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METHODS AND EQUIPMENT FOR THE SUN-DRYING OF FRUITS[1,2]

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ON THE FRESH BASIS, four to five times as much fruit is used in California for drying as for canning. Unlike the canning of fruit, which is conducted in large establishments located in urban centers of population, the drying of fruits is done on individual farms. Many problems arise in connection with drying and the farm storage of dried fruits; consequently the University receives numerous requests for advice and information on these subjects. The present circular has been prepared to answer such requests, and to serve as a guide to those who wish to establish or operate a drying yard.

In table 1 are given the tonnages of the more important sun-dried fruits produced in California. Apples are not commercially dried in the sun but are evaporated; prunes and clingstone peaches are either dehydrated or sun-dried; freestone peaches, apricots, figs, pears, and nectarines are nearly always sun-dried; and most grapes are so treated although a considerable tonnage of seedless grapes is dehydrated.

FRUITS FOR DRYING

The principal drying localities, seasons, varieties, yields, and drying ratios[5] are given in table 2. The yields and drying ratios vary with the

[1] This publication replaces Extension Circular 75, *Methods of Sun-drying Fruits*, by P. F. Nichols, now out of print, from which much of the information used has been taken.

[2] Part of the nontechnical assistance in the preparation of this publication was furnished by the personnel of the Works Progress Administration Official Project No. 65–1–08–91, unit B–5.

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[5] The term "drying ratio" refers to the number of pounds of fresh fruit required to produce 1 pound of dried fruit. For example, if 3 pounds of fresh prunes are required to produce 1 pound of dried prunes the drying ratio is 3 to 1 (often expressed, 3:1).

variety and locality, as well as from year to year. Because of these variations it is extremely difficult to derive average drying ratios for the various fruits. It is undesirable to change the accepted "average" drying ratios from time to time because they are used by various agencies in establishing crop estimates and yields. Frequent changes would make it difficult to compare the statistics for various years; for this reason, averages are not included in this publication.

Choice of Fruit.—Certain general considerations affect the choice of fruit for drying. Since, in California, sun-drying is usually a primary

TABLE 1

CALIFORNIA PRODUCTION OF DRIED FRUITS IN DRY TONS*

Year	Apricots	Figs	Cling-stone peaches†	Free-stone peaches†	Pears†	Prunes	Raisins
1921	12,000	9,600	...	23,000	1,300	100,000	197,000
1925	18,000	9,600	...	18,000	3,800	146,000	334,658
1930	23,809	21,000	900‡	28,500	5,000	274,000	248,578
1935	25,818	24,000	4,000	17,000	6,700	258,000	235,000
1936	32,228	20,000	5,500	21,000	8,800	159,000	227,960
1937	34,364	28,700	4,000	20,000	3,800	249,000	234,716
1938	21,500	31,500	3,000	20,000	7,000	288,000	238,387
1939§	40,000	25,000	4,000	24,000	7,700	184,000	239,500

* Data summarized from: Shear, S. W. Deciduous fruit statistics as of January 1940. University of California Giannini Found. Agr. Econ. Mimeo. Rept. 69:1–87. 1940.

† Estimated from data given on the fresh basis.

‡ Tonnage produced in 1931.

§ Rough estimates.

industry, most of the fruits used are grown for this purpose. The only important exception is the Bartlett pear; and in some localities even this fruit is grown primarily for drying. In many instances, however, dried pears are prepared from fruit that is not suitable for shipping or canning. Some fruits, notably the Royal and Blenheim varieties of apricots, enjoy almost complete interchangeability of use and may be shipped fresh, canned, frozen, or dried equally well; thus they may seek the best market. In some districts it has become a common practice, however, to sell large unblemished and well-formed apricots to canneries, and dry the remainder of the crop. Certain varieties of apricots, especially Moorpark and Hemskirke are seldom canned or sold fresh, but are grown almost exclusively for drying. Raisin grapes may be dried, made into wine, shipped fresh, or canned, although relatively few are canned. The principal drying varieties of peaches, namely Muir and Lovell, are used largely for drying; whereas the Elberta variety is planted chiefly for fresh shipment although some of this fruit is dried. During the last few

TABLE 2

DRIED-FRUIT LOCALITIES, VARIETIES, SEASONS, AND YIELDS IN CALIFORNIA*

Fruit	Principal localities	Principal varieties	Drying season	Yield per acre in dried tons			Range of drying ratios†
				Low	Medium	High	
Apricots	Santa Clara, Sacramento, and San Joaquin valleys	Blenheim, Royal, Tilton	June 15 to Aug. 1	0.5	1.0	2.5	4:1 to 7.5:1
Figs	San Joaquin Valley	Adriatic	July 20 to Nov. 1	0.5	1.5	2.5	.....
		Black Mission	July 20 to Nov. 1	1.5	2.0	3.0	.....
		Calimyrna	July 20 to Nov. 1	0.5	1.0	2.0	.....
		Kadota	July 20 to Nov. 1	0.5	1.5	2.5	.....
Nectarines	Sacramento and San Joaquin valleys	Hardwick, Newboy, Quetta, Stanwick	July 15 to Aug. 30	0.5	1.5	3.0	5.5:1 to 8.5:1
Peaches (clingstone)	Sacramento and San Joaquin valleys	Midsummer varieties and Phillips	Aug. 1 to Sept. 15	0.5	1.0	2.0	6.5:1 to 10:1
Peaches (freestone)	Sacramento and San Joaquin valleys	Elberta, Lovell, Muir	July 15 to Sept. 15	1.0	2.0	4.5	4:1 to 8:1
Pears	Lake and Mendocino counties; Napa, Sacramento, Santa Clara, and Sonoma valleys	Bartlett	July 15 to Oct. 1	0.5	1.5	3.0	4:1 to 7:1
Prunes	Napa, Santa Clara, Sonoma, Sacramento, and San Joaquin valleys	French, Imperial, Sugar, Robe de Sergeant	Aug. 15 to Oct. 1	1.0	2.0	5.0	2:1 to 3.5:1
Raisins (natural)	San Joaquin Valley	Muscat	Aug. 15 to Nov. 1	0.5	1.0	2.0	3:1 to 5:1
		Sultana	Aug. 15 to Nov. 1	0.5	1.0	2.0	4:1 to 6:1
		Thompson Seedless	Aug. 20 to Oct. 1	1.0	1.5	3.0	3:1 to 5:1
Raisins (sulfur-bleached)	San Joaquin Valley	Thompson Seedless	Aug. 20 to Oct. 1	1.0	1.5	3.0	3:1 to 5:1
Raisins (soda-dipped)	San Joaquin Valley	Thompson Seedless	Aug. 20 to Oct. 1	1.0	1.5	3.0	3:1 to 5:1
Currants (Zante)	San Joaquin Valley	Black Corinth	Aug. 5 to Aug. 20	0.5	1.5	2.5	4:1 to 6:1

* The drying season, yield per acre, and drying ratio vary with the year and locality of production.

† Most of the fig drying usually occurs before the fruit is harvested. For the conversion of dried weights into green weights a drying ratio of 3:1 is commonly used and for converting dried weights into fruit weights as harvested, 1.5:1 is sometimes used.

years there has been an increase in the canning of Lovell, Elberta, and J. H. Hale freestone peaches. A small tonnage also is being frozen each year. Clingstone varieties of peaches are grown almost exclusively for canning although during the past few years a considerable tonnage has been sun-dried or dehydrated. Figs are for the most part dried or shipped fresh; only one variety, the Kadota, is canned. Prunes are grown in California primarily for drying although sugar prunes are shipped fresh in some districts.

Cultural Practices.—In the production of dried fruits of high quality it is very important to observe proper cultural practices, maturity standards, and improved harvesting methods. Cultural practices are discussed fully in several other publications[6] of this station and for this reason will not be reviewed here.

Maturity.—In order to produce the best possible dried product, the fresh fruit must be of fully developed flavor, well colored, and of maximum sugar content. In other words, fruit used for drying should be at least as ripe as desired for eating in the fresh state. If immature fruit is dried the resulting product has a poor color and flavor and undesirable appearance. Immature fruit frequently undergoes fermentation during drying and always has a high shrinkage ratio. These effects are apparent in all fruits that are dried in the sun. Bartlett pears are picked while hard but with a maximum pressure test of not over 19 pounds. They are then allowed to ripen in boxes while in storage. Figs and prunes are for the most part allowed to become so ripe that they drop naturally from the tree; in fact figs usually dry to a considerable extent on the tree before dropping. In order to produce the best raisins and to obtain a greater yield, Thompson Seedless grapes should not be picked for drying until the Balling or Brix degree (approximate sugar percentage determined by use of a hydrometer) of the juice reaches 23°; nor Muscat of Alexandria before 25° is reached. In rainy or cool seasons, however, it is sometimes difficult or even impossible to attain these sugar contents. Cherries should be picked and dried when at the eating-ripe stage.

[6] Hendrickson, A. H. Apricot growing in California. California Agr. Ext. Cir. 51:1–60. Revised, 1937.

Condit, Ira J. Fig culture in California. California Agr. Ext. Cir. 77:1–67. Revised, 1941.

Philp, Guy L., and Luther D. Davis. Peach and nectarine growing in California. California Agr. Ext. Cir. 98:1–62. 1936.

Howard, W. L. Home fruit growing in California. California Agr. Ext. Cir. 117:1–95. 1940.

Tufts, Warren P. Pruning deciduous fruit trees. California Agr. Ext. Cir. 112:1–67. 1939.

Jacob, H. E. Grape growing in California. California Agr. Ext. Cir. 116:1–80. 1940.

Davis, L. D., and W. P. Tufts. Pear growing in California. California Agr. Ext. Cir. 122:1–88. 1940.

Harvesting.—As a rule, figs and prunes drop to the ground when they are ready for drying. In the Sacramento and San Joaquin valleys, however, prunes often remain on the tree even after they are fully mature and it is necessary to knock them from the trees with poles. When this is done care should be taken to avoid harvesting immature fruit. The other kinds of fruits should be picked by hand from the tree in order to secure the best quality. While the harvesting of apricots and peaches can be done at a lower cost per ton by shaking the fruit to the ground or onto sheets of canvas, the quality always suffers; first, because in falling the fruit becomes bruised or dirty, or both; and, second, because immature fruit is always mixed with the ripe. Therefore, shaking should never be practiced for apricots or peaches except from real necessity such as inability to get sufficient pickers, when the orchard is on hilly terrain, or when the price obtainable for the best fruit will not cover cost of picking, drying, and delivery. A comparative study made in the Hanford area showed that the net value per pound was greater when fruit was picked by hand than when knocked from the trees. When shaking appears necessary, the most satisfactory and least costly safeguard is to throw away all damaged and immature apricots and peaches while they are being cut for drying.

In fairness to cutters (who are paid by the box), the boxes should be filled uniformly. This can be done at the cutting shed if necessary.

Washing and Removing Spray Residue.—All fruits that have come in contact with the ground should be thoroughly washed to remove adhering bits of soil, straw, and other foreign materials. In recent years much more attention has been given to the washing of apricots and peaches picked from the ground. Pears are treated in an acid solution to remove lead and arsenic spray residues. This is discussed on page 14. Pears should also be washed after cutting when spread on the trays in order to remove adhering particles of foreign matter. Prunes and "sulfur-bleached" and "soda-dipped" raisins are washed at the time of dipping in lye or hot water. "Natural" raisins and other fruits are not normally washed prior to drying.

Preparation.—The preparation of the fruit for drying should include the elimination of waste parts as far as possible, and the rejection of fruits that are unacceptable. Returns from culls usually do not justify the expense of drying. Preparation should also include any cutting, pitting, lye-dipping, sulfuring, or other treatment necessary to make the fruit dry rapidly and without decomposition or objectionable change in color. While preservation by drying depends upon the reduction of the moisture content to such an extent that bacteria, yeasts, and molds can

no longer grow upon and damage the fruit, the reduction of moisture content alone does not always lead to the retention of a sufficiently attractive and stable color. To this end some of the fruits are subjected to the fumes of burning sulfur through which small quantities of a harmless fruit preservative, sulfurous acid, are introduced. The public health aspects and harmlessness of this compound are discussed fully in a publication by Nichols.[7] Sulfur dioxide not only stabilizes color and flavor and protects the fruit against microörganisms, but also is essential to the retention of some of the vitamins for which fruits are especially valuable in the diet.

Treatment of Pits and Waste Materials.—With most fruits, the pits, cores, and trimmings are treated as waste materials. Only apricot pits are at present considered to have any commercial value. They are used for the manufacture of cooky fillers (similar to macaroon paste), charcoal, and chemicals obtained by distillation of the shells. In properly operated drying yards, pits are collected in clean containers and never mixed with trimmings or decomposed parts of fruit. The pits are dried by spreading them about 4 inches deep on trays or on concrete drying surfaces where they are periodically stirred by raking during drying. Apricot pits should never be sulfured because this reduces their commercial value. In fact if apricots are sulfured whole before pitting, the pits from this fruit should never be mixed with unsulfured pits.

Pear trimmings and decomposed fruits have no commercial value at present. Peach pits may be dried as described for apricot pits. Trimmings and decomposed fruit are often thrown into holes, a nearby arroyo, or in a pile near the cutting shed. This is an undesirable practice, since the fermenting material is an excellent breeding place for insects which may later damage fruit on the drying field or in storage. In order to eliminate this hazard, these waste materials should be spread thinly so they will dry rapidly; or if holes or piles are used, then sufficient quantities of lye, quicklime, or chlorinated lime should be added to prevent fermentation, with the resulting odors. The drying yard should always be kept free of such refuse in order to reduce insect infestation and to produce clean high-quality dried fruits.

EQUIPMENT

Fruit Boxes.—Wooden lug boxes about 15 × 24 × 9 inches, to hold 40 pounds of fruit, are commonly used in transporting fruit to the cutting shed. The box should be made of lumber having a thickness of ½ inch;

[7] Nichols, Paul F. Public health aspects of dried foods. Amer. Jour. Pub. Health 24(11):1129–34. 1934.

for the sides and bottom ends, 1 inch; triangular corner posts, 2×2 inches; and top cleats across the ends, $\frac{3}{4} \times 2$ inches. All material is pine, nailed on about 3-inch centers, around sides and bottom, with 6-penny cement-coated box nails. The top cleats are essential to protect the fruit and give a space for ventilation when the boxes are stacked. In handling pears, boxes holding 44 or 45 pounds of fruit are used. The respective dimensions of these boxes are $14\frac{7}{8} \times 20 \times 10\frac{23}{32}$ inches, including a $\frac{25}{32}$-inch top cleat; and $14\frac{3}{4} \times 20 \times 10$ inches, including a $\frac{3}{4}$-inch top cleat.

Larger boxes holding 60 pounds of fruit are not recommended for orchard use because of the difficulty of handling and the increased bruising of fruit. Boxes with the sides and bottom of exterior-grade Douglas fir plywood are being introduced, at a greater initial cost, on the merit of their light weight and greater durability. Some use has been made, on an experimental scale, of sheet-metal boxes; their proponents claim for them advantages in sanitation, improved ventilation through the fruit, improved shape to lessen bruising, lower weight, longer life, and decreased storage and hauling space requirement for empty boxes since the design permits nesting.

Delivery of Fruit from Orchard.—Automotive trucks or pneumatic-tired wagons, as illustrated in figure 1, *A*, are commonly used to haul fruit from the orchard to minimize bruising. The wagon, or the sled illustrated in figure 1, *B*, may be used as pickup conveyances within the orchard, particularly in hilly sections or where a large truck is used to haul to a distant drying yard. A canvas covering is used over the fruit on a sled to protect it from dust and heat. Where delivery of the picked fruit is likely to be delayed for any reason, orchard shelters such as shown in figure 2 protect the fruit from sunburn or heating, and facilitate loading.

The Drying Plant.—On the average about 1 acre of drying-yard area is required for each 20 acres of orchard or vineyard, but local conditions may cause this ratio to vary considerably. Favorable drying conditions, sanitation, efficient fruit-handling routines, and comfortable working conditions are some of the factors that must all be considered in selection of the layout.

It is essential that the fruit be exposed to the most favorable conditions available so that it may dry rapidly and, when sulfured, retain sufficient sulfur dioxide to preserve quality during subsequent storage. Relatively dry air and exposure to the prevailing winds facilitate drying. To further aid drying, the fruit trays may be set at an angle as nearly perpendicular to the sun's rays as possible to receive a maximum heating effect. Proximity to luxuriant vegetative growth or bodies of water increases

the moisture content of the air and delays drying, with higher resultant loss in sulfur dioxide content. A gentle southern slope is desirable, but a steep slope increases the labor of handling the fruit and the chances for accidents. The problems of sulfuring fruits and of sulfur dioxide absorption and retention by fruits are discussed more fully in another publication.[8]

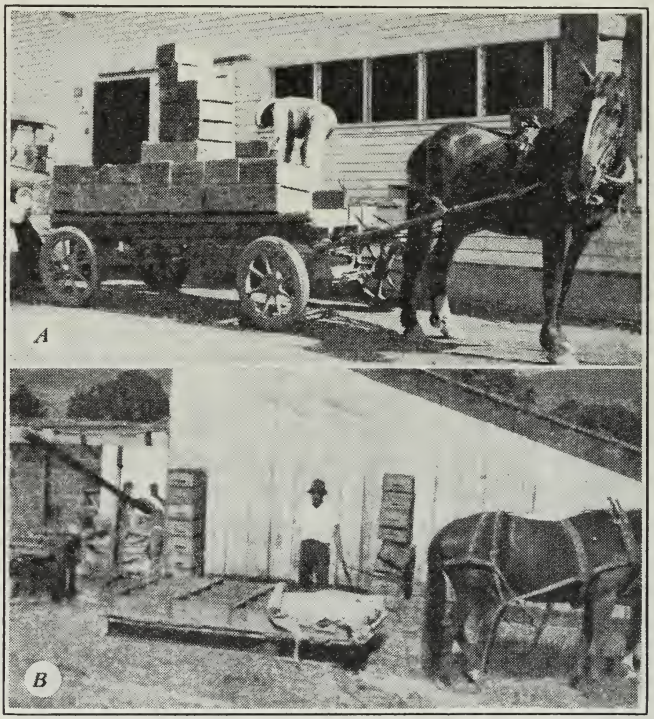

Fig. 1.—Means of orchard transportation especially suited to small farms: *A*, pneumatic-tired wagon; *B*, sled showing canvas cover for fruit.

Undipped grapes are dried between the rows in the vineyard, and figs are usually dried in the orchard.

Cleanliness attending all phases of dried-fruit production should be strictly observed, as in the processing of any food product intended for human consumption. Wash bowls, paper towels, and soap and water at convenient places in the cutting shed, encourage the cutters to keep their hands clean. Drinking fountains are a great convenience. Sanitary toilets should be conveniently located. Sewage lines from toilets and lava-

[8] Long, J. D., E. M. Mrak, and C. D. Fisher. Investigations in the sulfuring of fruits for drying. California Agr. Exp. Sta. Bul. 636:1–56. 1940.

tories should run to a septic tank, with the final disposal line outside the yard area. Rotten and waste fruit should be removed daily and treated as previously described. This is of primary importance in reducing breeding places and sources of insect infestation. All waste fruits and fruit pits are potential sources of infestation; fruits which dry in the shade under the trees, and fallen grapes under the vines, offer suitable breeding places. Few insects breed in similar fruits exposed to the heat of the sun. Peach and apricot pits spread in the sun and dried do not become infested. Sweeping the cutting-shed floor should be part of the

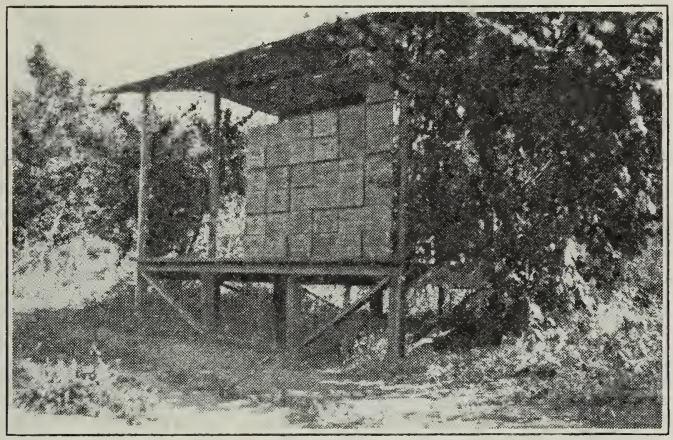

Fig. 2.—Shaded loading platform to protect fruit and expedite transportation from the orchard.

daily routine of cleaning. Barnyards and dusty roads should be on the side of the drying yard away from the prevailing winds, and barnyards or corrals should be at least 100 feet distant.

Roads, earth, cutting-shed floors, and paths along distribution tracks should be treated to settle dust which otherwise may find a lodging place on the fruit. Such dirt becomes embedded on the juicy cut surfaces of freshly spread fruit and is almost impossible to remove in subsequent processing. Sprinkling the dirt surfaces with water at frequent intervals and compacting to a hard surface is satisfactory, but likely to be neglected during the rush season. Deliquescent materials, such as calcium chloride, spread on an earth surface absorb moisture from the atmosphere and keep the soil surface moist and in condition to be compacted by traffic. The calcium chloride may be distributed at the rate of one-half pound per square yard, and may be either spread dry and raked into the surface, or dissolved in water and spread with a sprinkling can. In some very arid localities the atmosphere may not give up sufficient mois-

ture to the chloride, and treated areas may require one or two light sprinklings during the season. Being soluble in water, the chloride will be leached away by winter rains and requires replacing annually. On a cutting-shed floor it can be expected to last longer. Asphaltic oils may also be used, if a heavy grade is secured with sufficient asphalt content to cement the soil surface. Lighter oils which do not consolidate the soil

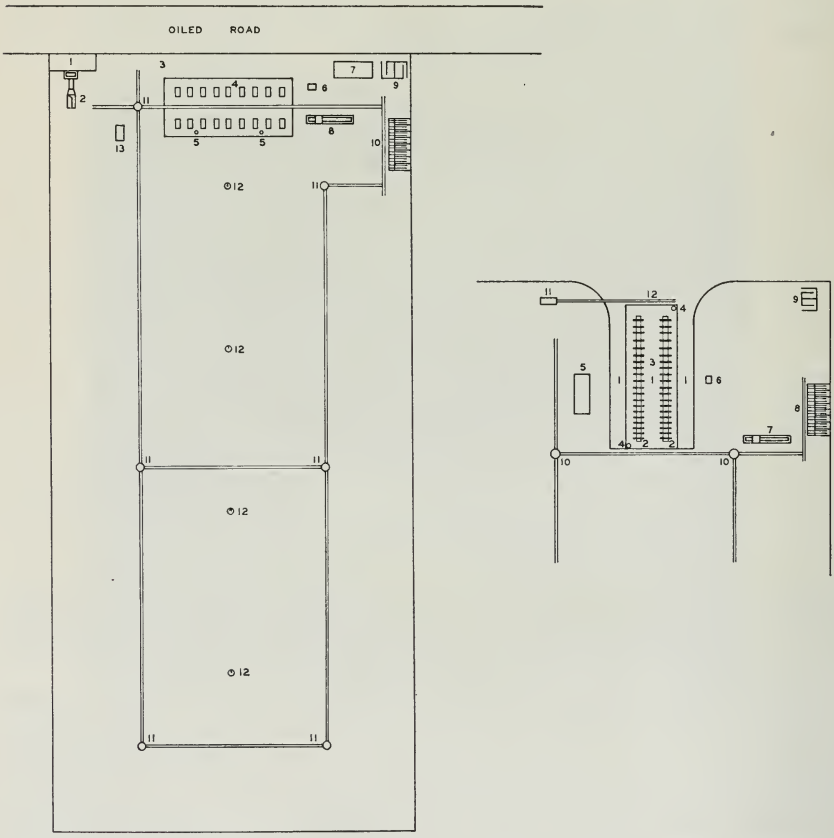

Fig. 3.—Left: Ground plan of a drying yard of 2½ acres (225×485 feet), sufficient for 50 acres of orchard: *1*, unloading platform for prunes or grapes; *2*, dipper; *3*, other fruit for cutting stacked here (fruit washer included, if desired); *4*, cutting shed with tray tables; *5*, drinking fountains and wash bowls; *6*, box washer; *7*, pit-drying box; *8*, cut-pear washer; *9*, lavatories; *10*, transfer track and sulfuring houses; *11*, turntables; *12*, electric lights on poles; *13*, tray washer.

Right: Cutting shed layout using two 80-foot continuous-type cutting tables of the design shown in figure 9: *1*, orchard trucks unload on either side of shed and in 8-foot center aisle; *2*, cutting tables; *3*, cutting shed, 30 × 90 feet; *4*, drinking fountains and wash stands; *5*, pit-drying box; *6*, box washer; *7*, cut-pear washer; *8*, transfer track and sulfuring houses; *9*, lavatories; *10*, turntables; *11*, tray washer; *12*, conveyor with removable sections.

are objectionable, for coated particles kicked or brushed onto the fruit are difficult to remove by washing.

Planning the entire drying yard, to eliminate interference or retracing of steps in handling, is very important. Careful selection of equipment for a maximum output under comfortable working conditions reduces labor costs. On some sites it will be possible to take advantage of ground slopes to secure gravity flow through the cutting shed and out into the drying yard. Placing the sulfur house "down-the-wind" or to one side of the cutting shed will protect the cutters from the discomfort of escaping sulfur dioxide fumes.

The principles of drying-yard layout have been incorporated in the plan sketched in figure 3, left. The arrangement shown is, of course, subject to modification in an actual installation according to the prevailing conditions.

TABLE 3

SOME APPROXIMATE REQUIREMENTS FOR DRYING APRICOTS, PEACHES, AND PRUNES, BASED ON A 20-ACRE ORCHARD

Fruit	Drying yard, acres	Pounds fresh fruit picked per man per day*	Pounds fresh fruit cut per man per day	Single-car sulfuring houses	Square feet of tray surface per acre of orchard
Apricots	1	1,000	1,000	5	1,150
Peaches	1	2,000	2,000	5	2,000
Prunes	1	1,800	...	...	2,780

* Apricot orchards picked two or three times; peaches, three times; prunes three or four times in the coastal areas and one or two times in the Sacramento and San Joaquin valleys.

TABLE 4

AVERAGE INVESTMENT AND DEPRECIATION PER GREEN TON HANDLED, STANISLAUS COUNTY, 1937, 1938, AND 1939*

Item	Investment	Interest	Depreciation	Total annual cost
	dollars	*dollars*	*dollars*	*dollars*
Land	1.88	0.09	..	0.09
Buildings	0.82	0.04	0.07	0.11
Sulfuring houses	0.50	0.03	0.06	0.07
Boxes	0.41	0.02	0.08	0.10
Trays	3.08	0.15	0.47	0.62
Tracks and cars	0.43	0.02	0.04	0.06
Miscellaneous	0.09	..	0.01	0.01
Total	7.21	0.35	0.73	1.08

* Based on records from 17 apricot and peach drying yards, handling 4,011 tons of green fruit. Study made by B. B. Burlingame and W. K. Hilliard, University of California Agricultural Extension Service.

Some of the requirements for drying apricots, peaches, and prunes, are given in table 3. These of course are approximate and may vary considerably with the particular locality of the drying plant. A summary of data on investment and depreciation per green ton handled, for 17

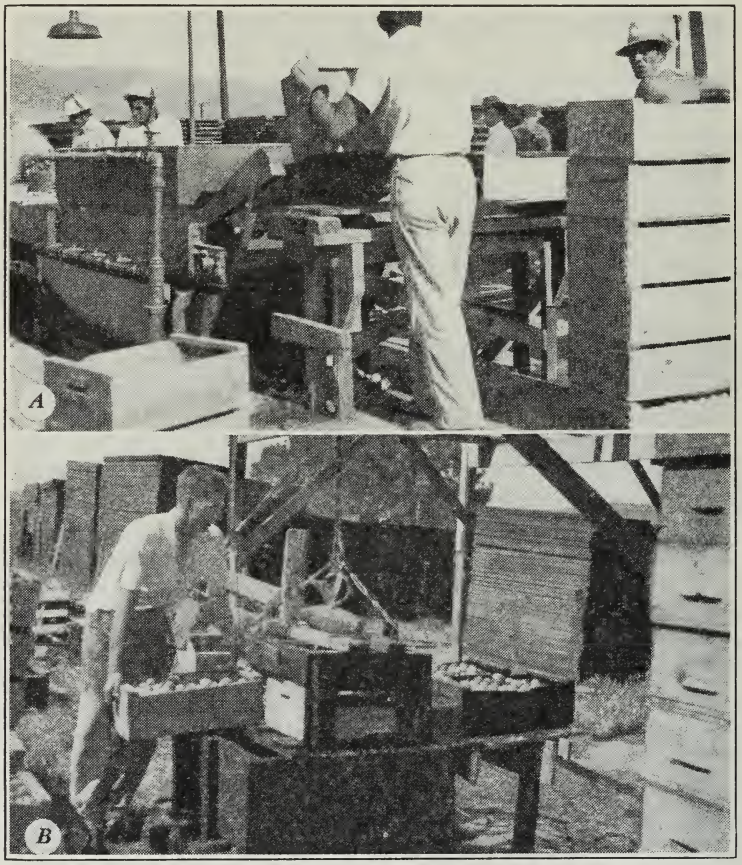

Fig. 4.—Fruit washers: *A*, continuous spray washer and sorting table used in large-scale production; *B*, simple homemade dipping type with drainboard.

apricot and peach drying-yards in Stanislaus County in 1939, is given in table 4.

Fruit Washers.—Where fruit has been shaken from the trees to the ground, or is covered with dust, it should be washed in cold water before going to the cutting tables.

Figure 4, *A*, is a shop-built machine of continuous type in which the fruit is carried on an endless belt between water sprays, over a sorting

table, and is weighed onto the trays ready to be delivered to the cutting shed. Figure 4, *B,* shows a simple homemade wooden vat, with a two-box dousing rack suspended from an overhead lever. Both machines are used for apricots, but may be adapted to other fruits.

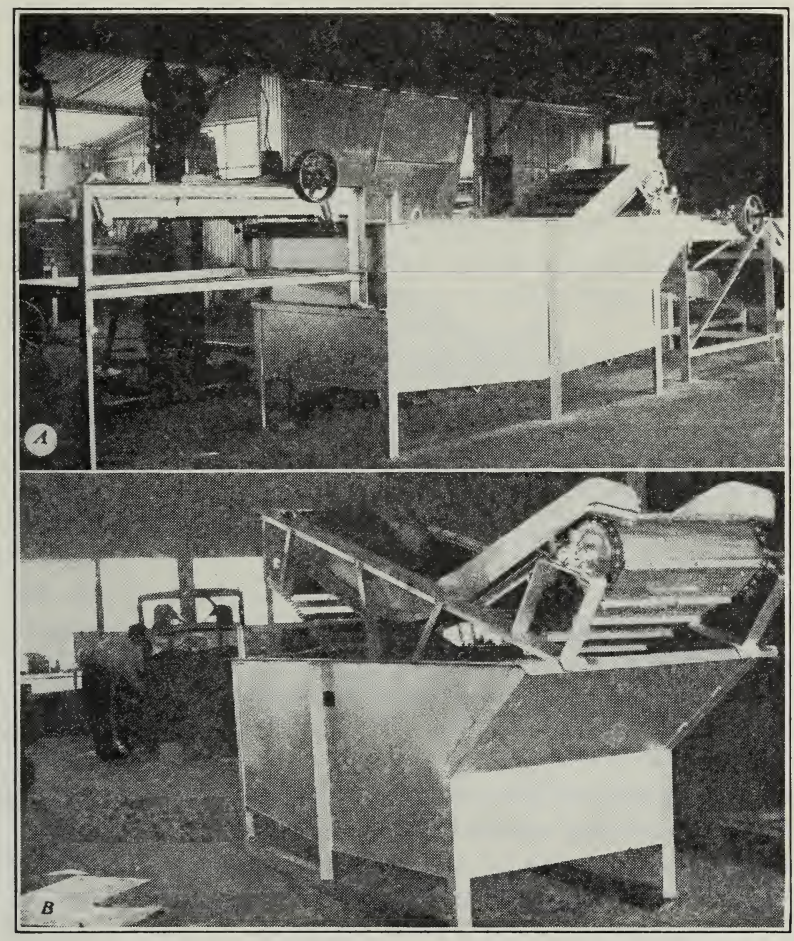

Fig. 5.—Immersion-type fruit washer: *A,* washer shown in equipment line-up; *B,* close-up view of washer and elevator. (Courtesy of Elliott Manufacturing Company, Fresno, Calif.)

Figure 5 presents two views of an immersion-type washer used for grapes and prunes. Figure 5, *A,* shows the setup of equipment, including a cull sorting table from which the fruit is dropped into the washer, the washer with elevator belt, and the spreading and sorting table where the fruit is placed on the trays. Figure 5, *B,* is a close-up view of the washer showing the elevator lifted to permit cleaning the tank.

After pears have been cut and before they are sulfured it is advisable to pass them under a water spray in order to remove adhering particles of dirt and evidences of insect infestation. As the trays are removed from the cutting tables they should be submitted to the spray prior to stacking on the car. A hose and nozzle may be used, but more positive results will be obtained by passing the trays slowly under a battery of fixed spray heads, arranged to wash both top and bottom. The area under the spraying equipment and dripping tray stack on the car should

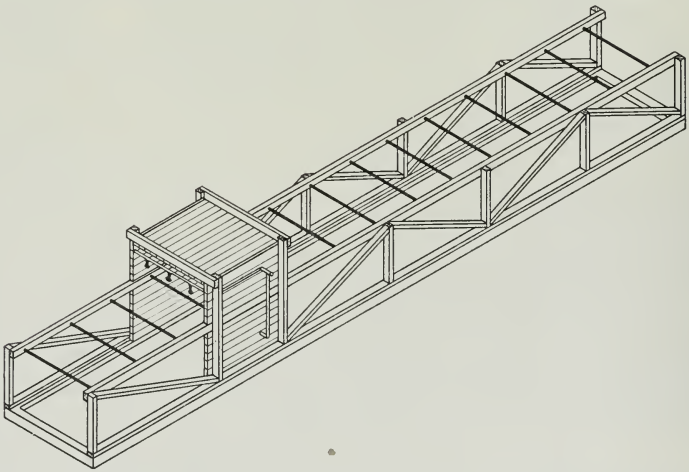

Fig. 6.—Cut-pear washer. The loaded trays are placed on a roller conveyor and passed into a spray chamber where rows of spray heads, two from above and one from below, wash the fruit and bottom of the tray. The conveyor and catch basin are extended to permit the trays to drain. (Plans through courtesy of California Packing Corporation, San Francisco, Calif.)

be paved with concrete and provided with a suitable drain. A design for a continuous cut-pear washer is shown in figure 6.

Washers and Materials for Spray-Residue Removal.—Some materials used in the orchard spray program leave residues on the fruit which above certain quantities are considered injurious to human health. Laws exist, and are enforced, which limit the amounts of arsenic, lead, or fluorine that may remain on foods for human use. Definite limits or "tolerances" have been established by the Food and Drug Administration of the Federal Security Agency for these spray residues. The Agency recently announced that the tolerances for lead and arsenic had been liberalized because of experimental results obtained by the U. S. Public Health Service after three years' study. The new tolerances as of August 10, 1940, are: 0.025 grain arsenic as arsenic trioxide per pound

and 0.05 grain of lead per pound. Flourine was not included in the study made, so the tolerance remains at 0.02 grain of fluorine per pound, as of November 14, 1938. These limits apply to fruits whether they be fresh or dried. The tolerances for spray residues are changed from time to time so growers uncertain of current tolerances should obtain this information from the Federal Security Agency, Washington, D. C., or the federal Food and Drug Administration, Federal Building, San Francisco, California.

A more complete removal of spray residues from fruit to be dried is of greater importance than for fruit to be consumed fresh because drying increases the percentage of residue, in proportion to the drying ratio. In order to cope with this problem the fruit should be washed before drying and the use of toxic insecticides should be avoided for as long an interval before harvesting as possible. These procedures are discussed more fully in other publications.[9]

For the removal of spray residue it is generally considered advisable to pass the fruit through a vat or spray of acid at 70° F. When excessive wax, however, has formed or when oil sprays have held much lead arsenate on the fruit, it may be necessary to use higher temperatures or an alkaline wash. Most alkaline washes leave much of the lead and impair the keeping quality of the fruit although they do remove arsenic efficiently. Pears are practically always sprayed with lead arsenate in California and require thorough washing before drying. One of the more successful methods has been to wash the fruit in a 0.5 to 1.0 per cent solution of hydrochloric acid. When the simple immersion method is used, sometimes a period of as long as 3 minutes is necessary; but when power-spray washing machines are used, 30 seconds may be sufficient. Removal of the calyx or blossom end and the stem of the pear fruit at the time of cutting helps greatly in reducing the spray residue on the fruit, since much of the spray material left on washed fruit is found in these areas.

Two general types of washing machines are in common use. Simple dipping vats have not proved so effective as machines of larger capacity consisting of conveyors and dipping vats or spray chambers and wetted cloth or rubber wipers. These may be built from available designs[10] or

[9] Allen, F. W. Apple growing in California. California Agr. Exp. Sta. Bul. 425:50–52. 1937.

Essig, E. O., and W. M. Hoskins. Insects and other pests attacking agricultural crops. California Agr. Ext. Cir. 87:146–47.1939.

Haller, M. H., Edwin Smith, and A. L. Ryall. Spray-residue removal from apples and other fruits. U. S. Dept. Agr. Farmers' Bul. 1752:1–25. 1935. (Obtainable from Superintendent of Documents, Washington, D. C., for 5 cents in coin.)

[10] Hartman, Henry. The Oregon apple washer. Oregon Agr. Exp. Sta. Cir. 92:1–8. 1929.

secured commercially. One of the latter is shown in figure 7. Somewhat simpler designs of such equipment are being manufactured in local shops in fruit-producing areas of the state, the local designs usually being adequate for the task required in that particular locality. Such designs are frequently very flexible and may eliminate some of the steps

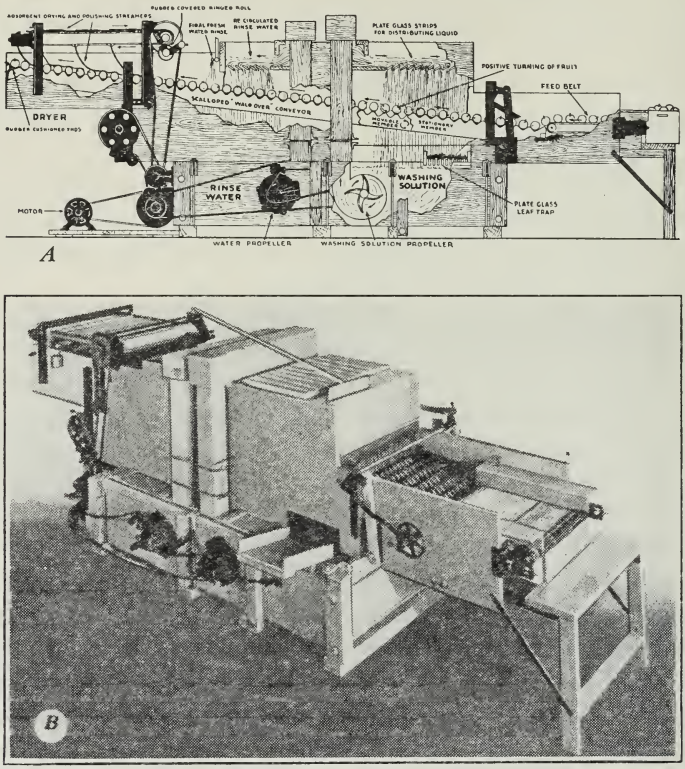

Fig. 7.—Fresh-fruit washer and drier for spray-residue removal: *A*, section sketch; *B*, photograph. (Courtesy of Cutler Manufacturing Company, Portland, Ore.)

or equipment necessary to increase the capacity or effectiveness of the equipment. Responsible care is required in operation to maintain the solutions used at the concentrations and temperatures necessary for optimum results. In several instances smaller growers have found it to their advantage to have large community washers rather than the small farm type.

Cutting Shed.—This structure customarily fulfills a secondary duty as a box- and tray-storage space during the off-season months, and must serve two sets of conditions. Figure 3, right, shows a plan for one type of cutting shed.

During the fruit-harvesting season in California the sun is the major climatic element from which workers require protection. Good light and ventilation are necessary, hence the cutting shed usually becomes merely a roof with supporting posts spaced to interfere to the least extent with the working routine. Temporary shelters roofed with palm thatch or trays are undesirable for the well-established drying yard. On hot days metal roofs may radiate heat to the cutters working under them and add materially to their discomfort unless cooled with water sprays. Low roofs are particularly undesirable. A tight sheathing under metal roofs or a ceiling above the cutting floor shields the workers from the radiant heat waves. In coastal areas cool breezes may require the protection of walls along one or two sides during a part of the season.

Tight walls are sometimes considered desirable for winter tray storage. One very satisfactory structural design includes solid panels hinged at the top for walls. During the harvest season these are propped open and provide a shaded area along both sides of the cutting floor for fruit storage or additional cutting tables.

An earth floor compacted to a level surface and maintained by a daily sweeping and sprinkling is usually satisfactory. A floor of asphaltic concrete, or of oil stabilized with asphaltic emulsion, reduces the required maintenance care and, being somewhat more resilient than Portland cement concrete, is more comfortable.

The arrangement of cutting tables should not be crowded, and should provide for the convenient supply and removal of fruit and trays. A first-aid kit, including iodine or some other good disinfectant, bandages, and adhesive tape, should be conveniently available, and the foreman trained to use it in order that immediate cleansing and treatment may be given to cuts.

Cutting Tables.—The tables holding the fruit trays should be of a convenient height for the cutters to reach the center of the tray. Shelves should be provided to hold boxes of fruit on each side, and space should be allowed for the cutter to move about comfortably and occasionally to sit down. Every cutting table should be equipped with a pit box for each cutter. Pits should never be put into boxes of uncut fruit.

The customary designs of tables are shown in figure 8. Unique designs permitting easier tray handling are illustrated in figure 8, *C* and *D*. These permit the cutting-shed men to walk through the table standards, and minimize lifting. The design shown in 8, *C*, also has the advantage of requiring very little storage space when not in use.

A recent innovation in cutting tables is the continuous type shown in figure 9. In use, four to eight sections of the tables are joined lengthwise.

Each section provides space for eight cutters, and twice the number can be crowded in. Empty trays are pushed into one end of the table, and the filled trays removed at the other. The fruit supply is stacked in each aisle along the tables; the arms at each stall hold two boxes so that cutters need never be delayed for lack of fruit or trays. Rotating the position of the cutters along the table at regular intervals equalizes any preferential placement. Proponents of this table claim that the fruit is handled

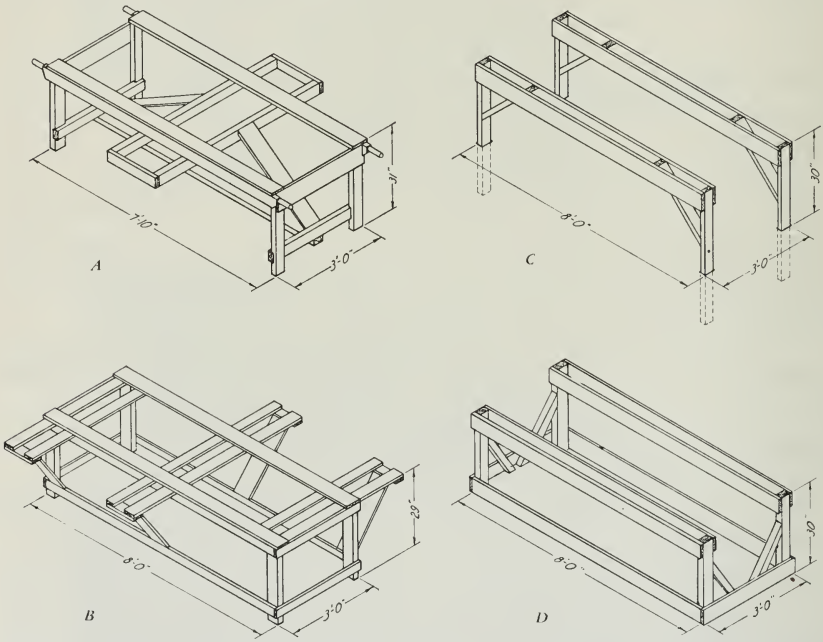

Fig. 8.—Standard-design fruit cutting tables: *A*, arrangement for two fruit boxes, and *B*, for four fruit boxes; *C*, a "walk-through" table held in place by boxed holes to permit the moving and stacking of table parts during the off season; *D*, a movable type of "walk-through" table, which does not require anchoring in boxed holes. Work plans for *A* (listed as B-43) are obtainable from the Agricultural Extension Service, University of California, Berkeley, Calif.

in an orderly manner, with less confusion, noise, waste motion, lost time, and carrying, than is usual with the customary stationary tables, and that the output of the cutters is increased.

Pitting and Cutting Machines.—Equipment has been developed to facilitate the preparation of clingstone peaches and of pears. Where the former are lye-peeled a standard peeler and pitter such as is used in canneries may be employed.

The pear-cutting machine has been evolved over a period of several years by several rural shops and designers. At the present stage of its development it is being used successfully in several drying yards. Six

stalls are provided where girls push the fruit against rotating spindles to remove the calyx and then place it on a rope-belt conveyor leading over a rotary knife. Unless the fruit is properly placed on the belt it may be cut diagonally, but this need be true of only a very small percentage of the fruit. Four women are required to tray the fruit as it leaves the knife; the entire crew handles about 60 boxes of fruit per hour.

Miscellaneous Small Equipment.—Sharp cutting knives and satisfactory equipment for sharpening them should be provided. A container for rotten and cull fruit should be placed convenient to each cutter, and

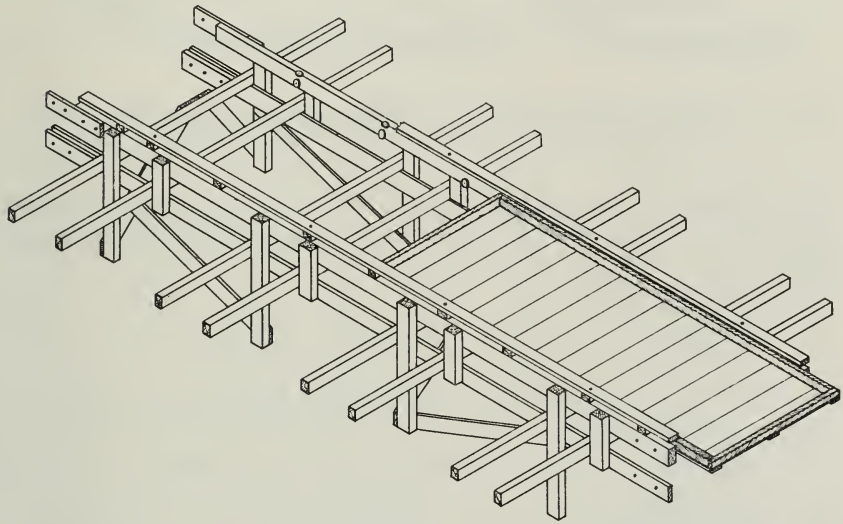

Fig. 9.—A continuous-type cutting table. Complete plans for construction (listed as C-196) are available at nominal charge from the Agricultural Extension Service, University of California, Berkeley, Calif.

the contents emptied frequently for removal to a dumping place away from the drying yard. Pit boxes which clip to the side of the fruit box or hang from the side of the cutting table should be provided when handling stone fruits. Cutters should be instructed that dumping whole fruit on the tray bruises it unnecessarily, and tends to smear any rotten particles over fruit and tray. Pits must be kept free of rotten fruit and are not to be thrown into the fruit box because they make the boxes sticky, which mars the appearance of the fruit. A wooden or concrete platform adjacent to the cutting shed should be provided for the drying of the pits.

A system of numbered cards for the cutters and a foreman's punch for indicating the number of boxes cut each day makes a satisfactory record for payment of the cutters.

Trays.—Wooden trays for sun-drying fruit are grouped into three size classes: the 2 × 3 foot raisin trays, the 3 × 6 foot cut-fruit trays, and the 3 × 8 foot prune trays. All three sizes are used to some extent for all varieties of fruits. The large 3 × 8 foot tray appears to be increasing in popularity, owing to the economy in handling because of its greater capacity. When used for pears the heavy weight of this fruit requires stronger construction than the standard tray commonly used.

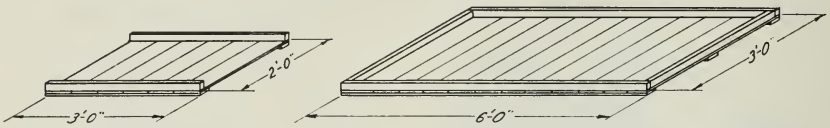

Fig. 10.—Standard types of trays for sun-drying fruits. Eight-foot trays are also made in the same design as the 6-foot tray shown.

The common construction of all these trays is shown in figure 10, and capacities and costs are given in table 5. The specifications are listed as follows:

Materials for 2′ × 3′ tray:

End cleats	2 pcs. 7/8″ × 1 1/4″—3′
Side cleats	2 pcs. 3/8″ × 7/8″—3′
Bottom boards	5 pcs. 5/16″ × 5 3/4″—2′ 1 pc. 5/16″ × 7 1/4″—2′

Materials for 3′ × 6′ tray:

End cleats	2 pcs. 1 3/8″ × 1 3/4″—34 1/4″
Side cleats	2 pcs. 7/8″ × 1 3/4″—6′
Clinch cleats	3 pcs. 3/8″ × 1 1/4″—6′
Bottom boards	12 pcs. 1/4″ × 5 3/4″—3′

Materials for 3′ × 8′ tray:

End cleats	2 pcs. 1 3/8″ × 1 7/8″—34 1/4″
Side cleats	2 pcs. 7/8″ × 1 7/8″—8′
Clinch cleats	3 pcs. 3/8″ × 1 1/4″—8′
Bottom boards	16 pcs. 5/16″ × 5 3/4″—3′

Pine is the wood most commonly used, but spruce cleats give additional strength. Redwood is sometimes used, but new trays of this wood may stain light-colored fruits. In constructing trays, the unplaned sides of the bottom boards are placed on the fruit side in order to reduce sticking of fruit to the trays. Douglas fir plywood (three-ply) of the waterproof grade, designed for exterior use, is being tried for tray bottoms instead of the customary tray shook, but has not been in use long enough to demonstrate its economic value. Greater stiffness and longer life with materially reduced repair costs are claimed for the more costly plywood construction. When plywood is used, it is necessary

to provide holes or slits for water drainage from washed fruits such as grapes and pears. A patented plywood dehydrater tray incorporating this feature is on the market.

Nails are an important consideration in the durability of a tray under the severe racking and exposure to which it is subjected. Cement-coated box nails of 7-penny size which can be clinched against the bottom cleat are recommended. Gluing the cleats to the bottom with waterproof glue would add materially to the strength and durability of both the shook and plywood trays.

If scantlings or wooden horses are used in the drying yard, and care is exercised at other points to keep the trays from becoming dirty, it

TABLE 5

CAPACITIES AND APPROXIMATE COSTS OF STANDARD FIELD TRAYS

Size of tray	Tray capacities with the various fruits						Cost of material	Total cost
	Apricots	Figs	Grapes	Peaches	Pears	Prunes		
feet	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*dollars*	*dollars*
2 × 3.....	10–12	13–17	18–22	15–20	18–24	18–24	0.12	0.15
3 × 6.....	30–36	40–50	54–66	45–60	54–72	54–72	0.46	0.50
3 × 8.....	40–48	53–67	72–88	60–80	72–96	72–96	0.63	0.70

is possible to have trays, either side of which may be used. Trays used in this way have end and side cleats 1 inch high on both faces of the bottom, to replace the clinch cleats. Nails are selected of a length to permit clinching. Such double-faced trays facilitate rush-season work by doubling the number of available clean tray surfaces; but they also double the areas to be washed eventually.

Trays of heavy wrapping paper are increasing in use for raisins, although they are not appreciably cheaper in annual cost than those made of wood. In rainy seasons they offer less chance of salvage than wooden trays, but in favorable drying seasons give considerable protection against insect infestation provided they are handled properly. It has been shown by actual count[11] that when paper trays with fruit are rolled into "biscuits" before removal from the field, infestation by the raisin moth (*Ephestia figulilella* Greg.) and the Indian-meal moth (*Plodia interpunctella* Hbn.) is greatly reduced. On the other hand, when made into "cigarette-rolls" with open ends they offer no better protection

[11] Simmons, Perez, Dwight F. Barnes, Heber C. Donohoe, and Charles K. Fisher. Progress in dried fruit investigations in 1935. U. S. Dept. Agr. Bur. Ent. and Plant Quar. Leaflet E–382:1–4. May, 1936. (Mimeo.)

Simmons, Perez, Heber C. Donohoe, Dwight F. Barnes, and Charles K. Fisher. Infestation in raisins and its control. U. S. Dept. Agr. Bur. Ent. and Plant Quar. Pub. 414:1–4. August, 1937. (Mimeo.)

against insect infestation than wood trays. A further advantage in using paper trays is the elimination of the washing, storing, repairing, and handling required when wood trays are used.

Tray and Box Washers.—It is imperative that trays and fruit boxes be kept clean. Some fruit juice adheres to the wooden surfaces with each handling, resulting in an accumulation of dirt and mold that may contaminate and injure the appearance of the dried product. Soaking the boxes or trays in a vat of clear water or in a heated solution of trisodium phosphate, or other cleansing material, then scrubbing thoroughly with a stiff bristle or wire brush and rinsing with clear water, will cleanse satisfactorily. Strong lye solution applied by a power orchard sprayer accompanied by vigorous wire brushing, and then rinsing, may also be used. The strength of cleansing solution needed will vary with the condition of the trays and whether or not brushes are used. A sufficient concentration should be maintained to clean thoroughly the trays. These alkaline cleansing agents must be employed with care, since they can cause serious burns. Spray equipment such as the cut-pear washer (fig. 6) may also prove satisfactory.

In large drying yards a continuous tray-washing machine is economical. One type of such equipment has a rotary fiber brush under which the trays are moved continuously. Another type has reciprocating-motion fiber brushes with interrupted movement of the trays to permit brush operation from the side. The second type has the advantage of working closer into the corners than the rotary brush, and rubbing with the grain of the wood in the tray bottoms. If heated water is used two operators can clean three to five per minute at a total cost of about 7/8 cents per tray.

To reduce mold growth on the trays during off-season storage, they should be thoroughly washed and dried, and then stored so as to permit good ventilation through the pile.

Drying-Yard Transportation Equipment.—In very small-scale operations the trays of fruit can be carried by hand from the sulfuring house and spread on the drying yard. In commercial production, however, a transportation system is essential. The equipment most commonly used is a system of tracks and cars to carry the tray stacks.

Small railroad rails weighing 8 to 12 pounds per yard, or preferably those of 10- or 12-pound weight, are recommended. Wood track faced with strap iron sometimes is used, but is inclined to warp out of alignment. To prevent early decay, wood rails should be made from timbers commercially treated with creosote or some other acceptable wood preservative. The steel rails may be spiked to wood ties or welded to steel

angle ties. The latter are preferable where the track is being set in a concrete floor, or for sectional construction. The track about the dipper, cutting shed, and sulfuring houses should be laid permanently, but the system through the drying yard may be of portable sections to economize

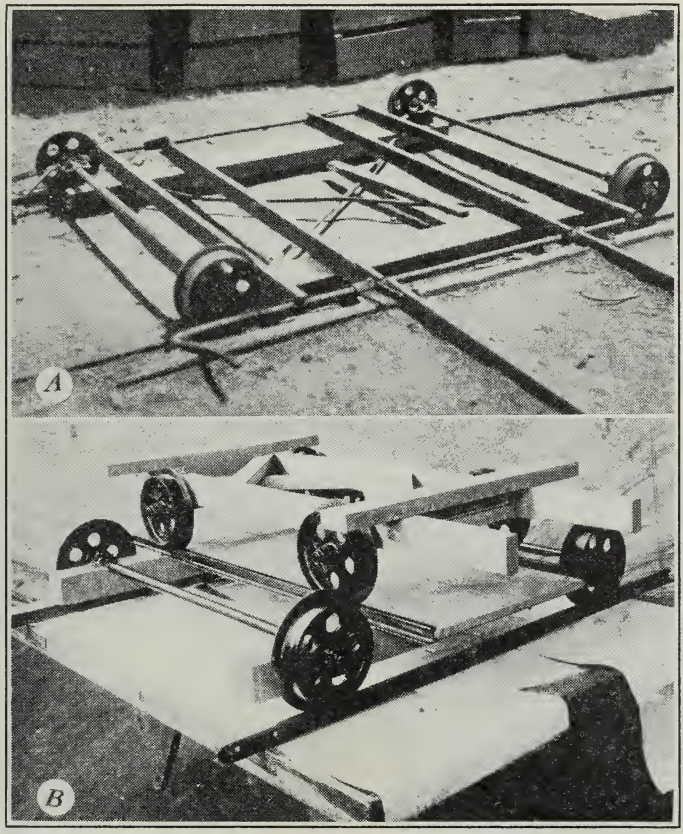

Fig. 11.—*A*, Transfer car in place at field or cross track. Note the handle of the locking device at the lower left. *B*, Wood-frame field and transfer cars. The steel wheels for the former are commonly 8 or 10 inches in diameter; for the latter 10 inches. (Courtesy of Anderson-Barngrover Company, San Jose, Calif.)

on trackage by moving it as different sections of the drying yard are filled, or to enable the use of the drying yard for other purposes in off-season. The customary track gauge for the tray cars is 2 feet, and for the transfer cars 4 feet.

In order to permit change in direction of loaded cars either transfer cars (fig. 11), sunk below the main track level, or turntables (fig. 12) are necessary. At the sulfuring houses the transfer-car system is the only

satisfactory one, but turntables have distinct advantages in the drying yard proper. The extra equipment required, the hazard of running tray cars off the transfer cars, and the inconvenience of the two-car system limit the feasible use of the transfer system to short distances. Four slight depressions forged into the top of the rails on the transfer car to receive the wheels of the tray car are a safety device in preventing the car of trays from rolling off. It is awkward, however, to push cars from transfers equipped with these depressions. It is also possible to attach hinged blocks to the transfer car to throw behind the tray-car wheels. These are much more convenient than the depression stops. Where either transfer cars or turntables are used the adjacent trackage must be rigid and in accurate alignment. A sturdy, positive alignment lock for the car is desirable.

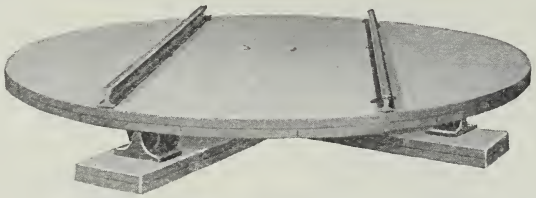

Fig. 12.—Turntables used for changing direction of tray cars. (From Ext. Cir. 75.)

The usual car for carrying the stack of trays is shown in figure 11. The frame may be of either wood or steel, and the empty car is of light weight to permit lifting on or off the track.

Another type of car lowers the tray stack onto ledges or rails built along the sulfuring-house walls or onto wooden horses, on each side of the track. The car may then be removed for other use. The initial cost of this car is somewhat less than that of a sufficient number of the common flat-car design, but it is not so flexible in use.

Automotive trucks, or carts of different designs as illustrated in figure 13, are preferred by some operators. These are well adapted to use in prune drying yards where cars and tracks are not so essential. The dust hazard from any wheeled equipment, however, should be taken into consideration.

Sulfuring Houses and Burners.—Before cut fruits and sulfur-bleached grapes are placed in the drying yard they are exposed to sulfur dioxide gas. (This chemical is commonly referred to among operators by its chemical formula—namely SO_2.) The sulfur dioxide absorbed by the fruit serves to maintain a bright, attractive color, prevent spoilage, repel insects, and preserve certain nutritive qualities.

Sufficient of the chemical must be absorbed by the freshly cut fruit to allow for losses that occur during drying and storage. Fruit is sulfured by placing it in a closed compartment with burning sulfur.

The sulfuring house and sulfur burner are essentially simple equip-

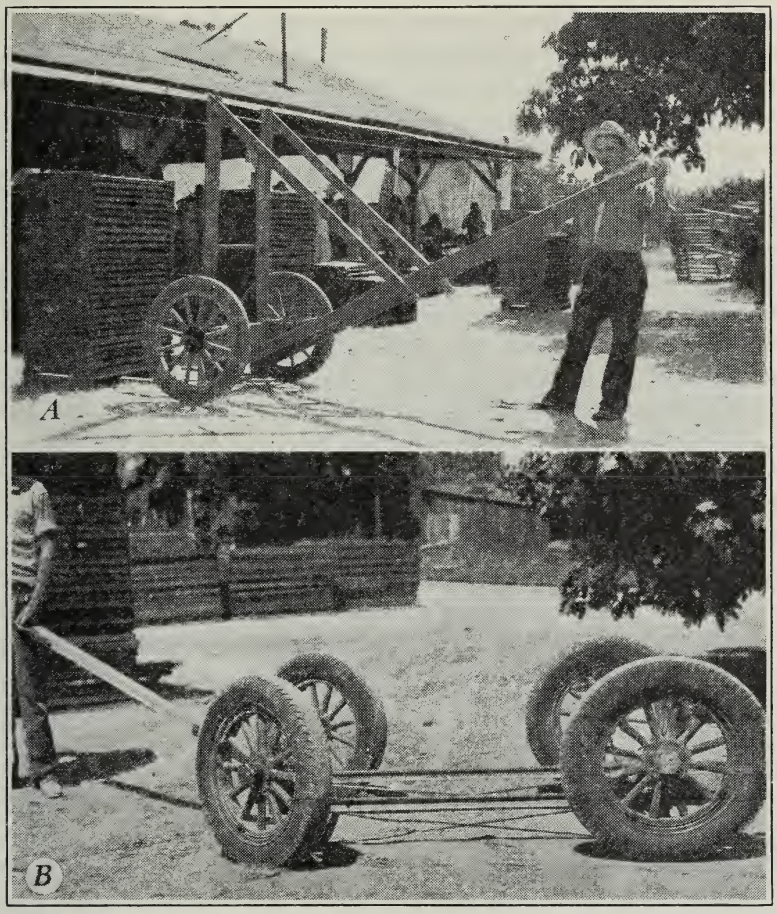

Fig. 13.—*A*, Tray-stack lift cart for use without tracks. *B*, Hand truck used to receive a car of trays at the sulfuring house and convey them into a trackless drying yard.

ment, but for favorable results careful attention must be given to certain details of construction and operation. In large drying yards it is considered advisable as a fire safety precaution to construct the sulfuring houses as two or more separate structures, rather than as one continuous building. The houses in use in drying yards in this state are of diverse design and construction. In a recent survey of such equipment

in the major dried-fruit-producing areas, very few houses were found adequate to best serve their purpose. The simple requirements of these houses are that they be economical in construction, durable under the severe usage they receive, and of a design promoting rapid, uniform sulfuring. Fundamentally, this requires durable, easily worked construction materials which can be made permanently tight against air infiltration and leakage. The compartment may be of a size to hold one or more stacks of trays, but should not contain excess space beyond the 6-inch clearances for convection circulation of air about the stack and adjacent to the open ends of the trays. The most positive convection distribution of sulfur dioxide gas is secured by making the compartment longer than the tray stack in order to permit placing the burner on the floor between the car and the door, without fire hazard.

For sulfur burners, clean metal pans are recommended; earth pits into which sulfur is sometimes dumped for burning have been found grossly wasteful of sulfur, and a major factor in the production of poor-quality fruit. A tin pan 10 inches in diameter and about 3 inches deep makes a very satisfactory burner for a single-car house. Concrete hearths of an area equivalent to that of the pan burners, and shallow to readily permit cleaning, are satisfactory. Insulated, regenerative, or forced-draft burners may be advisable for burning the poorer grades of sulfur, or sulfurs which do not ignite well because of contamination. Such devices are not economically feasible, however, at current sulfur prices or for the character of operation practiced in most drying yards. Some care is required with such devices, also, in order that the burning rate is not so rapid as to permit some sulfur to be carried through the flame and sublimed onto the fruit. It is preferable to use pan burners, and sulfur that burns readily. A grower can test the extent to which a particular lot of sulfur will burn, by igniting a weighed quantity of the sulfur in a weighed 10-inch pan in an empty, but closed, sulfuring house. After the sulfur has ceased burning, the pan should be removed and weighed with the remaining slag, if any. The percentage of sulfur burned can then be calculated. When good sulfurs are subjected to this test, from 95 to 100 per cent of the sulfur should burn.

Where the compartment is short, and the burner pan must be set in a pit under the end of the tray stack, a metal baffle sheet may be fastened under the end of the car for fire protection. Loose baffles laid over the pit are likely to materially reduce the opening and restrict the burning rate, with lower sulfur dioxide gas concentrations as the result.

In a house of sufficiently tight construction to prevent drafts, vents will be required to provide air for the fire. The simplest, adequate system appears to be an inlet of not more than 1×2 inches beside each track at

the base of the door, and outlet holes of 1-inch diameter located at the top center of both the rear wall and door (fig. 14). These outlet vents provide about 1 square inch of area to 50 square inches of burner surface, when a 10-inch-diameter pan is used as a burner. This ratio must be maintained, and the vent area modified if the pan size is changed.

A good grade of refined sulfur is recommended for use because it is more economical and less troublesome than cheaper grades. The sulfur should burn completely, leaving not more than 1 or 2 ounces of residue

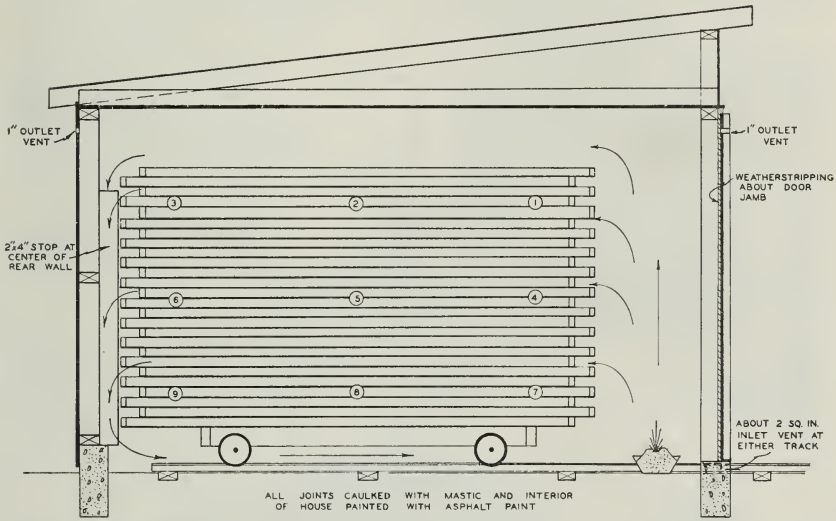

Fig. 14.—Section of sulfuring house showing a car loaded with fruit trays and the location of the sulfur burner and ventilation openings. Convection currents aid in equalizing the gas distribution; the arrows indicate the direction of the gas flow as determined by measurements made at the points designated by numbers. (From Bul. 636.)

from the standard 4- or 5-pound charge per car containing about 1,000 pounds of cut fruit. If an appreciable amount of slag remains, the cause may be surmised from its color; a clean yellow color indicates an insufficient air supply, whereas a black-coated residue indicates a poor sulfur and one probably contaminated with oil or other organic material. Proper handling and storage of the sulfur supply is essential; it must be kept dry and must not be permitted to come in contact with oily surfaces or vapors. It should not be stored in garages, or near oil storages.

A sketch of a simple lift-over sulfur box or hood for small-scale operations is shown in figure 15. Illustrations of two satisfactory designs of permanent sulfuring houses are given in figure 16.

Maintenance of the sulfuring house is a most important phase of drying-yard management. It is poor economy to attempt to remodel old

houses unless the framework is in good condition. If the structure is on mud sills, it should be raised and a continuous concrete slab for floor and foundation poured. This slab base imparts a rigidity to the structure which helps keep it tight. It also holds the track firmly in position. Top-heavy, vertically sliding doors and swinging counterbalances for top-hinged doors cause warping and should be replaced by closely fitted and

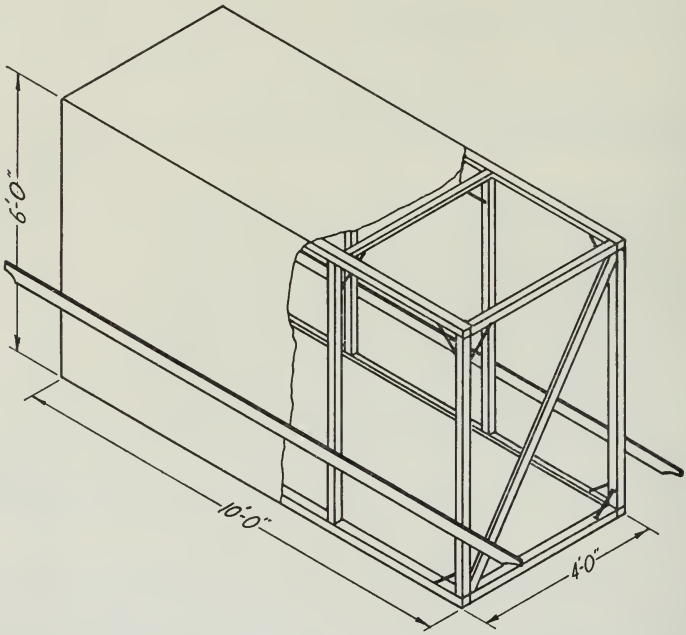

Fig. 15.—Lift-over sulfuring box or hood. The frame is constructed of 1 × 2 inch lumber braced at the corners with steel angles or plywood gussets, and is covered with sturdy building paper. This hood may also be used for small-scale fumigation of dried fruit on the farm.

weatherstripped side-hung doors. All cracks and structural joints of the interior walls and ceiling, particularly those at the sill and plate, should be caulked with asphalt mastic and two coats of asphalt paint applied in a continuous film to seal the structure. It is imperative that all visible leaks other than the vents be closed. If the interior cannot be readily sealed, it should be lined with plywood and sealed at all joints with mastic or asphalt-impregnated felt with sealed edges.

Skin-checking Equipment.—Prunes and grapes, to be sulfured, are usually given a treatment to "check" or puncture the skin because this facilitates drying. The treatment consists of a lye dip, and sometimes a subsequent water spray.

Of the several types of dippers in use, the simplest is shown in figure 17, *A*. This consists of a semicylindrical dump basket with a perforated sheet metal or wire-screen bottom hinged to one side of the lye tank. The fruit is poured into the heated lye solution from the boxes while the basket is submerged. After the desired period of immersion the basket

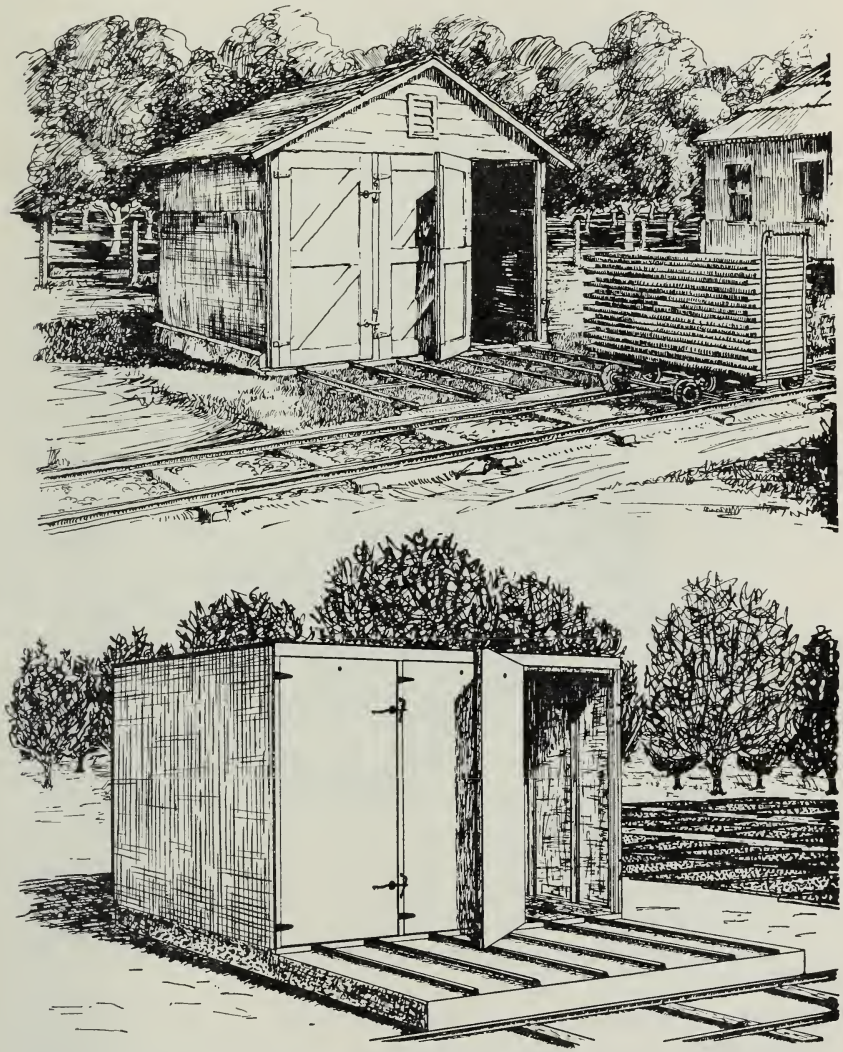

Fig. 16.—Sulfuring houses embodying the principles of good design. Plans and specifications for these are available for a nominal fee from the Agricultural Extension Service, University of California, Berkeley, Calif. The upper picture shows a gable-roofed three-compartment house, listed as plan C-173; the lower is a three-compartment, flat-roofed plywood structure, plan C-194. (From Bul. 636.)

is raised by a hand-operated lever, and the fruit discharged upon a shaker or a chute leading to the trays.

For large-scale operations a power-driven rotary or conveyor-type dipper is used. The rotary dipper, used for prunes, consists of a per-

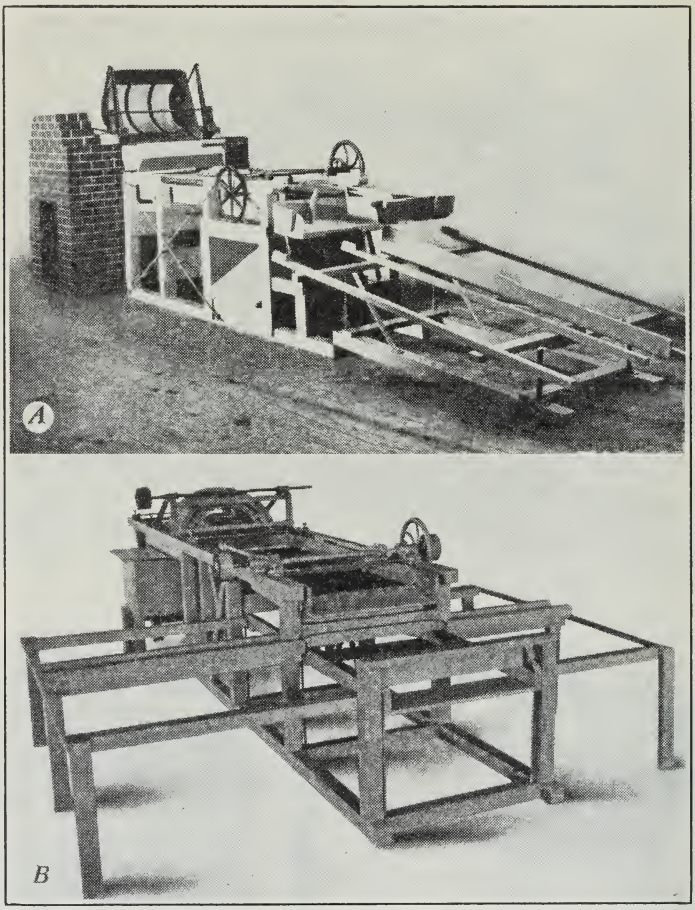

Fig. 17.—*A*, Hand-operated, basket-type prune dipper consisting of a power-driven grader, firebox under the lye tank, dipping basket, refuse screen, refuse outlet, and tray stands. *B*, Rotary-drum prune dipper with roller tray conveyors. (Courtesy of Anderson-Barngrover Company, San Jose, Calif.)

forated metal cylinder mounted on a horizontal axis and containing a helical baffle to maintain positive discharge (fig. 17, *B*). The lower third of the cylinder is submerged in the lye bath. The prunes are introduced continuously at one side and discharged at the other. A variable control on the speed of rotation governs the time of immersion. The conveyor-

type dipper has either baskets suspended from chains or a metal belt with cross vanes to carry the fruit. This enters at one end of an elongated lye tank and emerges at the other. The conveyor discharges the fruit on a shaker or a chute leading to the trays.

The lye tanks are usually built of black iron, because zinc galvanizing dissolves in a lye solution. Oil burners are frequently used under the vats, but gas, wood, or coal may be used. Where steam is available because of other needs, the lye solution may be heated by steam coils. In order to maintain the temperature of the solution at or near the boiling point a relatively large heating surface is necessary. The tanks usually hold 100 to 200 gallons or more; the heat capacity of the relatively large volume of solution tends to maintain a more uniform temperature.

Passing the fruit over a trash screen before it enters the lye bath is a material aid in maintaining a clean dipping solution. It is not usually provided for in hand-operated basket dippers, but is commonly installed on power dippers. All types should have a screen between the lye tank and the tray, where additional debris and the film of hot lye may be removed with sprays of cold water. This is usually mounted as a shaker to facilitate segregation of debris and for thorough washing.

Pricker or needle boards for prunes are sometimes used between the lye bath and the tray, but are not very satisfactory because they are difficult to keep clean and in good order. Furthermore, they appear to be of little value except for the thin-skinned varieties of prunes such as the Imperial, in the dipping of which little or no lye is used.

Prune dippers are often provided with grading screens. These segregate the large plump prunes from the small or shrunken ones and permit the trays for the two grades to be handled separately and thus secure more uniform drying. When green grading is used it is entirely for the purpose of facilitating drying and not for packing-house receiving.

The lye commonly used in preparing the dipping solution is commercial caustic soda or sodium hydroxide in flake form. It absorbs moisture quickly from the air; therefore, to preserve the flake form it should be kept in tightly closed metal containers. The amount put in the vat, or concentration of the solution, varies with the character of the fruit and other conditions, and is usually adjusted to give a uniform checking of the fruit skin to the degree found best by experience for the existing conditions. Overchecking, with consequent loss by excessive juicing of the fruit, must be avoided. Concentrations of lye ranging from ½ to 1 per cent at a temperature of about 200° F are commonly used.

Small producers will find it advisable to purchase lye in small (1 pound) containers; larger producers will find purchases in drums more economical.

There is a growing trend in the dehydration of prunes to omit the lye treatment, and merely wash the fruit in hot or cold water, because the drying has been found to be sufficiently rapid without resorting to checking. In this case the fruit is given a cold-water bath to wash off gummy exudations and facilitate traying. However the use of lye or other checking agent is usually necessary when prunes are to be sun-dried. Imperial prunes are sometimes sun-dried without using the lye dip.

The Drying Yard.—As previously stated, the drying yard itself should be so located as to secure every possible advantage of factors favoring rapid drying. This increases the output of the equipment (and thus reduces the area of yard and number of trays needed), permits a higher retention of sulfur dioxide in the sulfured fruits, and reduces the opportunity for microbial deterioration, insect infestation, and dirt contamination of the exposed fruit. The area should be fenced if there is any danger of animal or human marauders.

Control measures for allaying the dust nuisance from roads and drying-yard paths have been discussed. It is also important that the surface of the yard itself be as free as possible from loose dust, sand, chaff, or any debris that can be scattered on the fruit by the workmen or the wind. With adobe or clay soils an excellent surface may be obtained by smoothing and allowing it to pack hard without any cultivation or irrigation. Another method of securing a satisfactory surface is by growing hay or grain which is harvested close to the ground and carefully raked just before the drying season; the stubble on such areas must not be burned for the embers are light in weight and badly contaminate the fruit. It has been recommended that the best surface for sandy soils is obtained by growing alfalfa, stopping irrigation some weeks before the drying season, and cutting just prior to the fruit season. These procedures make possible an additional return from the drying yard. It has been found recently, however, that green vegetation on the drying yard transpires sufficient moisture to materially reduce the rate of fruit drying. This reduced rate and the attendant greater loss of sulfur dioxide in cut fruits, may result in a significant reduction in fruit quality. Some alleviation of this loss may be secured by raising the trays off the ground on 2×4 inch scantlings spaced in lines 4 feet apart, or on wooden horses a foot or more high as shown in figure 18. Raising the trays is also desirable for keeping their bottom edges clean, and in reducing the possibility of chaff blowing on the fruit. An excellent drying yard can be made by using asphalt to mix with the soil and then rolling. The objection to this is that the drying yard cannot be used for growing crops such as hay.

The dried fruit may be scraped directly from the tray stack into lug

boxes, but a better practice is to lift the trays on a pair of wooden horses or table of convenient height as in figure 18. This affords more opportunity for inspection and the sorting out of pieces that are discolored, dirty, slabbed, or otherwise defective. A simple wooden or metal scraper is used for loosening fruit which adheres to the trays.

Raisin Cleaner.—Mechanical screening of the natural raisins as they are removed from the drying-yard trays has been found to materially improve their condition by removing organic debris, sand, worm eggs, and insects. Field tests have shown that the average sand content of

Fig. 18.—Tray stands used to keep trays off the ground while the fruit is drying. They help protect the fruit from contamination, and to some extent expedite drying over green vegetative areas. This design is collapsible to facilitate winter storage.

Thompson Seedless raisins cleaned with the machine is only about 0.1 per cent. The violent agitation imparted by the screens separates the clusters of raisins and breaks the leaves into fragments so they fall through the screens. There is some danger if the agitation is too violent, of loosening many cap stems from the raisins and thereby favoring sugaring and consequent loss of quality.

Boxing Thompson Seedless raisins from paper trays by putting them over the cleaner has, in experiments by the U. S. Department of Agriculture at Fresno, resulted in a reduction of about 90 per cent of the raisin moth infestation. Removal of infestation from Muscat of Alexandria and other varieties was somewhat less effective. There is no evidence that the cap stems are removed by this process any more than by ordinary boxing by hand without screening.

The average labor cost of screening and boxing is about the same as, or slightly less than, the cost of boxing by hand without screening. A four-

man crew is required for efficient operation. Too rapid feeding of raisins at the hopper results in overloading the screens, and reduces the cleaning effect. A simple, homemade shaker is shown in figure 19.

Storage and Delivery Equipment.—Better provision for and supervision of storage for the dried fruit is generally to be found at packing-houses rather than on the farm. Fruit undergoes a moisture equalization during the first two weeks of storage on the farm. This is termed "sweating" in the industry.

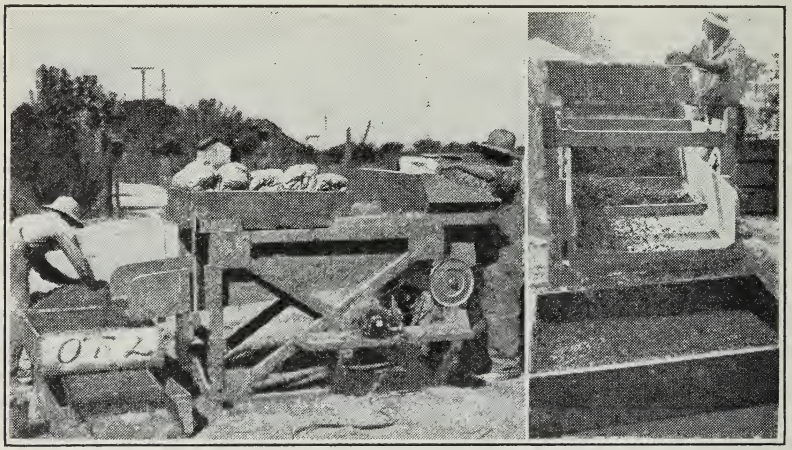

Fig. 19.—Raisin cleaner. The side view of the machine shows the use of a roller conveyor (at left) to facilitate handling the cleaned raisins. The sweat box of paper trays rolled into "biscuits" on top of the machine has been placed there as a weight to minimize vibration. The end view of the machine shows raisins passing over the screens. Three cross cleats are placed above the screen to check the flow of raisins and produce a churning effect. (This machine was developed at the Fresno office of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, from a design originated by a grower. Plans are available from the Dried Fruit Association of California, San Francisco, Calif.)

The farm storage conditions should be the best that can be provided, regardless of whether the storage is to be for a long or short period. The storage space should be cool, dry, and ventilated. Rodents and poultry must be excluded. Extreme care should be taken to prevent insect infestation. Any dried fruit from the previous crop must first be removed from the building and the sweepings burned, for such material is always infested and the infestation will quickly spread to the new fruit. The building should be thoroughly cleaned, and if possible either "gone over" with fly spray or fumigated to kill hidden insects. If the fruit is to be fumigated as soon as it is placed in storage, this will serve the two purposes. Typical farm storage structures for dried fruit are shown in figure 20.

Different containers are favored in practice for the different fruits. That preferred for raisins and figs is the sweat box, into which the trays are scraped. These are pine boxes about 38½ × 26¾ inches in area and 7¾ inches deep. The ends are 1¼ inches thick, and sides and bottom

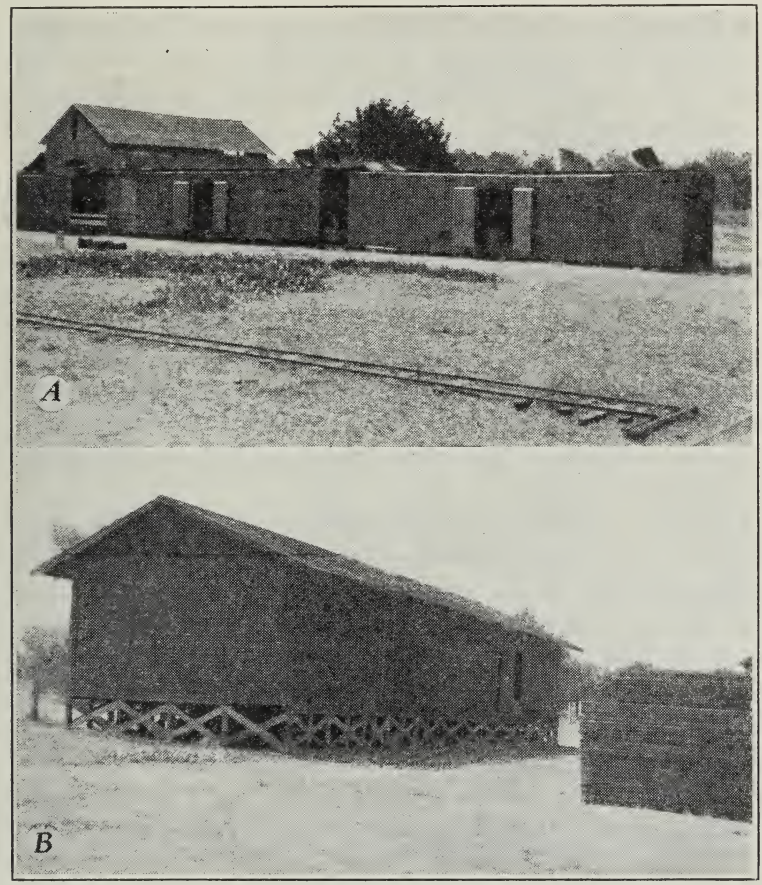

Fig. 20.—Farm storage structures for dried fruit: *A*, old refrigerator cars converted into storage structures; *B*, farm storage shed—note the provision for under-floor ventilation.

are ⅞ inch thick, strengthened by corner posts and sometimes bound at the ends with steel tape. Each holds about 135 to 200 pounds of fruit. Apricots, peaches, pears, and figs are often placed in lugs or sweat boxes by the grower. Prunes are usually dumped by the grower in piles upon a clean wooden or concrete floor, where they are turned with shovels at intervals of a few days during the sweating period, which apparently expedites moisture evaporation and equalization. When the cut fruits,

such as apricots and peaches, are dumped in piles they are not generally shoveled over, owing to the danger of curling and destroying the shape of the fruit. In fact it is not good practice to store cut fruits in bins because of the danger of mechanically injuring the fruit and thereby lowering the quality. Pears, and often other fruits, are placed in orchard lug boxes after drying. Only when clean boxes are not available and a number of lots of fruit must be held in a small floor area by the grower is it necessary for him to construct bins with removable sides of planking, such as those used in packing-houses. This method of storage is not advisable if the fruit must be piled too high to conserve floor space.

Prunes are sometimes stored in burlap sacks; their use for delivery to the packing-house is almost universal. Clean sacks must be used for this purpose, otherwise undesirable flavors may be imparted to the fruit. In order to protect themselves against unnecessary infestation, packers usually fumigate sacks before using them for dried fruits. This is a desirable practice. Sacks are not recommended for cut fruits, however, because of the tendency of the pieces to accumulate dirt and to curl, so that they lose their actual size classification when put through screens in subsequent grading. The sacks are filled with a scoop shovel while mounted in a sack filler.

Fumigation Chambers and Applicators.—Fumigable storage, consisting of compartments which can be sealed against loss of the fumigant, is desirable on the farm. Sulfuring houses of the type illustrated in figure 16 may readily serve as fumigating chambers when the cracks around the door and the ventilation openings are tightly closed. It is likely, however, that solar radiation will cause higher interior temperatures than are desirable for long-time dried-fruit storage during the early fall months unless precautions are taken to shade the structure.

Since most fumigation failures are due to leaky chambers it is essential that the construction be gastight, not merely light-proof. Figure 21 shows a design of a chamber built of Douglas fir plywood or sheet steel, with the joints filled and sealed with asphalt mastic. The portable chamber is built of plywood for rigidity and light weight, and is intended to be set over a stack of fruit boxes on solid soil. A seal is made to the ground with damp soil to prevent the loss of gas. A portable chamber with a capacity of about 300 cubic feet is about as large as can be handled conveniently. Since the same dosage of fumigant is required for an empty or partially filled chamber as for one completely filled, two small chambers may serve more economically than one large one.

The permanent chamber design shown is intended for construction inside of some other structure. The chamber may be built outside if ex-

terior-grade plywood is used for the walls and a gable roof is added. The single-panel thickness of walls and ceiling is advantageous in locating any leaks at construction joints. A simple means of checking the construction is to burn sulfur in the compartment to form sulfur dioxide gas, and move an ammonia-soaked rag along the exterior face of the wall adjacent to all construction joints. The formation of heavy white

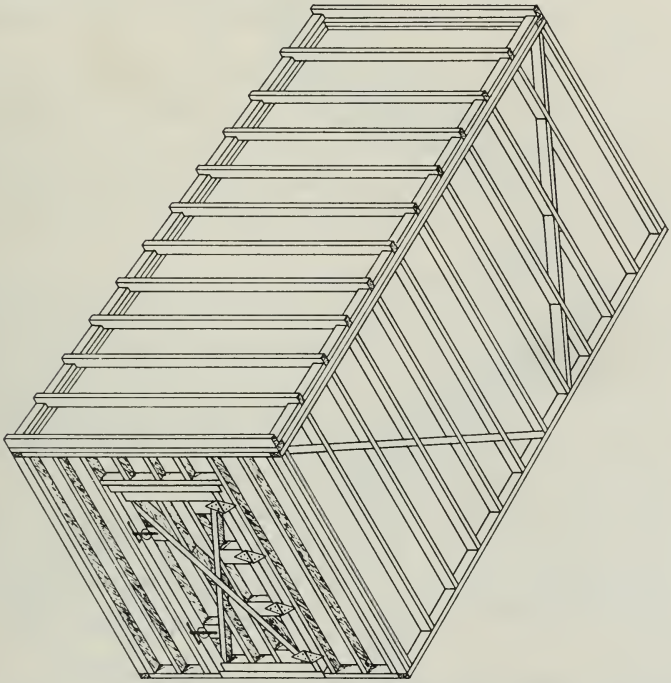

Fig. 21.—Gastight fumigation chambers should be used. The design shown is that of a satisfactory permanent structure; it has a concrete floor, and panel walls without outside framework to facilitate tighter wall construction. (Detailed plans for the construction of these chambers are available from the Dried Fruit Association of California, San Francisco, Calif.)

fumes of ammonium sulfite indicates leakage of sulfur dioxide gas. Other sensitive leak detectors are available for use with some of the other fumigants.

A concrete floor should be used for the permanent chamber, since the flexure of a wood floor under load makes the maintenance of a gastight joint between the sill and wood floor very difficult. The most difficult place to seal is the door. The door jamb must be designed to permit the use of weather stripping, so that the door may be wedged against it. A

removable sill designed to wedge between the bottom of the door and the floor, is also required.

Provision should be made for venting the chamber so that fumigants may be dispersed quickly at the end of the exposure period. This is accomplished by placing a vent in the side opposite the door and installing a fan which will exhaust outside the building. The same precautions must be used in sealing the vent as are taken in sealing the loading door. Outside chambers with doors on opposite ends are readily ventilated by natural draft.

Unless other considerations prevail it is suggested that the permanent chamber be of 1,000 cubic feet volume, or some multiple of that size. This facilitates the measurement of the fumigant and may permit economies in the use of the fumigants. As with the portable chamber design, several small compartments will permit greater flexibility in use than one large chamber.

All figs except Kadotas are fumigated on the farm immediately after picking. Other dried fruits which are to be held in storage should be fumigated immediately after removal from the trays. The best conditions for holding these products are provided by tight compartments in which they may be stored and refumigated when necessary. This is essential to prevent infestation by the Indian meal moth and other insects that attack dried fruits in storage.

Storage boxes should be well cleaned before they are filled with fruit. This can be accomplished by immersion for a few seconds in a tank filled with boiling water to which is added 1 to 5 pounds of trisodium phosphate per 100 gallons. This treatment should be followed by rinsing in clean water.

A number of fumigants are available for farm use, including chloropicrin, ethylene oxide, and methyl bromide. All are hazards, to some degree, to human and animal life and must be used with due precaution. Furthermore, some fumigants may be inflammable or explosive under certain conditions. These dangers can be avoided by closely following the instructions of the distributors. The use of cyanide gas for fumigating dried fruits is not advisable because of the possibility of toxic residues, with subsequent seizure by the federal Food and Drug Administration. When using fumigants on the farm the grower should receive full instructions and warning signs from the dealer.

Pest control in rural warehouses has been discussed rather extensively in a publication by Mackie and Carter.[12] These authorities have recom-

[12] Mackie, D. B., and W. B. Carter. Pest control in rural warehouses and suggested improvements. California Dept. Agr. Bul. 26(3):275–93. 1937.

mended the following dosages of fumigants to be used per 1,000 cubic feet of space: chloropicrin, 2 pounds; ethylene oxide plus ethylene dichloride, 9.5 pounds; methyl bromide, 1 pound. These dosages apply

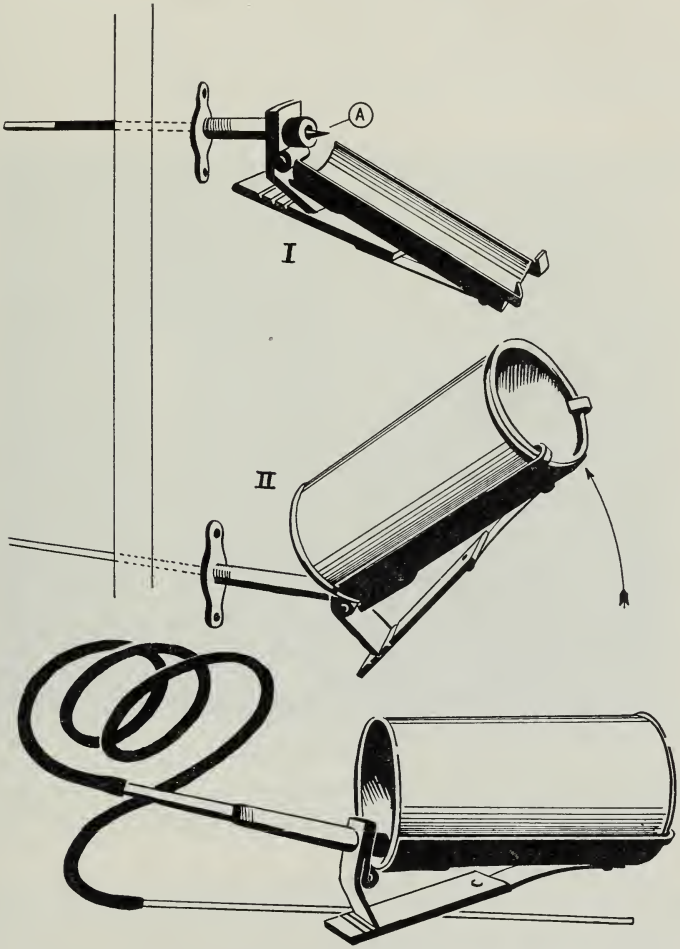

Fig. 22.—Safety applicators should be used in fumigation. The type shown above is designed for use with fumigants in cans. The can is laid in the inclined rack of the applicator (position I) which is attached to the outside of the fumigation-chamber wall. Lifting the rack upward (position II) forces the end of the can against the opener, *A*, and the contents drain through the tube into the chamber. The sketch at the bottom illustrates use of the applicator without attachment to the wall. In large chambers it is advantageous to use electric fans for 30 minutes after the application in order to secure rapid distribution and prevent stratification. Rubber or copper tubing may extend the outlet tube to reach any desired position within the chamber. (Courtesy of Neil A. Maclean Company, San Francisco, Calif.)

whether the space be nearly empty or filled with the products to be fumigated. The effectiveness of all fumigants varies with temperature; at lower temperatures, longer periods of exposure are required. Methyl bromide is the most recent fumigant to come into commercial use, and is very effective when applied according to the carefully detailed directions of its distributors. The general recommendations are for use of 1 pound of fumigant per 1,000 cubic feet of tightly sealed space for an

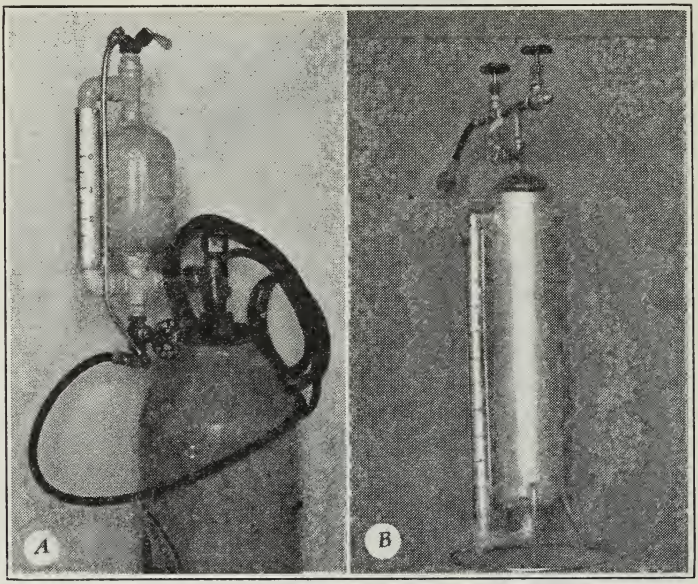

Fig. 23.—Applicators for use with cylinders of fumigants: *A*, applicator attached to the cylinder—it has the advantage that the operator is not exposed to fumes at any time; *B*, portable applicator; this type offers the advantage of mobility after filling. (Courtesy of Neil A. Maclean Company, San Francisco, Calif.)

exposure of 15 to 24 hours at ordinary atmospheric temperatures. Most fumigants are heavier than air and should be applied near the top of the chamber, or the pile of fruit if a tarpaulin is used.

Fumigants are available in ½- and 1-pound cans, as well as cylinders of various sizes, and may be applied by applicators of various designs. Figure 22 shows close-up views of satisfactory equipment for handling cans of fumigants, which are under pressure, without danger to the operator. Figure 23 shows two styles of applicators used with cylinders.

Fly sprays with a strong odor of kerosene or carbolic acid should never be used around fruit, whether it is fresh or dried. While many of these are effective in killing or repelling insects, the odor is very pene-

trating and persists even after cooking; hence their use is likely to make the fruit unsalable.

Equipment for Packing Fruit on the Farm.—Very little fruit is packed on the farm; and in the few instances where it is practical to do so, improvised equipment is used. The packing of dried fruits requires cleaning, usually some processing treatment, grading, and packing. Large-scale packing-house equipment is obtainable from food-machinery establishments but is much too large and expensive for farm-scale operations. Some of the small-scale manufacturers in the fruit-drying areas have at times made custom-built packing machinery for farm use. These manufacturers are probably the best sources for this equipment.

METHODS OF PREPARATION AND DRYING

Apricots.—Apricots are dried with the skin attached and usually without washing unless they have been soiled by contact with the ground. Washing is recommended for all apricots, however, and should be done before cutting. Apricots are always cut by hand with a sharp knife, completely around the suture; care should be taken to avoid tearing the fruit when the halves are separated and the pit removed. Many cutters will tear soft fruit apart because it is easier or quicker, but this injures the appearance of the fruit, and may cause the halves to flatten out into "slabs." The cut fruit should be placed on the trays closely and uniformly with the cut side up. If the halves are too far apart, movement of the trays may cause juice to run from the cups. The juice, on drying, sticks the fruit to the trays and tears some of the fruit during scraping, with a consequent decrease in quality. The pits should be collected in special cans or boxes to avoid soiling fruit, and should be dried in the sun, without sulfuring, for use in the manufacture of by-products. Trimmings, decomposed fruit, or foreign substances should never be mixed with the pits.

Apricots can be dried whole although the halved product is the only one prepared on an extensive scale. If dried whole, the fruit can be dipped for about 10 seconds in 1½ per cent boiling lye solution and then sulfured; or sulfured without the lye treatment. The sulfured fruit is then spread in the drying yard for a few days after which the pits are squeezed or pushed out. The drying process may be completed in a dehydrater or in the drying yard. In the latter case resulfuring is advisable in the cool coastal regions, if the fruit has not been lye-dipped prior to the first sulfuring. Pits that have been exposed to sulfur dioxide fumes should not be mixed with unsulfured pits since they are of lower commercial value.

The trays on which the cut or whole fruit has been spread should be stacked on the trucks in staggered fashion so the ends of alternate trays overhang about 6 inches, to facilitate handling and circulation of the sulfur dioxide fumes. The fruit should be sulfured as soon as practicable after being placed on the trays. Some growers sprinkle the fruit with water before sulfuring, if the surface has become dry, because they believe it softens the surfaces hardened by drying and facilitates the absorption of sulfur dioxide. The benefits derived from this treatment, however, are questionable, according to the best information available.

Most growers sulfur halved apricots for 2 to 4 hours. Many leave them in the sulfuring house overnight, even though the sulfur burns out in a few hours. This practice is not advisable in districts where the fruit is inclined to "bleed." In a tight sulfuring house, that is operating efficiently, an exposure of 2 to 3 hours and the use of 3 to 4 pounds of sulfur per fresh ton of fruit are sufficient for halves; whole fruit requires about twice as long for a similar absorption. These practices, of course, should be varied according to the characteristics of the fruit, district, and specific operating conditions. This is particularly true in regard to the sulfuring houses found on most farms, since they are not tight and require the use of more sulfur and a longer sulfuring period. To secure and retain the best commercial color, apricots when dry should contain at least 2,000 parts per million or more of sulfur dioxide; but on account of governmental regulations in certain important markets, the amount should not exceed about 2,500 parts per million. The only reliable way to determine whether or not the fruit is properly sulfured is by chemical analysis, facilities for which are usually maintained by dried-fruit packers. Cutting the fruit when removed from the sulfuring house to determine whether or not it is thoroughly "cooked" does not give any indication of what the final sulfur dioxide content will be.

As soon as possible after sulfuring, the fruit should be spread in the sun. Allowing the trays to stand on the car favors the accumulation of juice in the cups; if there is much juice it is likely to be spilled, and spilling of juice not only soils the trays but also decreases the yield and quality by favoring slab formation.

Some growers leave the fruit on the drying field, in the sun, until it is sufficiently dry to remove from the trays and put in storage. Somewhat better color and size can be obtained by stagger-stacking the trays with the ends toward the prevailing winds, before the fruit is fully dried. Exposure to the sun for 1 or 2 days, in the interior valleys, and for 2 to 7 days in the coastal areas, is desirable. The essential time of exposure to the sun depends upon the drying climate and district, ranging from 2

days to 2 weeks for half-drying, preparatory to stacking. The fruit should attain a flexible "kid-glove" texture in the stack before it is boxed.

The transfer of the fruit from trays to boxes affords the best opportunity for sorting out pieces that are discolored, dirty, slabbed, or otherwise defective.

According to a survey made several years ago[13] approximately 28 man-hours per fresh ton were required on the average for picking and all other labor except cutting.

The cost of drying apricots and peaches undoubtedly varies considerably with the district and season. A summary of costs, exclusive of harvesting and handling to the drying yard, made in Stanislaus County during the years 1937, 1938, and 1939 is given in table 6. It should be pointed out that the averages do not reflect conditions in all drying yards even in that county. Nevertheless, they give an indication of the cost of drying apricots and peaches. It is apparent from the data that certain cost items may vary considerably from year to year.

Freestone Peaches.—Like apricots, freestone peaches are pitted and dried with the skin attached. Whole-dried peaches are not prepared as a commercial product. Other practices are very similar to those used for apricots.

The pits should be collected and dried rather than placed in a pile where insects will multiply. They are dried in a manner similar to that used for apricots; they are of less value and at present are used chiefly for fuel. Some are also used for manufacture of charcoal and chemicals such as acetone and acetic acid although this use is not so extensive at present as in the past.

The sulfuring and drying of peaches differs from that of apricots chiefly in that the sulfuring period is about 1 hour longer and the drying period is at least 2 days longer. Lovell peaches will darken rapidly after drying unless sulfured more heavily and dried more thoroughly than is common for Muir and other varieties. For this reason it is advisable to dry Lovell peaches for a longer period of time.

In a survey of peach drying yards, an average of 17.3 man-hours for picking and all other labor except cutting, were used in drying 1 fresh ton of peaches.[14]

The results of drying-cost studies for peaches in Stanislaus County are given in table 6.

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[13] Christie, A. W., and L. C. Barnard. The principles and practice of sun-drying fruit. California Agr. Exp. Sta. Bul. 388:1–60. 1925. (Out of print.)

[14] See citation in footnote 13.

TABLE 6

APRICOT AND FREESTONE- AND CLINGSTONE-PEACH DRYING COSTS IN STANISLAUS COUNTY FOR THE YEARS 1937, 1938, AND 1939*

Item	Apricots				Freestone peaches				Clingstone peaches			
	1937	1938	1939	1940	1937	1938	1939	1940	1937	1938	1939	1940
Number of records	16	4	14	1	18	10	16	16	7	1	10	7
Number of green tons dried	1,067.75	201.21	1,242.98	4.25	1,138.58	1,389.47	1,999.06	1,683.72	1,320.97	9.50	770.14	465.60
Drying ratio	6.40:1	7.52:1	6.33:1	5.20:1	6.92:1	6.85:1	6.64:1	7.11:1	6.39:1	7.28:1	6.71:1	7:25.1
Cost per ton for drying, in dollars, based on weight of fresh fruit												
Maintenance and repair labor	0.25	0.06	0.12	0.16	0.19	0.13	0.07	0.09	0.18	0.06	0.08	0.14
Washing trays	0.34	0.11	0.18	0.08	0.35	0.20	0.23	0.24	0.14	0.21	0.14	0.27
Cutting	5.79	4.28	4.92	4.80	2.48	1.95	1.97	2.08	4.88	3.81	4.45	4.31
Shed and yard work	4.41	2.48	3.42	1.32	2.54	1.45	1.93	2.18	2.94	0.25	2.15	1.88
Horse, truck, and tractor work	0.03	0.02	....	....	0.03	0.01	....	....	....	....	....	....
Total labor costs†	10.82	6.99	8.65	6.36	5.59	3.74	4.20	4.59	8.14	4.33	6.83	6.60
Material cost (sulfur, power, etc.)	0.46	0.44	0.32	0.61	0.38	0.30	0.27	0.24	0.29	0.27	0.20	0.18
Cash overhead	1.02	0.68	0.83	0.84	0.62	0.37	0.41	0.47	0.66	0.63	0.65	0.67
Total cash costs	12.30	8.11	9.80	7.81	6.59	4.41	4.88	5.30	9.09	5.23	7.68	7.45
Depreciation	0.86	0.45	0.70	1.76	1.03	0.91	0.77	1.10	0.61	1.52	0.58	0.67
Total cash and depreciation costs	13.16	8.56	10.50	9.57	7.62	5.32	5.65	6.40	9.70	6.75	8.26	8.12
Interest on investment at 5 per cent	0.52	0.23	0.35	0.60	0.52	0.44	0.38	0.54	0.34	0.54	0.31	0.38
Total all costs for fresh ton	13.68	8.79	10.85	10.17	8.14	5.76	6.03	6.94	10.04	7.29	8.57	8.50
Cost per hundredweight, in dollars, for drying, based on weight of dried fruit												
Labor	3.46	2.63	2.74	1.65	1.94	1.28	1.39	1.63	2.60	1.58	2.29	2.39
Material	0.15	0.16	0.10	0.16	0.13	0.10	0.09	0.08	0.09	0.10	0.07	0.07
Cash overhead	0.33	0.26	0.26	0.22	0.21	0.13	0.14	0.17	0.21	0.23	0.22	0.24
Total cash costs	3.94	3.05	3.10	2.03	2.28	1.51	1.62	1.88	2.90	1.91	2.58	2.70
Depreciation	0.28	0.17	0.22	0.46	0.36	0.31	0.26	0.39	0.20	0.55	0.20	0.24
Total cash and depreciation	4.22	3.22	3.32	2.49	2.64	1.82	1.88	2.27	3.10	2.46	2.78	2.94
Interest on investment at 5 per cent	0.17	0.08	0.11	0.16	0.18	0.15	0.12	0.19	0.11	0.20	0.10	0.14
Total all cost per hundredweight of dried fruit	4.39	3.30	3.43	2.65	2.82	1.97	2.00	2.46	3.21	2.66	2.88	3.08

* Based on records from 17 apricot and peach drying yards, handling 4.011 tons of green fruit; study made by B. B. Burlingame and W. K. Hilliard, University of California Agricultural Extension Service.

† Includes miscellaneous costs.

Clingstone Peaches.—Until recently, clingstone peaches were not dried in commercial quantities. As a result of the decreased market for canned peaches of this type a portion of the crop was not utilized. With this surplus to be disposed of, the drying of this fruit has increased considerably. When used for drying, the fruit should be tree-ripened and hand-picked. It should be thoroughly washed in cold water before cutting to remove particles of dirt and some of the skin fuzz, in order to produce a superior product.

In the preparation of clingstone peaches for drying the fruit is cut in a line extending around the suture; then the pit is usually removed by use of a hand-pitting spoon. In large modern drying yards these operations are done by automatic cutting and pitting machines. The pitted fruit may then be dried with the skins attached as described for freestone peaches. In some cases, however, after pitting, this fruit is peeled by immersion in a 1½ to 2 per cent boiling lye solution and then rinsed under heavy sprays of water to remove the disintegrated particles of skin. Fruit peeled in this manner is then spread on trays, sulfured, and dried in a manner similar to that used for the unpeeled fruit.

The sulfuring period is about 6 hours, somewhat longer than that employed for freestone peaches; otherwise the drying-yard practices are very similar. It is, however, difficult to determine when clingstone peaches are sufficiently dried for stacking or boxing. The only safe procedure is to have the moisture content of the fruit checked periodically. If this is done with a moisture-testing machine, 1½ per cent should be added to the percentages given for freestone peaches in order to obtain the correct answer. A summary of cost studies for dried clingstone peaches is given in table 6. Peeled clingstone peaches are very often dehydrated; this procedure results in a better appearing product than that obtained by sun-drying. Disposal of clingstone peach pits offers somewhat of a problem since considerable flesh adheres and undergoes fermentation. These fermenting pits harbor insects and create an unpleasant drying-yard atmosphere. They should be spread in thin layers in order to dry as rapidly as possible; or if placed in piles, treated with lye or with a mixture of lime and chlorinated lime.

Nectarines.—The procedures used for nectarines are similar to those for freestone peaches although the sulfuring and drying times may be somewhat less. Both freestone and clingstone nectarines are dried; and when the latter varieties are used it is necessary to employ a preparation procedure similar to that used for unpeeled clingstone peaches. Nectarines are seldom washed prior to cutting, although it is advisable to do so.

Pears.—The preparation of pears for drying includes two steps not usually employed for other fruits. Since the pears are still green and hard when picked, they must be brought to a suitable stage of ripeness. Those produced for drying, however, are allowed to remain on the tree for a longer time than when picked for fresh shipment, in order to attain greater size and sugar content. Ripening is usually accomplished by allowing them to stand in lug boxes at a moderate temperature, and sorting out the fruit for cutting as it ripens. Sorting may be reduced and ripening hastened by treating with ethylene gas in a tight room or under a tarpaulin. This treatment will soften pears in about 5 or 6 days and very often the fruit does not require a preliminary sorting before going to the preparation tables. Where the usual method of ripening is giving satisfactory results there may be little if any advantage in using the gas. When fruit is being stored for a period of 10 days or more, and has to be sorted several times, ethylene gas will save both time and labor. The most satisfactory dosage of the gas in a tight room is about ⅕ cubic foot, at atmospheric pressure, for each 1,000 cubic feet of space, applied twice daily, with a good airing or ventilation between applications of the gas. Under a tarpaulin or canvas, 1 cubic foot of gas should be used per 1,000 cubic feet of space, and special ventilation is unnecessary. For best results the temperature of storage should be between 70° and 80° F. Temperatures over 90° retard ripening. Humidity need not be controlled, for it has little or no effect. The advantage of the ethylene treatment is that all the pears ripen at a uniform rate, and thus greatly reduce the need and cost of sorting. This procedure, however, is of doubtful economy for a small-scale operator. Small producers on the other hand may take advantage of the fact that ripe or nearly ripe pears emit ethylene gas which can be used to accelerate the ripening of immature pears. The procedure consists of stacking several boxes of fairly ripe pears with about twice the amount of green pears in a closed room or under a tarpaulin. All fruit should be watched closely to avoid overripening.

In California, pears are always sprayed with lead arsenate while on the tree, and require special treatment to remove the lead and arsenic residues. The methods used are discussed on page 14 of this circular.

When the pears are cut for drying the calyx should be removed and care should be taken to separate the fruit into two equal halves unless it is of abnormal shape. Besides cutting out the calyx the cutters should pull or cut out the stem. It is not customary to remove the core. Worm holes should be removed with a knife; badly damaged fruit should be discarded. The fruit is then spread on trays with the cut surface up.

The trayed pears should be thoroughly washed with cold water on a rack before stacking on cars. It is poor practice to wash the trays of fruit after stacking on trays of previously washed fruits; when this procedure is followed the washings fall on to the clean fruit below. After washing, they are sulfured for from 24 to 72 hours, with the sulfur replenished at about 8-hour intervals. Lake and Mendocino County pears are reputed to be of the highest quality produced, a fact probably due to the use of better quality of fresh fruit and longer sulfuring periods. In other sections the pears dried are generally sulfured less that 24 hours. Six hours may be regarded as a minimum for satisfactory keeping quality, but a longer period is usually required. Thoroughly sulfured Lake County pears are very soft and mushy when removed from the sulfuring house. This favors the production of translucency, an important characteristic of high quality. As with other fruits, the riper the fruit the shorter will be the sulfuring period required.

In order to secure the best color, pears should be exposed to the direct sunlight for ½ to 2 days. Tilting the trays toward the south is common in Lake County. After exposure to the sun the trays are stagger-stacked and the top tray is covered. The trays are often separated by blocks or sticks to facilitate circulation of air. During the 2 to 4 weeks' period usually required to complete drying in the shade, the trays are restacked several times and culls as well as pieces that are underdry or overdry are sorted out for separate handling. The finished product should be flat and flexible, but not mushy, with little curling or browning of the cut edges.

Labor to the extent of 26.5 man-hours, exclusive of cutting, were found by Christie and Barnard[15] to be used in drying a fresh ton of pears.

Dried pears are hand sorted and removed from the trays in the drying yard as is done with apricots and peaches.

Figs.—Since figs are already partly dried when brought in from the orchard, the drying process is relatively simple. They are usually gathered from the ground at frequent intervals and carted to fumigating chambers as soon after picking as possible; here they are fumigated overnight in the picking boxes to kill insects and insect eggs that may be present. Farm fumigation of figs and other fruits is discussed more fully on page 36 of this circular. After fumigation, the figs may be trayed and exposed to the sun for a few days until sufficiently dry for boxing. The length of time required for drying in the sun, however, depends on the weather and dryness of the fruit when picked. If the fruit is sufficiently dry at the time of picking it need not be exposed to

[15] See citation in footnote 13, page 43.

the sun for further drying. Figs are frequently dried in shallow boxes placed in stacks or set at an angle in a single layer. Even when figs are spread on trays the trays may be held in stacks until the fruit is sufficiently dried. Adriatic figs are sometimes dipped in water and sulfured before being spread in the drying yard. The dipping cleans the fruit and facilitates the absorption of sulfurous acid. The dipped fruit is sulfured for a period of about 4 hours, then spread in the sun for 2 to 4 days, and drying finished in the stack. Kadota figs are sometimes sulfured but the Calimyrna and Mission varieties usually are not. The most common practice today is to produce naturally dried figs without the use of dipping or sulfuring treatment. At one time it was a more common practice to dip and sulfur figs before drying.

During the past few years appreciable tonnages of cannery-cull fresh Kadota figs have been dried. These are simply spread in the sun until sufficiently dried for boxing. The outlet for such figs has been limited mostly to manufacturers of fig paste.

As soon as the figs are dried they should be sorted to meet the requirements of the federal Food and Drug Administration and the fig prorate zone if they are produced in such a zone. In 1927, the federal Food, Drug, and Insecticide Administration, in order to protect California growers against competition from imperfect imported figs (as well as the consumer against infested, decomposed, and filthy figs), reduced the tolerance for bad figs to 10 per cent. While this has decreased the importation of figs, most California growers and packers have difficulty in meeting this tolerance. Packers accept figs from growers without penalty only if the proportion of insect-infested, moldy, sour, bird-picked, dirty, or worthless fruits does not exceed 10 per cent.[16]

Sorting may be done in small drying plants direct from boxes. In larger drying plants, however, it is more economical and satisfactory to use continuous sorting belts. In both cases the sorting is done by hand by individuals familiar with this specialized type of work. As several types of spoilage cannot be detected until the fig is opened, it is obvious that the grower should cull out *all* fruit that can be seen to be bad while sorting.

On account of the increased danger of infection with endosepsis during caprification, the Calimyrna is somewhat more difficult to keep clean than the Adriatic, while the Mission is the least difficult. Light shaking of the trees and frequent harvesting of fruit from the ground help to forestall orchard infection, which occurs when figs are allowed to lie on the ground for any considerable length of time. Careful orchard

[16] At present prorate standards are established periodically, defining what is acceptable fruit.

sanitation and disinfection of caprifigs have been found beneficial in the case of Calimyrnas, at least as far as the mold disease known as endosepsis is concerned. Endosepsis as well as other fungus spoilage agents of figs, and their control, are discussed by Smith and Hansen in another publication of this station.[17] The cannery-cull Kadota, which is picked fresh before infection and insect infestation become serious, is relatively free from these troubles. Cultural methods that should be used for the production of clean high-quality figs are described fully in another publication by Condit.[18] Fig insects of California have been discussed extensively by Simmons, Reed, and M'Gregor in a circular published by the United States Department of Agriculture.[19] If dried figs are stored on the farm for prolonged periods they should be held in clean storage, fumigated every 10 days, and checked carefully at frequent intervals for live infestation. (See p. 36.)

When properly dried the interior of the fig should be of the consistency of stiff jelly, free from juice, and the skin should be flexible.

Prunes.—In most localities practically all prunes are allowed to drop from the trees and are harvested from the ground. In certain areas, however, particularly the Sacramento and San Joaquin valleys, it is necessary to first knock most of the fruit from the trees. In the coast districts practically all of the fruit drops to the ground without the necessity of shaking the trees although some shaking is used. The common practice is to make three harvestings. The first is made without shaking the trees; the second after shaking the trees lightly; and the third after a "cleanup" shaking. Fruit obtained from the first picking is usually poorer in quality than that obtained from subsequent pickings, and for this reason should be segregated. There is evidence to indicate that the yield and quality are not improved, and may be impaired, by leaving the fruit on the tree after the middle of the usual harvesting season has been reached. A darkening of the flesh frequently appears by midseason or earlier and becomes more pronounced as the fruit remains on the tree. On the other hand, harvesting all the fruit from the tree before midseason tends to reduce yield and quality. In the interior-valley districts, therefore, only moderate shaking of the trees in early-season pickings, with a cleanup shaking in midseason, seems likely to give the best results, although growers in these areas rarely make more than two pickings.

[17] Smith, Ralph E., and H. N. Hansen. Fruit spoilage diseases of figs. California Agr. Exp. Sta. Bul. 506:1–84. 1931.

[18] Condit, Ira J. Fig culture in California. California Agr. Ext. Cir. 77:1–67. Revised 1941.

[19] Simmons, Perez, W. D. Reed, and E. A. M'Gregor. Fig insects in California. U. S. Dept. Agr. Cir. 157:1–72. 1931. (Obtainable from the Superintendent of Documents, Washington, D. C., for 20 cents in cash.)

Three or four harvestings should be made in the coastal districts in order to eliminate the possibility of drying immature fruit.

Immature prunes tend to discolor and ferment with formation of gas pockets resulting in the formation of "chocolates," "bloaters," "frogs," or "frog bellies" (fig. 24).[20]

Prunes should be lye-dipped and spread on trays as soon as possible after harvesting. Fresh dipping solution should be made each day, and its strength maintained by frequent small additions of lye during use, to compensate for mechanical loss and neutralization by fruit acid. For

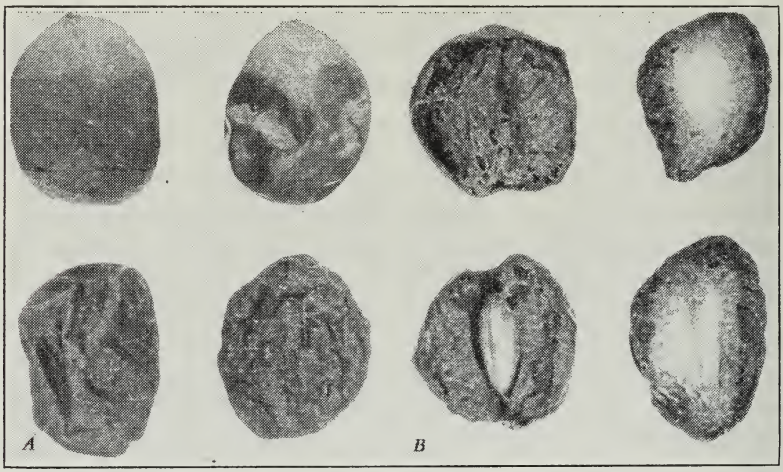

Fig. 24.—*A*, External appearance of "puffy" (left) and sound (right) prunes at two stages of drying. Sound prunes should have numerous small wrinkles, as shown at the lower right, rather than long coarse wrinkles as in the prune at the left. *B*, Interior appearance of "puffed" prunes (left) and of sound prunes (right). The two prunes at the left show large gas pockets, and the pit is pulled away from the darkened flesh; this is characteristic of prunes undergoing fermentative spoilage during drying.

French prunes the dipping solution should contain about 1 pound of lye (caustic soda) to 20 gallons of water, and should be maintained at about 200° F close to the boiling point. At certain times, however, when the skins do not check readily, it may be necessary to use use 2 or 3 pounds of lye to 20 gallons of water. Under these conditions, immersion for 5 to 15 seconds is sufficient. It is desirable that the temperature and the strength of lye be great enough to do the necessary checking in the shorter exposure time. The skin should be definitely checked as shown in figure 25, but large cracks or peeling of any fruits should be avoided.

[20] "Chocolates" are prunes that dry to a chocolate-brown color. "Bloaters" and "frogs" are puffy prunes containing large air pockets usually resulting from fermentation. They are all of off-grade quality.

Tough-skinned varieties such as the Robe de Sergeant require a more severe dip, while a weaker, cooler, or shorter dip should be used for the Imperial prunes. Some growers dip Imperial prunes in plain hot water only. Rinsing the fruit after the lye dip by immersion in running water, or better, by sprays, is desirable. Although lye-dipping is being replaced by dipping in hot or cold water for prunes to be dehydrated, it is always necessary to use a lye dip for prunes to be sun-dried, except for Imperial prunes.

Fig. 25.—Effect of proper lye dipping on the skins of prunes. (From Ext. Cir. 75.)

If the freshly dipped prunes are not fairly uniform in size, or if some of the fruit is slightly or partially dried, it is advisable to use a "green-fruit" size grader in connection with the dipping equipment. The small and the large prunes are then spread on separate trays for drying. This reduces the possibility of overdrying the smaller and already partially dried fruit. A hand-operated or power-driven shaking device is of great assistance in spreading the fruit, which should be only one layer deep on the trays.

The average requirement for dipping has been found[21] to be 1.3 pounds of lye, 2.5 kilowatt-hours of current, 2 gallons of fuel oil, and 1.95 man-hours of labor per fresh ton. The labor requirement for drying was 8.3 man-hours per fresh ton.

[21] See citation in footnote 13, page 43.

In the drying yard the prunes are left exposed to the sun until they are at least three quarters dried, when the trays are stacked. This usually requires a week or more, and during this time large prunes, especially Imperial, Sugar, and Burton varieties, should be turned to secure even drying. Prunes of these varieties are sometimes stirred by having two men shake the trays back and forth. In case of rainy or very foggy weather the trays must be stacked and covered and then spread again as soon as the weather will permit drying. In long-continued bad weather, prunes that are less than three quarters dry may have to be finished in a dehydrater in order to save them. Because prunes are dried late in the season, the weather may increase the cost of handling or the danger of loss to such an extent that many growers use dehydration altogether.[22]

When the fruit is sufficiently dry the flesh should be firm and the pit should not slip when a prune is squeezed between the thumb and forefinger. On emptying the trays, mashed prunes, slabs, bloaters, "frogs," scabby, or cracked prunes and "chocolates," should be culled out; at this point they can be more easily seen and removed than at any later time. This culling is done from endless belts in the larger drying yards and from trays or tables in smaller plants.[23]

Prunes are commonly purchased by packers from growers on a sliding price scale termed the "base price." By this system the grower is paid a base price per ton for prunes counting 80 to a pound; a premium of one dollar per ton is paid for each count per pound less than 80. On the other hand, he is paid one dollar per ton less than the base price per count per pound greater than 80. Prunes counting 33 or less per pound or 101 or more per pound are usually sold for a flat price. If the base price were 3 cents, a grower would receive 60 dollars per ton for prunes counting 80 to a pound, and 65 dollars per ton for prunes counting 75 to a pound. On the other hand, if the count were 85 the grower would receive only 55 dollars per ton.

Prune-drying costs, exclusive of harvesting and handling, have been obtained in the Colusa area and are summarized in table 7. The cost of sun-drying prunes, of course, varies considerably with the year and to some extent with the locality; furthermore, the variation between drying yards in the same locality might be considerable.

Grapes.—Most raisins produced in California are dried by the "natural" method, in the vineyard. Before picking begins and before the trays are distributed, most growers smooth the soil between the rows of

[22] For information concerning prune dehydraters, see: Christie, A. W. The dehydration of prunes. California Agr. Exp. Sta. Bul. 404:1–32. Revised, 1929, by P. F. Nichols. (Out of print.)

[23] At present, prorate standards are established periodically, defining what is off-grade fruit.

vines. Others use a plow or drag to throw up a ridge of soil on the south side of every other east-and-west row. The pickers spread the fruit one bunch deep on the trays as it is cut from the vines, resting the north end of the tray on the ridge, to tilt the tray to the south. The ends of the trays are sometimes reversed after about 4 days. By covering with an empty tray and then flipping the two trays over, the fruit is turned upside down after the top layer of berries has browned and shriveled, usually a week or 10 days after spreading. When all traces of green have disappeared and the grapes are about two thirds dry, the trays are stacked. When paper trays are used the grapes are turned by rolling

TABLE 7

COST PER DRIED TON OF SUN-DRYING PRUNES IN COLUSA COUNTY, FOR THE YEARS 1928, 1930, 1931, AND 1938*

Year	Labor	Material	Cash overhead	Interest and depreciation on drying equipment	Total
	dollars	*dollars*	*dollars*	*dollars*	*dollars*
1928	12.89	1.08	0.80	3.68	18.45
1930	15.50	1.10	0.87	2.88	20.35
1931	7.21	1.05	0.78	4.30	13.34
1938	7.60	0.50	0 52	4.14	12.76

* Table compiled by B. B. Burlingame from studies made in 1928, 1930, and 1931 by V. C. Bryant, and in 1938 by John Fiske and Arthur Shultis; all of the University of California Agricultural Extension Service.

onto another tray or are not turned at all. When the fruit is dry enough for stacking, the edges are turned in and the trays are then rolled into "biscuits." Paper trays are sometimes rolled in the manner of a cigarette. This latter practice should be discontinued, however, because these open-end rolls permit a great deal more insect infestation than do the "biscuit" rolls. The trays having been stacked or rolled, the raisins remain in the vineyard for curing until they are ready for boxing. The time may range from 10 days to over 2 weeks. Naturally, grapes or raisins on paper trays, whether rolled or not, are very susceptible to damage in case of rain, and they may become badly sanded as well as moldy. When the raisins are so dry that juice cannot be squeezed out between the fingers, they are ready to be placed in sweat boxes. A recent and desirable practice that has been used in many vineyards during the past few years is that of passing the raisins from the trays over a shaker. This treatment eliminates a high percentage of sand, insects, and insect eggs that may be present on the newly dried fruit (fig. 19). The sweat boxes should remain either in the vineyard or in a stack for several weeks

before delivery to the packing-house in order to permit the final curing or equalization of moisture.

While all currants, nearly all Muscat of Alexandria (hereafter called simply "Muscat"), and most of the Thompson Seedless (Sultanina) and Sultana varieties are dried in the natural condition, about 5 to 15 per cent of the Thompson Seedless raisins are dipped before drying. Aside from the dehydrated Thompson Seedless that are dipped and sulfured to produce the so-called "golden-bleached" raisins, the seedless raisins dried after dipping are of three types: "soda-dipped," "oil-dipped" and "sulfur-bleached."

Soda-dipped Thompson Seedless are dipped much like prunes. The dip usually contains 1 pound of lye (caustic soda) to 20 gallons of water, although some growers prefer the weaker sal soda (sodium carbonate) or the still weaker baking soda (sodium bicarbonate) solutions in order to avoid the danger of overdipping. A very small quantity of olive oil may be added to the dip. When lye is used and the solution kept at or near the boiling point, immersion for 5 seconds or less will produce numerous minute cracks in the skin which facilitate sulfuring and drying. The degree of checking, however, varies greatly with the maturity and general condition of the fruit. For uniform checking the grapes must be of uniform maturity; underripe fruit checks much more readily than that fully ripe. After rinsing in fresh water the grapes are spread on trays and exposed to the sun, turned after 3 or 4 days, and stacked in about a week. The finished raisins are somewhat translucent and of a distinctly reddish-brown color.

Oil-dipped raisins are made in two ways: In one, the grapes are dipped for 30 seconds to 3 minutes in an unheated solution containing about 30 pounds of baking soda (sodium bicarbonate) and 1 pound of lye in 100 gallons of water, on which a film of olive oil is floated. About 5 pounds of baking soda and 1 quart of olive oil are consumed in dipping 1 ton of grapes. In the other method the solution is used hot, and sal soda can be substituted for the baking soda. In both cases the grapes acquire a perceptible film of oil as they leave the dip. Drying is carried out as for soda-dipped raisins. The finished product is usually darker in color than the soda-dipped and has a slightly oily surface.

Sulfur-bleached raisins are first dipped in the same manner as soda-dipped raisins, spread on wooden trays, then sulfured for 2 to 4 hours. They are then spread in the sun, turned after 3 hours or a full day (according to the weather) and stacked after twice that length of time. The fruit near the ends of the trays should be pushed toward the center to protect it from the sun and avoid subsequent discoloration. After about

10 days the fruit is turned by placing an empty tray over a full tray and then "flipping them over." Several weeks are required for the drying, which is completed in the stacked trays, except for the final curing or moisture equalization in boxes. The finished product should be of a yellowish-white waxy color. Overexposure to the sun will produce an undesirable pink-brown or amber color.

A type of raisin produced extensively in Australia, but so far only in an experimental way in California, may be worth describing here for the benefit of those who might wish to undertake its production. It represents an attempt to produce a raisin of the Smyrna type, which enjoys a good trade in the British market. Only the Thompson Seedless variety is used, and the grapes should be well and uniformly colored though not sunburned, with juice testing between 23° and 26° Balling. An unheated dip is used, containing 25 pounds of commercial potassium carbonate to each 50 gallons of water. To this is added 1½ pints of olive oil previously emulsified in a small portion of the solution, care being taken to discard any floating oil not emulsified by the shaking or stirring. In certain areas in California it is impossible to prepare a good emulsion because of certain salts occurring in the water. In such instances this water must be softened or different water used. The grapes are immersed in this solution until the bloom is removed, which usually requires from 1½ to 4 minutes, according to the temperature of the dip which seems to work best at 90° to 100° F. More solution and especially more emulsified olive oil must be added from time to time to replace that lost in dipping the grapes; it is not necessary to make up a fresh solution until the old becomes sirupy from the juice of the grapes. After dipping, the grapes are drained and spread to dry either on wooden trays or on wire-screen racks supported 12 to 18 inches above one another in a shed without sides. During drying the grapes are lightly sprayed after 24 hours, in good weather, and again at the end of a week, with the dipping solution; but when there is heavy dew, fog, or rain the grapes are sprayed more frequently, sometimes every day. Care is taken to avoid touching the grapes during drying, and to avoid spraying the grapes heavily enough to cause them to drip. When the grapes are dried on wooden or paper trays or burlap in the sun only the above treatments are required, and the product closely resembles the California soda-dipped raisin although when dried rapidly in good weather it is considerably lighter in color. When dried on the wire racks in the shade a finished product of much lighter and more uniform color is obtainable. When shade-dried raisins are sufficiently dry to box and have been lifted from or shaken through the wire racks, they are distinctly greenish in color. To remove any in-

crustation of potassium carbonate that remains from the first dipping and the spraying during drying the fruit is again dipped or rinsed, this time for a few seconds in a weak solution, containing only 2½ pounds of potassium carbonate and 1½ pints of olive oil, thoroughly emulsified, in 50 gallons of water. When drained the fruit is spread on trays or tarpaulins (in Australia burlap is used) and exposed to the sun until the green color disappears and the raisins attain a light-amber appearance. This final exposure usually requires from 1 to 3 days, according to the weather, and during this period the raisins should be raked or stirred frequently to get a uniform color.

The amount of handling necessary to produce this raisin is obviously a disadvantage, but when successfully applied a product of exceptional color and uniformity is obtained.

A modified procedure is now being used extensively in Australia. It is termed the "mixed dip." The grapes are dipped in an emulsion prepared by adding 2½ pounds of potassium carbonate, 1½ pounds of lye (caustic soda), and 1½ pints of olive oil to 50 gallons of water. The temperature is maintained at about 180° F and the period of immersion ranges from 1½ to 2 seconds. The drying procedure is similar to that described in the preceding paragraph, but drying is much more rapid than for the grapes treated in the low-temperature dip.

In Greece, a special wood ash containing 80 to 85 per cent potassium carbonate and 10 to 12 per cent sodium carbonate is used in preparing the emulsion. There is some evidence to indicate that this mixture of carbonates gives better results and it is reported as being used throughout the Mediterranean region. In Greece the grapes are dried in the sun and in favorable years light-colored raisins are produced.

An objection to the use of the Australian and Greek procedures in California is the necessity for consistently favorable drying weather in order to produce a light-colored product, although experimental lots of good quality have been prepared at Davis, Livingston, Fresno, Kerman, and Reedley. In unfavorable drying seasons the experimental samples were much darker. California producers would probably find it more costly to process a product requiring so much hand labor. Recently it has come to our attention that producers in certain Mediterranean countries are seriously considering sulfuring the Greek-process raisin when removed from the field in order to obtain a good color consistently.

In view of these circumstances it appears that the California producers are following a safer course in developing the golden-bleached as a light-colored raisin. This raisin, according to Cruess[24] competes very well with

[24] Personal observation by W. V. Cruess in Great Britain in 1938 and 1939.

the Smyrna raisin in the English market. In general golden-bleached raisins are prepared in a manner similar to that used for sulfur-bleached raisins except that the former are dehydrated.

Currants.—Currants (Black Corinth raisins) are dried without any preliminary treatment in a manner similar to that used for natural raisins. When the weather is hot, currants are dried on stacked trays without any direct exposure to the sun.

Cherries.—All light-colored varieties, including the Napoleon (Royal Ann) should be sulfured for about 1 to 2 hours if a light color is desired. A light lye-dipping is also advisable before sulfuring. Black varieties may also be lye-dipped and lightly sulfured although a good product is made by drying these varieties without any treatment.

Persimmons.—Dried persimmons are commercially important in Japan and China but are not dried commercially in California, although they are preserved in this manner occasionally for use in the home. Fully mature fruit should be cut or shredded into pieces of desirable size and dehydrated or placed in the sun for drying. If persimmons are dried after sulfuring the resulting product will be "puckery" and have a less desirable taste than the unsulfured product. Persimmons are commonly picked while still firm and very astringent. The ripening process can be speeded by use of ethylene gas in the same manner as described for pears. The Oriental drying procedure consists in threading the peeled persimmons on a string and suspending them from the rafters to dry indoors.

Handling Rain-damaged Fruit.—During the season for drying apricots, peaches, pears, and figs there is little danger of damage by rain, but the prune- and raisin-drying seasons are later, and more or less difficulty from rain and foggy weather is to be expected in the sun-drying of these two fruits.

In the event of rain the trays should be stacked, before the rain starts, if possible, and the stacks covered with empty trays.

The difficulty of handling raisins on paper trays under these circumstances is obvious, and in case of a heavy rain, even of short duration, serious damage to the fruit is likely to occur. The trays should be spread again as soon as possible after the weather clears. The processes of stacking and spreading must be repeated as often as the weather changes, sometimes daily. Stirring the fruit on the trays is very desirable.

When the weather is bad and the trays and fruit become very wet, such practices as elevating the trays by propping one against another, transferring to dry trays, or dipping in hot water, lye, baking soda, or salt solutions will not avail. In such situations only two treatments are likely to be of much use: sulfuring, or finishing the drying in a dehydrater.

Many growers who dry prunes and natural raisins are not equipped with sulfuring houses. In such cases the hood type of sulfur box, shown in figure 15, can be constructed quickly and cheaply, and may be of great value. Sulfuring the fruit from 1 to 3 hours will effectively prevent molding or fermentation. Unless the fruit is nearly dry, sulfuring will cause the prunes to be distinctly red in color; but where dehydrating facilities are inadequate or unavailable, this is preferable to a complete loss.

There are now in the state many dehydraters, in which a considerable portion of the prune crop and some of the raisin crop is normally dried. Dehydration is the ideal way of meeting the rain-damage difficulty, and should be applied as promptly and fully as possible. For natural raisins the temperature should not exceed 140° to 150° F, while for prunes 170° is safe but should not be exceeded. Dehydration is also useful in saving other food crops that may have been exposed to rain.

HANDLING FRUIT AFTER DRYING

There are a number of considerations affecting storage and treatment that are more or less common to all dried fruits, especially after drying. Most dried fruits are not offered for consumption as they come from the drying yard, but are first stored for some time and subjected to some cleaning or other treatment that amounts to a refining process. Ordinarily this is not done on the farm but in a packing-house, with which this circular has nothing to do directly. The success of the packing process and of the entire dried-fruit industry is, however, dependent on the grower's care and skill in all operations from the growing of the fruit until it actually reaches the packing-house. Failure to dry his fruit sufficiently, or to store it properly while in his possession, may result in partial or complete loss of the product.

Proper Degree of Dryness.—Overdrying reduces the weight of the dried product to no good purpose, but thorough drying is essential to good keeping quality. From the best information available concerning the relation of moisture to keeping quality, raisins should contain from about 12 to not over 14 per cent moisture, while most other fruits have a somewhat higher percentage. If these upper limits are not exceeded, the fruits will keep well during prolonged storage, and the necessary addition of moisture during processing at the packing-house may be made without much risk of spoilage. The relation of moisture content to keeping quality varies with the year and district, however. When the sugar content of the fruit is high, deterioration is less; whereas when it is low, spoilage is considerable. As a general rule, growers cannot undertake the

accurate determination of moisture content in their product and must depend on certain rather crude tests at which skill is acquired only after long experience. For example, it should not be possible to squeeze out with the fingers any sirup from individual pieces of fruit; the skin should not separate from the flesh by rubbing; and the pits of prunes should not "slip." Pieces that fail to pass these tests should be sorted out when the trays are emptied. On the other hand, the fruit should not be so dry as to rattle and sound like pebbles when pushed about or shaken on the trays. When a handful is squeezed the fruit should feel pliable; yet on release of the pressure the pieces should not stick together to form a ball, but should fall apart immediately and return to their original shape.

It has been suggested a number of times that dried fruit be bought and sold on a moisture-free basis. This system has sufficient merit to warrant discussion here. Moisture-free basis means that the moisture content of a particular lot of fruit would be determined at the time of the transaction and that the individual selling the fruit would receive payment for the fruit solids only. In other words, the weight of moisture would be deducted from the total weight of the fruit. To compensate for the decrease in weight the price per pound would be proportionately higher and neither the producer nor the packer would find the price situation any different than at present. The advantage of such a system is that it encourages a grower to deliver fruit as dry as possible; this would greatly increase the keeping qualities and the ultimate quality of the fruit sold to consumers. It is generally agreed that the quality of dried fruits must be continuously improved in order to sell with other competitive foods. A second advantage of selling on a moisture-free basis is that it would pay a bonus to the grower producing quality fruit and penalize the grower producing poorer fruit. For example, if a grower sold a lot of prunes low in moisture but high in sugar he would receive a greater value per ton of fruit delivered than a grower selling a lot of prunes high in moisture but low in sugar. Under the present system it is possible for both growers to receive the same amount per ton. Until some such system is used it is difficult to see how a grower can be expected to deliver prunes sufficiently dry to keep well in storage.

Curing.—When placed in storage, the individual pieces of fruit always vary in moisture content. During the first 1 to 3 weeks in the box or bin some moisture is transferred from the wetter to the drier pieces either by direct contact or by evaporation into the air spaces and absorption therefrom. It is from the latter type of transmission that the process gets the more common name of "sweating." Until this equalization of

moisture is virtually complete it is difficult to judge accurately whether the moisture content is within the satisfactory range. Sweat boxes are ideal for this curing process except perhaps for prunes, which are usually dumped on a clean concrete floor and turned with shovels every few days.

Storage on the Farm.—For the safety of prunes it is best that they be delivered to a packing-house not less than 2 weeks nor more than a month after removal from the trays, whereas cut fruits may be delivered as soon as dried. While packing-house facilities and processes are not to be described in detail in this circular, it may be said that as a rule better provision for supervision and storage are available there than on the farm. But whether the storage on the farm is short or long, the conditions should be the best that can be provided. As indicated on an earlier page, the storage space should be cool, dry, well lighted, and ventilated. Care should be taken to screen the storages to exclude insects; rodents, poultry, and other animals should also be kept away from the fruit. To this end any dried fruit from the previous crop should first be removed from the building and the sweepings burned; such material is always infested and the infestation will quickly spread to the new fruit. Grains and other cereals should not be stored near the fruit since they usually harbor insects. Farm fumigation is feasible and desirable but the grower must take the proper precautions to prevent injury to workers, to other people, or to farm animals. Farm fumigation and fumigants are discussed fully on page 36. The use of mineral oil on the floors is helpful in preventing the movement of insects.

Prevention of Insect Infestation.—Insect infestation is the most common type of deterioration although discoloration and microbiological changes are also important. Although insects and their eggs can be killed by fumigation it is highly desirable to do everything possible to minimize infestation in the orchard, while drying, and during storage. Orchard and drying-yard sanitation are extremely important. The dried fruits should be handled in clean boxes. One should fumigate all dried products when removed from the drying yard although this is common practice only for figs and peaches.

The following are recommendations for the protection of drying and dried fruits from damage by insects as given by Donohoe, Barnes, Fisher, and Simmons.[25]

The insects that do the major part of the damage to cut fruits are the

[25] Prepared by Heber C. Donohoe, Dwight F. Barnes, Charles K. Fisher, and Perez Simmons of the U. S. Department of Agriculture Bureau of Entomology and Plant Quarantine as a mimeographed insert for California Agricultural Extension Circular 75.

raisin moth, *Ephestia figulilella* Greg., and the Indian meal moth, *Plodia interpunctella* Hbn. The dried fruit beetle, *Carpophilus hemipterus* (Linn.) is occasionally attracted during drying and becomes abundant in any wet, fermenting fruit.

The raisin moth occurs in the field throughout the dried-fruit-producing areas of California and infests the fruits during drying and storage on ranches. Control of this insect lies in measures to reduce its numbers in the field, and to prevent its access to or survival in the drying crop. After thorough drying, reinfestation is slight or absent. The abundance of the raisin moth in the field may be reduced by the elimination of all waste fruits and fruit pits as sources of food. Any fruits which dry in the shade under the trees, and fallen grapes under the vines, offer suitable breeding conditions for raisin moth larvae. Similar fruits exposed to the heat of the sun breed few moths. Peach and apricot pits spread in the sun and dried do not become infested.

Of particular importance in many localities are mulberries. This fruit is produced early in the season and provides food for large numbers of larvae, which appear as adults in time to infest the drying fruit crops. Removal of fruiting mulberry trees or the removal and destruction of all dropped fruits at 10-day intervals will reduce this infestation.

During drying, infestation of the fruit by the raisin moth occurs largely on stacked trays and after boxing. If the stacks and boxes are kept covered with tobacco shade-cloth (a durable, inexpensive, loosely woven cotton material), this infestation can be greatly reduced.

Any dried cut fruit to be held in storage should be fumigated at once. The best conditions for holding these products are provided by fumigable storage in which they may be stored and refumigated when necessary. This is essential to prevent infestation by the Indian meal moth and other pests that attack dried fruits in storage.

Prevention of Microbial Deterioration.—The most practical means of minimizing microbial activity is to store well-dried fruit in cool, well ventilated storage. When prunes, raisins, or figs relatively high in moisture content, are stored at the higher temperatures, sugar-tolerant yeast, molds, and bacteria may develop. A common manifestation of yeast growth and fermentation in figs and prunes is the formation of a white coating on the surface of the fruits that is commonly referred to as "sugaring" (fig. 26). This white material is usually composed of a mixture of sugar crystals and yeast cells when it occurs on unprocessed dried fruits. The "sugaring" that occurs on processed or packed dried fruits is more commonly made up entirely of sugar crystals. The development of yeast cells on unprocessed prunes is a definite indication of incomplete drying

or poorly ventilated storage. In ventilated storage the natural movement of air currents apparently dries the surfaces of the fruits sufficiently to prevent extensive microbial development. In this connection it is advisable to store boxes or sacks in such a manner that aeration channels are plentiful. It is inadvisable to store fruit in a sealed room or basement since this favors yeast growth or sugaring. Ventilation openings to the outside should be plentiful, well distributed, and

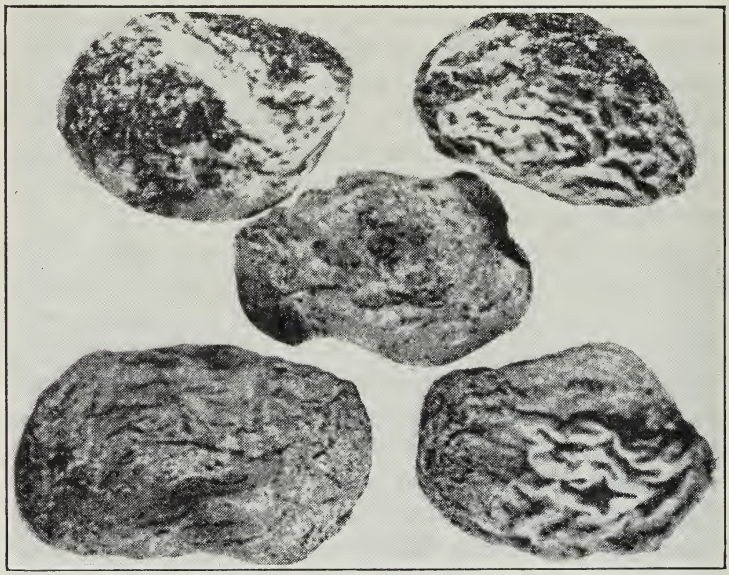

Fig. 26.—"Sugared" prunes. The white material on these prunes is a mixture of sugar crystals and yeast cells.

screened to exclude insects. An extensive microbial development may cause changes in flavor, appearance, and sugar content. Investigations in the Fruit Products Laboratory and by R. S. Hiltner of the Dried Fruit Association of California, about twenty years ago, showed that coating prunes with a harmless oil reduces the tendency for sugaring to occur. The use of oil for this purpose, however, is inadvisable unless oils that do not rancidify readily can be obtained from the respective fruits in sufficient quantities; in order to comply with the requirements of the food laws prune oil must be used on prunes, fig oil on figs, and so on. The use of mineral oil is contrary to the present state and federal food regulations.

Prevention of Discoloration.—Much of the deterioration from discoloration can be avoided by the production of a well sulfured and dried

product at the drying plant. Even when cut dried fruits are well prepared a certain amount of discoloration occurs during storage. Certain fruits darken more rapidly than others. Lovell peaches, for example, darken more rapidly than other varieties of peaches handled under comparable conditions, and for this reason special care should be taken in preparing and storing this variety. It is an established fact that fruit dried to a relatively low moisture content darkens more slowly than similar fruit containing a higher percentage of moisture; consequently it is advisable to dry fruits that darken rapidly as completely as is feasible.

The storage should be cool since dried fruits darken more rapidly at higher temperatures. Lovell peaches retain their color for a considerable period of time when stored at 60° to 70° F provided they are well sulfured and well dried. Aerated storage is also an advantage in color retention.

FARM-SCALE PACKING OF DRIED FRUITS

The procedures for packing dried fruit vary with the type of fruit. Grading is one of the most important steps in preparing the product for packing. Size grading is a relatively simple process and can be accomplished by the use of vibrating screens. Quality grading, on the other hand, is based on color, appearance, cracks, and other characteristics of the fruit and is best accomplished by someone familiar with quality grades. Sorting is frequently used to improve the quality grade.

Recently the Agricultural Marketing Service of the U. S. Department of Agriculture has established standards for dried apricots, prunes, and raisins.[26] From time to time federal standards will be established for other dried fruits, and growers should obtain copies of these rulings for their guidance.

Apricots.—This fruit should be size-graded before storage because it then moves freely and is not matted into lumps, a condition that develops in storage. Size grades are commonly separated by means of a grader and the fruit then stored in boxes or bins; but boxes are preferable because of less mechanical damage to the fruit. Table 8 lists the size grades for dried apricots from Santa Clara and San Joaquin valleys. Before

[26] Federal standards for dried fruits may be obtained from the Agricultural Marketing Service, U. S. Department of Agriculture, Agriculture Building, Embarcadero at Mission Street, San Francisco, Calif. The grades for dried apricots, prunes, and raisins are given in:

United States standards for grades of dried apricots. (Mimeographed leaflet. 4 p. May 1, 1941.)

United States standards for grades of dried prunes. (Mimeographed leaflet. 5 p. April 5, 1941.)

Federal specifications for raisins. (Federal standard stock catalog, section IV, part 5, Z–R–71a. 7 p. Nov. 1, 1939.)

processing and packing the fruit one should make certain that it is free of insect infestation, mold, and dirt, and that it fulfills the requirements of the food laws. This not only applies to apricots but to all dried fruits.[27]

Processing consists of passing the dried apricots over a shaking screen, to remove foreign materials and to break up lumps of fruit; and then through a cleaning machine consisting of a wire cylinder and rubber-tipped paddles. Water is sprayed into the machine over the moving fruit for the purpose of cleansing, to increase pliability, and to moisten the fruit to facilitate absorption of sulfur dioxide. The freshly wetted fruit is spread 2 to 3 inches deep on trays which are then stacked on cars in

TABLE 8

GRADING SIZES FOR DRIED APRICOTS

Grades	Screen sizes for "Santa Clara" apricots	Screen sizes for "San Joaquin" apricots
	inches	*inches*
Standard	28/32	28/32
Choice	32/32	32/32
Extra Fancy	36/32	38/32
Fancy	40/32	42/32
Extra Fancy Blenheims and Fancy Moorparks	44/32	Over 42/32
Extra Fancy Moorparks	46/32	...

the usual staggered manner. The fruit is then sulfured for 4 hours or overnight, after which it is ready for packing into boxes or cartons.

Figs.—Figs are graded for size and sorted to remove defective fruit. Instructions for testing dried figs have been published by the federal Food and Drug Administration.[28] The screen size grades used for the Black Mission, Calimyrna, and Adriatic varieties of figs are given in table 9. Although it is more economical to use size-grading machines, small lots of fruit can be size-graded by hand.

They are then immersed in boiling water for 1 to 3 minutes, the length of time depending on the original condition of the figs and the degree of pliability desired for packing. Immediately after processing they are sometimes sprayed with a glucose solution.

To form bricks the processed figs are packed in wooden molds while hot. When cool they are usually wrapped in a transparent wrapping material. In forming cut bricks the fruit is cut open on one side and spread flat; the use of this method facilitates the removal of sour, moldy,

[27] Howard, B. J. Testing dried cut fruits. U. S. Dept. Agr. Food and Drug Administration, Microanalytical Division Publication 4:1–16. Washington, D. C. May, 1935. (Mimeo.)

[28] Howard, Burton J. Fig testing. U. S. Dept. Agr., Food, Drug and Insecticide Administration. 11 p. July 1, 1929. (Mimeo.)

or other fruit with internal defects which are not apparent at the surface. After forming, they are sealed in an attractive wrapper. In making a fancy pack alone or with other fruit, the figs are rolled and pulled into the desired shape while they are still pliable after processing. For this pack they are not split open. For bulk pack, they are drained thoroughly after processing and placed in glassine paper-lined wooden boxes

TABLE 9

GRADING SIZES FOR DRIED FIGS

Grades	Screen sizes for the varieties given		
	Black Mission	Calimyrna	White Adriatic
	inches	*inches*	*inches*
Standard	26/32	30/32	30/32
Choice	30/32	34/32	34/32
Extra Choice	34/32	38/32	38/32
Fancy	38/32	44/32	42/32
Extra Fancy	Over 38/32	Over 44/32	Over 42/32

TABLE 10

GRADING SIZES FOR DRIED CLINGSTONE AND FREESTONE PEACHES

Grades	Screen sizes for the varieties given		
	Clingstone varieties	Lovell	Muir and yellow varieties
	inches	*inches*	*inches*
Standard	36/32	36/32	36/32
Choice	44/32	46/32	44/32
Extra Choice	48/32	50/32	48/32
Fancy	58/32	58/32	56/32
Extra Fancy	64/32	64/32	64/32
Jumbo	Over 64/32	Over 64/32	Over 64/32

of the desired size, using a wooden extension and a press in order to get the desired weight.

There is an increasing tendency in processing dried figs to subject the better grades of figs to a steam-pressure treatment. This treatment varies considerably but in general consists of exposing freshly processed figs to steam under pressure in a retort for a few minutes. The time and temperature must be so balanced that the fig attains a pleasing flavor, the skin attains translucency, and the texture of the fruit becomes more tender. When the retort treatment is too severe, because of too high temperature or too long periods of exposure, or both, the fruit may darken

considerably, become very sticky, and attain a caramelized or even bitter taste. Because of the necessity for using steam under pressure in a retort for the processing of this product it does not appear feasible as a farm-scale enterprise.

Peaches.—Peaches are handled in a manner similar to that described for apricots, although the size grades are different as is shown in table 10.

Nectarines.—The packing procedures used for nectarines are similar to those for peaches except that they have different grading standards.

Pears.—Pears are usually graded by hand. In general they are separated into various sizes, the largest and best of which are termed "Lake County" pears. Various designations are used for the other grades but there are no established size grades.

The sorted fruit is packed into 10-, 25-, or 50-pound boxes. Overdried fruit is processed before packing as described previously for apricots.

Prunes.—In packing-houses, prunes are usually passed over graders as received and the various sizes are stored in separate bins. On the farm this is not practicable for small quantities of prunes. Before entering the grader, however, they are passed over a shaking screen to remove loose dirt, leaves, etc. They are size-graded on the basis of the number of prunes to a pound. This grading is done by passing the prunes over screens having holes with the sizes given in the following tabulations:

Number of prunes per pound	Screen size, inches
20— 30	Over 40/32
30— 40	40/32
40— 50	38/32
50— 60	36/32
60— 70	34/32
70— 80	32/32
80— 90	30/32
90—100	28/32
100—110	26/32
110—120	24/32

It is common practice to blend different sizes of prunes before processing in order to obtain a desired count in the final pack.

The prunes should be washed and drained before processing. Rotary spray washers are most desirable but dipping in cold water in a prune dipper is satisfactory. Processing consists of dipping the prunes in boiling water for from 2 to 4 minutes, the length of time depending on size and the moisture already in the prunes. For large-scale processing a standard processor is required but for farm-scale operations an ordinary prune dipper is satisfactory. The freshly processed prunes should then be passed over a shaker in order to free them of excess surface

water. While still hot, they should be filled into boxes or cartons. A press is used to get the required weight into standard-sized boxes. For filling, extra height is added to the boxes by the use of an extension or collar made of four strips of shook, which fits the top of the box and enables the box to hold the desired weight. The fruit is then pressed to the upper surface of the box. The boxes are made of standard sizes of shook obtainable through most lumber dealers, and are always lined with a special type of paper before filling. Boxes in common use hold 10, 25, and 50 pounds of prunes; cartons usually hold 1 or 2 pounds. Filled and sealed cartons are packed into cases, and cooled. After closing the boxes of hot prunes, they must be stored in a staggered formation for cooling.

Raisins.—All raisins except Muscat layers are stemmed by use of the stemming machines. Grading is done by means of vibrating screens. The grading sizes for loose Muscats are as follows:

Grades	Screen size, inches
One-crown	12/32
Two-crown	17/32
Three-crown	21/32
Four-crown	Over 21/32

Seeded Muscats are the same as above, but seeded. The grading sizes for Thompson Seedless raisins are as follows:

Grades	Screen size, inches
Bakers	18/64
Choice	24/64
Fancy	Over 24/64

These are classified according to the drying procedure used as "natural," "sulfur-bleached" (dipped, sulfured, and exposed to the sun and then shade-dried), "golden-bleached" (dipped, sulfured, and dehydrated), and "soda-dipped" (dipped in lye or soda before drying).

Muscat layers are classified according to size of berries and bunches as described in a later paragraph.

The stemmed raisins must be "cap-stemmed" (cap stems are small stems adhering to the berries) by use of machines developed for this purpose. If a grower plans to do his own raisin packing it is advisable though not necessary for him to obtain a cap stemmer from one of the machine-manufacturing concerns. Cap-stemming can be accomplished, however, in a recleaning machine. Muscats must be dehydrated to secure low moisture content for cap-stemming.

The seeding and subsequent treatment of Muscats is also done by machines. They are dried to a very low moisture content, cap-stemmed

and then processed in boiling water to soften them before they enter the seeder. The seeded raisins are packed while still warm into lined cartons or boxes. Thompson Seedless raisins are packed by automatic machines into small cartons or boxes.

In general the equipment required for processing, size-grading, seeding, and packing of raisins, except Muscat layers, is too costly for the average raisin grower unless he coöperates with several neighbors. Some large producers, however, have installed such equipment and are operating it successfully.

Layer Muscat raisins consist of the largest, finest, unbroken bunches (clusters) of the raisins carefully handled in drying, to avoid shattering of the berries from the stems. They may be sorted and carefully layered in flat, lithographed cardboard boxes made for the purpose. These raisins are in good demand during the holiday season only. The following grades and designations are used in the trade: Vineyard Run, Three-crown Layers, Four-crown Clusters, and Six-crown or Imperial Clusters. The Three-crown are the smallest, and Six-crown or Imperial, the largest.

STORAGE AND TREATMENT OF PACKED DRIED FRUITS

Packed dried fruits are just as perishable as dried fruits in the natural condition. For this reason, if packed fruits are to be held for prolonged periods of time they should be stored in cool storage in accordance with the recent findings of Barger,[29] who has made a study of this subject. Fumigation is essential at the time of packing and of shipping. If fruit is to be stored it should be fumigated periodically until placed in cool storage. In this case it is advisable to fumigate the fruit before placing it in cool storage.

ROUTINE ANALYSES OF DRIED FRUITS

The most common chemical determinations made in the dried-fruit industry are for moisture and sulfur dioxide. During the last few years it has become routine procedure in packing plants to use the electric moisture-testing machine because it is simple to operate, rapid, and sufficiently accurate for the purpose for which it is used. Other methods for the determination of moisture are too complicated for use on the farm; furthermore the equipment needed is rather expensive.

[29] Barger, W. R. Effect of cold storage conditions on the keeping of dried fruit. West. Canner & Packer 33:47–50. 1941.

Barger, W. R. Refrigeration for dried fruits. West. Canner & Packer 33:57–60. 1941.

Barger, W. R. The effect of cold storage conditions in the keeping of dried fruit. Ice and Cold Storage 100:235–37. 1941.

The determination of sulfur dioxide involves some technical laboratory training and is rather complicated for use except in laboratories.[30]

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[30] Details of procedure can be found in: Association of Official Agricultural Chemists. Official and tentative methods of analysis. 5th ed. 757 p. 1935. Published by the Association of Official Agricultural Chemists, Washington, D. C.

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