driers into two classes, according to the source of heat; namely, steam, and hot air. Steam evaporators are not generally used, as they are very expensive. Some of them, however, do most excellent work and are splendidly adapted for the evaporation of other fruits, and more especially vegetables. With steam driers, the air is generally forced or blown over hot steam coils and forced through the tunnels. There are communities where it might be desirable to cooperate in the erection of large community driers. In such cases it might be well for those interested to look into the possibilities of steam evaporators, as well as hot-air evaporators.

Tunnel or Stack. The hot-air evaporators may he divided into two types; namely, the tunnel, and the stack. There are a number of models of tunnel driers and these models in turn are often modified to meet the desires of the owner. In a general way the tunnel drier may be described as a group of long, nearly horizontal wooden tunnels arranged side by side over a fire pit. These are generally built in units such as 3's, 6's, 7's or 8's. A separate stove is required for every three or four tunnels. These tunnels range in length from 20 to 50 feet. The tendency has been of late materially to shorten the tunnels. From investigations we have conducted we cannot see any advantage, under ordinary conditions, in having tunnels over 22 feet long. In fact, some
of the best work we have been able to do has been done with the tunnels not over 16 feet in length. These tunnels range from 4 to 6 feet in height and the slope from end to end is between 2 and 3 feet. Some tunnels are built on a slope equal to 3 inches to the foot. (Fig. 8). For general use we believe one is not justified in giving over 2 inches to the foot. The tunnels may be arranged so that each is complete in itself, or so constructed that the walls between each series are open. Along the walls are nailed cleats or rollers to support the trays of fruit and to serve as tracks along which they are pushed. (Figs. 10, 11, and 17). The fruit is placed in at the upper end and is gradually pushed down to

![Diagram of Evaporator](image-url)

**Fig. 15. CROSS SECTION OF THE GEORGE S. ZIMMERMAN EVAPORATOR.** *(See description in text.)*

the lower end as it passes through the process of drying. In most buildings the sets of cleats or rollers upon which the trays move are equally distant apart. In other buildings, however, greater space is allowed at the bottom and less at the top, the first, for example, being 6 inches apart, the next two 5 3/4 inches and the distance reduced 3/4 inch between each succeeding pair of cleats. This is done to give better air circulation.

At the lower end of the tunnels it is well to have a notch in the cleats so that the trays cannot be pushed out of the tunnel without first being lifted. The pit just below the tunnel should be of good size to give a large volume of heated air. These pits are generally nearly as
long as the tunnel, at least 15 feet in length, and the distance from the
topmost pipe to the floor of the tunnel will range from 6 to 11 feet. The
greater this distance the more even is the distribution of heat and the
less danger of scorching fruit on the lower trays. Often the greater the
distance, the larger the opening in the tunnel. Sheets of iron are often
placed just above the stove in order to reflect the heat and prevent an
excessive upward rush of hot air. The stoves in these pits generally
measure about 2' x 2' x 5'. The tunnel type of building allows for many
changes and gives one an opportunity to experiment. Changes may be
made in the floor plan, in the general arrangement, in slope of tunnels,
length of tunnels, use of cars in place of slides (Fig. 12), use of separate
ventilators, etc. Modifications of these various factors will greatly in-
fluence the time of drying and the product which is turned out.

Fig. 16. A HOLLOW-TILE HOT-AIR CHAMBER. In this instance there is ample
 provision made for intake of air.

The stack drier is really a vertical box arranged above a pit similar
to that planned for the tunnel drier. The bottom of the stack is open,
the hot air entering from below, passing through the trays and through
a ventilator at the top. Stack driers are all very much alike; there is
very little opportunity to change them.

Stack Dryer. The older type of stack drier consists of a vertical
series of from three to four compartments open to each other and each
holding three trays spaced 3 inches apart. The fruit is placed in at the
top and after a small amount of drying is moved down closer to the fire.
This means much extra handling. In the newer types of stacks all the
compartments are merged and from 12 to 17 or more trays are used
for each stack, the trays resting directly upon one another. Each stack
is provided with a lever and catches, commonly called "dogs" which
will raise all the trays slightly and hold them suspended while the bottom tray is being removed. When the levers are released the trays are lowered one notch and a new tray inserted at the top. Thus the fresh fruit is always placed in at the top and dried fruit taken at the bottom.

As a rule, about twenty stacks are heated with one furnace. If the bottom trays come too near the furnace there is great danger of scorching. The stack will probably turn out more fruit in a given time than will the tunnel type, since the air currents are always moving upward and the heat is less diffused than with the tunnel type. However, there seems to be more danger of scorching and overdrying with the stack than with the tunnel. This is especially true where the stacks are built too closely to the fire. The type of fruit turned out,

![Figure 17. DETAILS OF TUNNEL OUTLET.](image)

however, will depend somewhat upon the man handling the outfit. A good product can be turned out from either the stack or tunnel type of drier.

The size of evaporator which a man should erect will depend upon the acreage which he has to handle either for himself alone or for neighbors as well, since in some sections of the State, so-called "custom" drying is a regular business with some men, especially where the home orchard is too small to bear the entire expense of investment in evaporator and equipment. Speaking broadly, it would rarely be considered advisable to erect an evaporator to handle the product from less than 15 to 20 acres of good bearing orchard. With this as a lower limit, a small evaporator of three tunnels could be built to handle the output from such an orchard. With increases in acreage above this the units could be doubled or tripled; in fact, there need be no limit to the number of units included within one building save for considerations of convenience and fire risk.
Using small units which are entirely complete in themselves enables the owner to economize on fuel. At the beginning and end of the season, by firing only one unit at a time and then increasing the number as the height of the harvest comes on, only enough fires need be maintained to handle the amount of fruit available. Where the acreage is quite large, the units are sometimes doubled so as to have two furnaces or stoves serving the one set of tunnels; the practice of having a separate division for each fire, however, is to be encouraged.

Throughout the prune-growing districts are to be found a large number of evaporators of every kind and description with hardly any two built exactly alike. In most of the more recently constructed evaporators an attempt has been made to eliminate the defects in the older ones, and while even the newest do not claim to have reached perfection, they are, for the most part, turning out a more uniform, high-quality product at less expense than was general some years ago.

Fig. 19. A HOME-MADE APPARATUS FOR MAKING TRAYS. It is frequently cheaper and more convenient to buy the frame stock in shocks, cut to fit but to be made up at home.

Among the newer evaporators may be mentioned three, for which floor plans and cross-section drawings appear in this publication. There are many others throughout the State which embody features of considerable worth and which have much to commend them to the grower who is about to build. Lack of space alone preventing special mention of these other evaporators, it is suggested that those interested in inspecting several different types, write to the Division of Horticulture at the College, which will gladly furnish a list of additional evaporators that are doing very satisfactory work.

While it is not claimed that the three here selected are the best evaporators of their kind, they are in every case turning out a good product economically, and serve to illustrate certain details in construction. The accompanying pictures, together with a brief description of each, should give quite a comprehensive idea of those described.
The George S. Zimmerman evaporator (Figs. 13, 14, and 15) located one mile north of Yamhill in Yamhill County, is one of the larger evaporators, consisting of twenty-four tunnels in three units, each unit of eight tunnels being served by two stoves. The hot-air chamber in this instance is made of 6-inch hollow tile for the lower part, and of 4-inch tile for the upper part of four feet. The sloping top at present is corrugated sheet metal, but so much heat is lost by radiation that the owner purposes to make this top solid or else cover it with dirt or sand. Ample provision is made for air intake by placing the lower tiers of tile so that the openings lead into the stove room (Fig. 16), the openings being closed partly when less intake of air is desired. The stoves are heavy cast iron of sufficient size (2 1/2' x 2 1/2' x 8') and with enough pipe carried back and forth in the hot-air chamber so that the desired temperature can be maintained without over-forcing the fires. The pipes for leading the fumes of combustion from stoves to flue are of heavy gauged iron 16 inches in diameter narrowing to 13 inches, and evenly distributed around the chamber so as to warm the air as it draws in below the pipes and ascends to the throat leading to the tunnel. There is a separate chimney or flue (26" x 31" outside measurement) for each two stoves.

The heated air enters the tunnel through a 2-foot throat with a slide which allows for regulating the opening in order that the heat may not strike the prunes directly. In the tunnel the wooden tray slides (1 1/2" x 1 1/2") are so spaced as to cut down 1/4 inch in the distance between each successively higher slide, this arrangement apparently giving a good distribution of the heated air over the fruit. The trays are
off-set 1½ inches each, to intercept the upward flow of air (Fig. 17). The trays (31½" x 37½") are made of galvanized tray cloth placed between spruce frames made of 1½"x⅜" material. (Fig. 18). Each tunnel will hold 96 trays placed the short way, 8 deep on 12 slides, with space for three trays in each finishing oven. The tunnels in this evaporator are built with double floors; solid partitions made of three thicknesses of flooring; and a ¾" tongue and groove ceiling which this year is to be made double with paper between so as to reduce on loss of heat. The tunnels, 22 feet long, have a 3-foot rise between the lower and upper end. The ventilators, 30 inches wide, are partitioned for each tunnel and rise sufficiently high above the roof to insure a draft. A hinged damper inside at the lower end and hinged wings outside at the top of the ventilator provide opportunity for regulating the flow of air through the tunnels. The large doors at each end of the tunnels are made of beaver board on a light frame, thus making them much easier to slide up and down than if made solid of wood.

The actual evaporating parts just described are within a building of sufficient size to run at full capacity economically and conveniently. The large porch across the entire front makes unloading easy. (Fig. 13). The preparing room contains a power-driven dipper and spread (Fig. 3), the boiling water for which is furnished by coils in a separate brick furnace. The floor boards in this part (7' x 30') are slightly separated to give good drainage for spilled water around the dipper. The inclined runways between the evaporating sections are made wide enough for trucking the empty trays; while the rear aisle, the sorting table, (Fig. 19) and storage bin, make handling of the evaporated product convenient. Because of the fire risk involved, it would probably have been wiser to...
provide a separate storage for the finished prunes. The building itself is most advantageously located on a side hill.

Such an evaporator will hold one thousand boxes of prunes at a filling. In this instance the building itself is somewhat larger and cost a trifle more than would actually be necessary merely for handling that quantity of prunes. Mr. Zimmerman, however, uses the building also for pressing cider and drying apples.

**SMALL TUNNEL EVAPORATOR**

The evaporator owned by Mr. L. J. Eddens at Dundee, Oregon, (Fig. 20) was built in 1916 at a cost of only $1,300 actual cash, the owner's labor not being included. The parts to be used in the evaporating itself were built with the greatest care, which has resulted in an evaporator capable of turning off a very fine product. Figures 21 and 22 give the essential dimensions, while a few additional notes will bring out some interesting details.

The hot-air chamber, 12 feet high, is built of reenforced concrete 7 inches wide at the foundation, with 5-inch walls for the main structure, two iron pipes being inserted crossways inside from which the flue pipes are supported. While only one furnace was used last year, this evaporator is intended to be fired with two brick-arch furnaces 8 feet long, with runs of pipe (15" narrowing to 13") to increase the radiating surface. The distance of 8 feet between these pipes and the tunnel proper, gives a good-sized mixing chamber and minimizes the danger of scorching. The tunnel joists are 3 x 16s, since smaller joists when constantly subjected to so high a continuous temperature kill off quickly and need to be replaced.

Ample provision is made for intake of air on all four sides, there being 18 openings in all, each 1 foot square.
The tunnels have solid partitions of 2-inch planking with tongue and grooved floor and ceiling. The ventilator is divided, giving a separate shaft for each tunnel. The trays, made of galvanized tray cloth between double frames, run through the tunnels on telephone insulators as rollers (Fig. 11), a system which works quite well where there are solid walls to nail the rollers to and where these have been accurately placed. The successive tracks are slightly closer together toward the top and the trays are placed 1 1/2 inches off-set.

The tunnel doors, being made of wooden faves covered with oil cloth, are easily moved up and down. Linoleum has also been used in some places with good results.

The surrounding building has a small uncovered platform, used merely for unloading, but a large, receiving and preparing room, where

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Fig. 22. CROSS SECTION OF THE L. J. EDDENS EVAPORATOR.
(See description in text).

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the fruit can be kept out of the rain and sun as soon as delivered. The dipping and traying machine is home made and of a type which is used quite widely in the smaller evaporators. The water for this is heated by a separate fire (Fig. 6). In some evaporators, however, water for the dipping is heated by coils in the regular stove or furnace. (Fig. 5). After being filled, the trays are placed on a frame bench directly behind the tunnels, thus saving considerable handling; a trough beneath this bench catches the water draining from the wet prunes.

An inclined runway on each side serves to protect the outside tunnels from being directly affected by the cold winds and also allows the empty trays to be trucked back to the dipping machine. Against the end wall at the lower end of the building is the sorting table. This is partly covered with wire tray cloth which permits dried leaves, sticks, and debris to fall through, and is provided with openings so fixed that
the dried prunes can either be put directly into sacks or boxes or sent through chutes into the storage room below.

The stairs are placed on the outside of the building, to save space within. There are also a number of ingenious fixtures and arrangements which have been put into use to make this an economical and efficient small evaporator, with a capacity of close to 300 bushels at one filling.

**STACK EVAPORATOR**

The stack type of evaporator is used in some places and well deserves mention among the successful evaporators. As an example of this type may be cited the George Palmer evaporator located in the Rosedale district south of Salem, in Marion County, Oregon. (Fig. 23).

![The George Palmer Stack Evaporator](image)

The essential difference between the stack and tunnel, as has been said, is that in the former the heated air passes through the trays of fruit and out through a ventilator above, while in the latter, the air tends to follow along open channels between the tiers of trays passing over and under the fruit rather than through. Figures 24 and 25 give the important dimensions.

The heating system is similar to those already described, there being a hot-air chamber 12 feet high, made of hollow tile, the heat being furnished by one large stove and nine runs of pipes with two drums. The arrangement for intake of air is rather unique, inasmuch as the air is taken from within the building and carried down between the outside of the tile wall and an outer wooden wall and deliveerd
into the hot-air chamber below the pipes, the idea being to use partly heated air and so effect a saving in fuel.

The heated air passes directly through the filled trays of fruit, which are placed one above another. Each stack has a special device for elevating the entire lot of trays except the bottom one, which may easily be examined and either removed or returned for further evaporating. The type of lift in this evaporator is one which seems to work very smoothly was worked out by Mr. L. P. Hopkins (also in the Rose-dale district) after whose general plan the whole building was patterned. The trays, of galvanized wire cloth, are a special size 25" x 42" with high sides, to keep the prunes from being crushed when the trays are in the stack, and with two notches on each side to accommodate the working of the lifting device.

The ventilator is high enough to give a steady flow of air under most circumstances. Mr. Hopkins, however, in his own evaporator has supplemented the natural flow by installing fans inside the ventilators, a system which seems to have given excellent results.

The hand-operated dipping apparatus here used was made by a local hardware man. The water coils for the tank are heated by the same fire which evaporates the fruit, being placed in the first length of pipe back of the stove.

To save labor, there is a narrow runway two feet lower than the floor in front of each line of stacks along which the operator walks when examining and removing the bottom trays in the stacks. (Fig. 26). The labor of filling is also lessened, since with the main floor at the height indicated, the trays are quite easily inserted at the top of the stack. The sorting tables on both sides and the storage bins below (Fig. 23) are convenient and save considerable handling.

In this evaporator, where there are two rows of stacks placed back to back, so to speak, with thirteen stacks in each row and sixteen or more trays in each stack, the capacity is over 200 bushels at a filing.

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**Fig. 24. FLOOR PLAN OF THE GEORGE PALMER EVAPORATOR.**

(See description in text.)
KILN EVAPORATORS

So many inquiries have come for information as to what is meant by the kiln type of evaporator, that it has been decided to insert in this bulletin a few line drawings, (Figs. 27 and 28), to illustrate what such a building would be like, and to give proportionate dimensions. In essential features, there is little difference between this and the hop drier as used widely throughout Oregon. There is a fire-proof pit in which to develop the hot air, the cold air entering below the pipes and becoming heated in a manner similar to that described for the other evaporators, a difference coming in that the heated air passes directly up through a slatted floor, over which the product is spread, and then out through
the ventilator above. These slats are somewhat triangular in shape (Fig. 27), 1" on the top, 1/2" on the lower side and spaced 1/4" apart, the wider space below preventing clogging. The slats must be made of certain woods and given special treatment before being used. This type of evaporator may be built of any size although a 16' x 16' or 20' x 20' square floor is a convenient unit, which may be repeated as many times as needed to give the desired capacity. Accompanying the actual evaporating part, accommodations must be provided for receiving and preparing the fresh fruit and for caring for the finished product, the size of the rooms and the amount and kind of equipment being determined by the size of the plant and the amount of fruit to be handled.

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Fig. 26. INTERIOR STACK EVAPORATOR. All trays are inserted at the top and taken out at the bottom of the stack. In this illustration the central panels have been removed from some of the stacks in order to show the lifting arrangement. Each rope works the lift for a single stack.

Such an evaporator as is here briefly described, however, is not suitable for prunes. Although one occasionally finds where such a building has been fitted out with trays and racks in such a way as to evaporate prunes, it is neither convenient nor economical. This type of building is used quite exclusively throughout New York State for evaporating apples, black-cap raspberries, and very recently for some vegetables, but in general is much more limited in its adaptability to a variety of products than are the other two types previously described. For those who may be interested in this type, however, we will gladly answer any questions and give any other information that may be desired regarding construction and operation.
SUMMARY

An attempt has been made in what appears in this bulletin to cover the subject quite completely so that those who may never have evaporated prunes may avoid many mistakes and may at the very beginning profit by our own experiences as well as by those of many others whose methods have brought good results. It is thought also that this presentation of the subject may prove of value to the more experienced prune growers and evaporator men, since it brings out a number of observations which go to show how great are the possibilities for developing a more uniform product by means of a better standardized method of treatment.

With the erection of the new Horticultural products building on the campus and the installation later of careful tests and experiments under controlled conditions, it is hoped that soon we may be in a position to make definite recommendations which shall prove of considerable value to the entire industry.

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Fig. 27. KILN EVAPORATOR. Drawing to show general arrangement of the working parts in a kiln evaporator. For description of special slat floors, see text.
At the risk of repetition it seems best again to emphasize the importance of careful study on the part of everyone interested in the business of evaporating prunes. The problems are by no means all solved. We need to eliminate the causes which have hurt the industry in the past, to strive for efficiency in this as in every other business, to work to put out the best possible product at the lowest relative cost, and to endeavor to make it possible both through individual effort and community cooperation to put the Oregon prune into that place in the world market which it justly deserves to occupy.

Fig. 28. HEATING SYSTEM FOR KILN. Diagrammatic sketch showing one possible arrangement of flue pipes to give good distribution of radiating surface. ELEVATION OF FLUE PIPES.