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# MECHANICAL HARVESTING OF GRAPES FOR THE WINERY

**AGRICULTURAL EXTENSION**
**UNIVERSITY OF CALIFORNIA**



AXT-403
11/73

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This is an interim publication. Later revisions will contain photographs and any further information that develops.



Co-operative Extension work in Agriculture and Home Economics, Division of Agricultural Sciences, University of California, and United States Department of Agriculture co-operating. Distributed in furtherance of the Acts of Congress of May 8, and June 30, 1914. George B. Alcorn, Director, California Agricultural Extension Service.

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## INTRODUCTION

About 100 mechanical grape harvesters are currently in use in California. Each year one machine typically harvests the fruit from 250 to 300 acres. Currently the total tonnage of California grapes harvested by machine is below 10 percent. This percentage is expected to increase since most of the new grape plantings are wine varieties with the vines trained for mechanical harvest. Some of the more easily converted older vineyards are gradually being set up for machine harvest.

The ease of mechanical harvest varies greatly, depending on the variety, the vine training, the kind of trellising, the fruit maturity, the vine vigor, and a host of other factors. A few varieties, such as Carignane, Grenache, Emerald Riesling, and Petite Sirah, are considered difficult to harvest. Others, such as Rubired and Thompson Seedless, are easy. Usually well over half the total tonnage delivered to wineries is fruit of the Thompson variety so that this easily harvestable fruit will continue to constitute the bulk of machine harvested tonnage.

## HARVESTING METHOD

Almost all the single-row straddle harvesters employ a similar system of removing the fruit. These harvesters have double banks of flexible horizontal rods that strike and shake the vines. The fruit comes off as cluster parts, individual berries, and juice. With difficult-to-harvest varieties, the harvester delivers single berries and juice; with easily harvested varieties, the fruit is delivered as cluster parts and single berries and sometimes a few whole clusters. Good information does not exist about how much of the fruit mechanically harvested from a vine reaches the winery.

With easy-to-harvest, low juicing varieties, the mechanical harvesters probably deliver tonnage to the winery equivalent to that picked by average hand crews. With hard-to-harvest, heavy juicing varieties, the mechanical harvesters may deliver substantially less fruit to the winery than do hand crews. Mechanical harvester efficiency will undoubtedly improve as will techniques of preparing vines for harvest. If a few varieties prove impractical, they will either be hand-harvested if valuable enough, or be eliminated because of their unsuitability. Such decisions depend on the labor cost, labor availability, yield, and the price of grapes.

## VARIETY ADAPTABILITY FOR MACHINE HARVEST

Grape varieties vary widely in the ease and mode in which they are removed from the vine. The greatest contributing factors to machine harvestability involve the vines' vegetative growth habits, fruit characteristics, and adequate training and trellising.

### Vine Growth Characteristics

Dense, abundant foliage interferes with the machine and makes access to the fruit difficult. Also, excessive leaf removal during harvesting can interfere with or slow the conveying and leaf removal operations in the harvester. Varieties with such problems include French Colombard, Sauvignon blanc, Sylvaner (Franken Riesling), Mission, and Gray Riesling.

Those varieties that tend to develop a large vine framework with heavy, woody cane growth offer more harvester interference. Examples are Grenache and French Colombard. The brittle wood of French Colombard often results in more spur breakage and clogging of the fruit conveyors with canes and shoots.

Mechanical pre-trimming of the vine growth, and the use of foliage support trellising and proper pruning practices can help minimize these vine growth problems.

## Fruit Characteristics

The structure of the cluster framework and its adherence to the vine and to the berries are the main factors determining how easily and in what condition the fruit is removed.

Most varieties are primarily removed as single berries. This is particularly true of those with a fairly loose berry attachment, such as Thompson Seedless, Rubired, and Royalty.

Those with a more firm berry attachment -- including French Colombard, Chenin blanc, Grenache, Barbera, and Carignane -- require more energy or harvester contact for fruit removal. More of the fruit removal is associated with berry rupturing and the breakage of cluster parts. Weakness in the cluster attachment or framework helps fruit removal in such varieties. For example, the green stems of Aramon and Barbera clusters often detach or break into pieces as single berries are detached.

Varieties that have a firm berry attachment and a tough or wiry cluster framework are the most difficult to mechanically harvest. A notable example is Emerald Riesling, which has berries securely held by the internal vascular system or brush of the capstems. The harvester must "juice" the fruit off the vine, leaving the cluster framework and the large, wet brushes behind.

The soft, juicy berry texture of such varieties as Sémillon, Muscat Canelli, and Burger presents harvesting problems because of juice loss during fruit handling. Conversely, the very firm berries of the easily harvested Tokay and White Malaga varieties undergo almost no juicing during machine removal.

## Variety Ratings

The following list includes those varieties where there has been sufficient harvesting experience to make at least a preliminary rating. Obviously some ratings will change as more experience and knowledge are gained. These ratings are based on commercial experience provided by growers and machine manufacturers and on data from experimental harvesting by growers, vintners, and U. C. Agricultural Extension personnel. The ratings should be regarded as averages, or the most typical of experiences reported. Some differences are to be expected due to the variation in harvesting techniques and vineyard conditions.

| VARIETY | HARVESTABILITY | JUICING |
|---|---|---|
| | **White Wine Varieties** | |
| Burger | hard | heavy |
| Chardonnay | medium | medium |
| Chenin blanc | medium | medium |
| Emerald Riesling | very hard | very heavy |
| Flora | easy | light |
| French Colombard | medium | medium |
| Gewürztraminer | easy-medium | light |
| Gray Riesling | easy-medium | light |
| Malvasia bianca | medium-hard | medium |
| Muscat Canelli | hard | heavy |
| Palomino | easy-medium | medium |
| Pedro Ximinez | easy-medium | heavy |
| Pinot blanc | medium | medium |
| St. Émilion (Ugni blanc) | medium | heavy |
| Sauvignon blanc | medium | medium |
| Sémillon | medium-hard | heavy |
| Sylvaner (Franken Riesling) | medium | light |
| White Riesling | medium | medium |
| | **Black and Red Wine Varieties** | |
| Aleatico | hard | heavy |
| Alicante Bouschet | medium-hard | medium-heavy |
| Aramon | medium | light-medium |
| Barbera | medium | medium |
| Cabernet Sauvignon | easy-medium | light-medium |
| Carignane | medium-hard | medium-heavy |
| Gamay | medium | medium |
| Grenache | hard | medium-heavy |
| Mission | medium-hard | medium |
| Petite Sirah | medium | medium-heavy |
| Pinot noir | medium | medium |
| Royalty | easy | medium |
| Rubired | easy | medium |
| Ruby Cabernet | medium-hard | medium |
| St. Macaire | medium-hard | medium-heavy |
| Salvador | easy | medium |
| Souzao | medium | medium |
| Tinta Madeira | medium-hard | light-medium |
| Valdepeñas | medium-hard | medium-heavy |
| Zinfandel | hard | medium-heavy |
| | **Raisin and Table Grape Type Varieties** | |
| Black Corinth (Zante Currant) | medium | medium |
| Calmeria | easy | none |
| Emperor | easy | none |
| Muscat of Alexandria | easy-medium | light |
| Niabell | easy | light |
| Ribier | easy | none |
| Sultana | easy | medium-heavy |
| Thompson Seedless | easy | very light |
| Tokay | easy | very light |
| White Malaga | very easy | none |

## ESTABLISHING NEW VINEYARDS FOR MACHINE HARVEST

### Row Spacing

In California, row widths have generally been standardized on 12-foot centers. Consideration is being given to narrower row spacing to produce optimum returns within the available land area. With the advent of the over-row harvesters and other cultural equipment developed for narrow rows, there should be no problem in mechanically harvesting and maintaining normal cultural operations in vineyards with row widths of 10 to 12 feet.

### Training and Pruning Systems

Cordon-trained, spur-pruned vines. During training, an effort should be made to retain only those spurs that are in a vertical line with the vine row. Spurs pointing outward are easily broken or interfere with the harvester rods or fingers.

In general, most wine grape varieties are best suited to spur pruning. However, some growers have shown interest in cane pruning because of concern that harvesting will gradually become more difficult as the cordon-trained, spur-pruned vines increase in age and size. This concern often arises from machine harvesting experience in existing, older vineyards that have large, often crooked cordons where large, interfering arms are common.

This problem should be minimized in new plantings by better training methods to eliminate poorly directed or positioned spurs.

Cane-pruned vines. The only general recommendation for cane pruning is for the small-clustered varieties, such as Chardonnay, Cabernet Sauvignon, Sauvignon blanc, and Zante Currant, and the varieties, Thompson Seedless and Sultana, whose buds are sterile near the base of the canes. The wine varieties that do not fit in either of these catagories are usually capable of bearing full crops if sufficient numbers of spurs are retained on the cordons.

The real danger in cane pruning the large-clustered varieties lies in overcropping and the resultant decline in vine vigor. Most wine varieties are easily overcropped on canes because of highly fruitful buds (e.g., Rubired, Royalty, Muscat of Alexandria, and others) and/or large clusters (e.g., Chenin blanc, Carignane, Grenache, etc.). It is difficult to get pruners to leave the proper number of canes for the capacity of each individual vine. The resulting overcropping can delay fruit ripening and coloration, and contribute to vine weakening, especially in poorer soil areas.

An exception would be in "managing" excess vine vigor as in some French Colombard vineyards. Cane pruning or a combination of cane and spur pruning may be necessary to obtain sufficient crop to use and control excessive vegetative growth.

### Vine Support and Trellis System

Stakes - material. Stake breakage and replacement can be kept to a minimum by selecting from the following materials.

Cedar, split

Douglas fir, sawn
Malaysian hardwoods, sawn
(Kempas and Keruing species)
Redwood, split
Steel

} Avoid sawn stakes with large knots, abrupt crossgrain areas, or other defects that reduce sideload strength. (applies to Douglas fir, sawn; Malaysian hardwoods, sawn (Kempas and Keruing species))

(Note: Excessive stake breakage has been experienced with sawn redwood and cedar.)

All wood stakes should have a suitable preservative treatment.

Length. Use 7-foot stakes to establish cordon-trained wine grape vineyards to be machine harvested. The purposes of this stake height are: 1) to provide for adequate and convenient fruit height; and 2) to provide for space and flexibility in attaching overleaf foliage support wires of foliage support cross-arms. Cane-pruned vineyards might use 6-foot stakes and still have room for a vertical overhead foliage support wire. This is because the fruit height remains constant throughout the life of a cane-pruned vineyard, whereas the fruiting zone of spur-pruned vines will become somewhat higher.

Thompson Seedless vines to be used for wine can be trained on 6- or 7-foot stakes. However, where the option of drying for raisins is desired, 6-foot stakes are recommended to avoid any between-row shading of trays, with rows running east and west.

Wire - material. More attention is being placed on wire specifications since the advent of machine harvesting. This is due to concern over possible wire breakage and the loss of unharvestable fruit on the ground.

There appears to be little or no problem of wire breakage from machine harvesting itself. Most of the problems arise directly from pruning shear nicks in the wire, which can break under heavy fruit loads or during machine harvesting. To minimize this problem and the cost of wire repairs, it is suggested that the cordon or cane wire consist of 10- or 11-gauge, low-carbon wire or 12- or 13-gauge, high-carbon (high tensile) wire. It is possible to use 12-gauge, low-carbon wire or 13- or 14-gauge, high-carbon wire for the upper foliage support wires. The following chart compares low and high carbon wires of various gauges using domestic wire data.

| Wire Type (tensile strength) | Gauge | Wire Diameter (inches) | Feet Per Pound | Minimum Breaking Strength (pounds) | Pounds/Acre 1 Wire |
|---|---|---|---|---|---|
| Low carbon | 10 | .1350 | 20.6 | 1144 | 176.2 |
| High carbon | 10 | .1350 | 20.6 | 2863 | 176.2 |
| Low carbon | 11 | .1205 | 25.8 | 912 | 140.7 |
| High carbon | 11 | .1205 | 25.8 | 2281 | 140.7 |
| Low carbon | 12 | .1055 | 33.7 | 699 | 107.7 |
| High carbon | 12 | .1055 | 33.7 | 1748 | 107.7 |
| Low carbon | 13 | .0915 | 44.8 | 526 | 80.85 |
| High carbon | 13 | .0915 | 44.8 | 1315 | 80.85 |
| Low carbon | 14 | .080 | 58.6 | 402 | 61.95 |
| High carbon | 14 | .080 | 58.6 | 1005 | 61.95 |

Installation. The high carbon wire is more difficult to install because it is springy and stiff. However, it is more difficult to nick with pruning shears than low carbon wire and requires fewer pounds of wire per acre for comparable wire strengths. The commercially available wire-splicing devices are especially useful in stringing high carbon wire.

Pneumatically installed staples are preferable to hand driven staples. Hand driven staples tend to pull out as the stakes age. Pneumatically installed staples are necessary for the dense Malaysian hardwood stakes. After the wires are pulled taut, the staples should be set firmly to prevent wire movement, but not to the point of damaging or cutting the wire.

Trellis design. The six methods that can be used for trellising are described below.

1. Seven-foot stake, two-wire vertical system (Figure 1).

    The most common trellis currently used for wine varieties is the two-wire vertical trellis on a 7-foot stake. The head or cordon wire is located 40 to 46 inches above the ground surface. A catch (foliage support) wire is usually attached 12 to 14 inches above the cordon wire, but only 10 to 12 inches under windy conditions. To prevent cordon twisting, this wire should be attached the year the vine is trained.

    The top wire can be moved upward for better foliage support as the spur positions rise with age. Another option is the addition of a third wire at the top of the stake for additional support. Some growers may wish to install this wire along with the other two wires as shown in Figure 2.

2. Seven-foot stake with crossarm (Figure 3).

    A crossarm may be added to the two-wire vertical trellis described. Opinions vary as to the necessity or desirability of this crossarm. However, most agree that the crossarm should be installed for the French Colombard variety.

    Once the two-wire vertical trellis is installed, the decision to add a crossarm can be made at any later date, preferably after trying crossarms on a few rows to determine the benefit.

    Crossarms are principally used for additional foliage support in high- to exceptional-vigor vines. They also serve to guide and support most of the shoots upright. This helps minimize spur breakage and foliage interference during harvest. Much of the foliage can be retained beyond harvest due to its position within and above the crossarm, thus escaping harvester contact.

    The width of the crossarm is determined by vine vigor and the choice of mechanical harvester. For example, very vigorous French Colombard, Sauvignon blanc, Grenache, or Chenin blanc vines can use up to a 36-inch crossarm width, whereas a 24- to 30-inch crossarm will suffice for most others. Also, the harvester to be used must accommodate the crossarm width and design. Refer to manufacturer

# SEVEN-FOOT STAKE TRELLISES

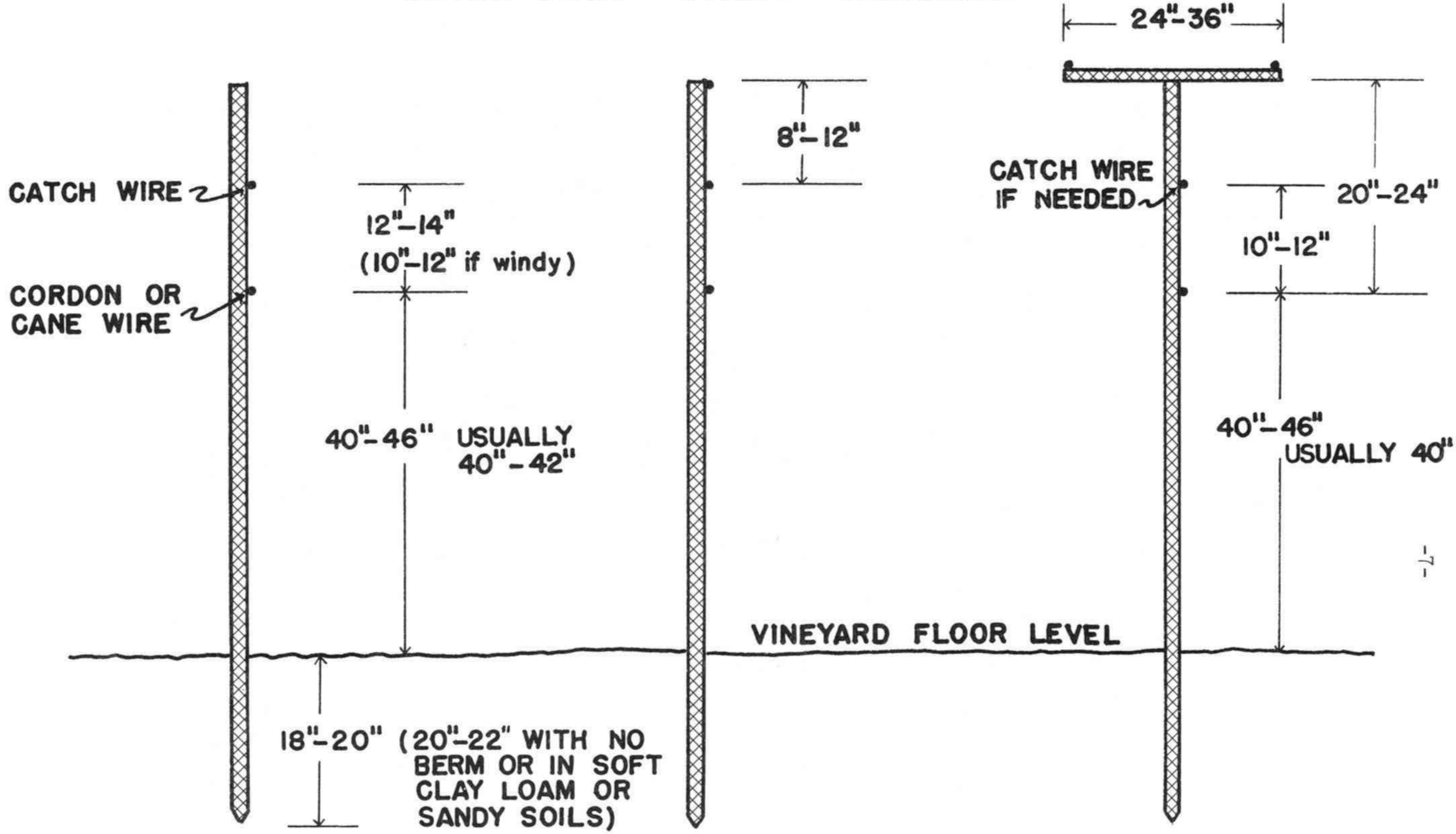



Fig. 1 2-WIRE VERTICAL    Fig. 2 3-WIRE VERTICAL    Fig. 3 "T" TRELLIS literature or consult with manufacturer representatives for recommended trellis dimensions.

The distance between the fruiting wire and the crossarm is a compromise between maximum foliage support, accessibility of harvester rods or fingers, and the anticipated increase in spur height.

With cane pruning, the recommended distances are 16 to 18 inches between the fruiting wire and crossarm wires for 24- and 30-inch-wide, two-wire crossarms and 18 inches for 36-inch-wide, three-wire crossarms. A catch wire is not needed for cane-pruned vines.

With spur pruning, the recommended distance is 20 to 24 inches. This distance is in anticipation of the increase in spur height with vine age. This reduces the need to eventually raise the crossarm, but should involve the use of an intermediate catch wire. This helps direct the shoots up through the crossarm and may be removed in later years.

Crossarm brace interference should be avoided when attaching crossarms. Braces should be attached from the stake top where excessive stake length is available above the crossarm. Otherwise, braces attached to the underside should be at a flatter angle (20 to 30 degrees) than the traditional 45-degree angle. Several types of steel straps or brackets are commercially available for nailing on wooden crossarms. There are also prefabricated steel or plastic crossarms that do not require traditional bracing and wiring methods.

3. Six-foot stake, two-wire vertical system (Figure 4).

This system can be used for low- to moderate-vigor vineyards, spur-pruned wine varieties, or for cane-pruned varieties. The lower cordon or cane wire should be at 40 to 46 inches. The second or overhead foliage support wire is attached to the top of the stake. The distance between the two wires should be 12 to 14 inches under average conditions and 10 to 12 inches in windy areas. The top wire is especially important in catching and supporting upright shoots to prevent cordon twisting in young vines. For this reason, it should be installed before training the vines.

4. Six-foot stake, one-wire vertical system (Figure 5).

This trellis is used primarily for the cane-pruned Thompson Seedless variety. A single wire is attached to the top of the stake, usually 52 to 54 inches from the ground.

5. Drying option for raisin varieties.

Either of the two 6-foot stake trellises allow the option for raisin drying. In addition, some growers have indicated a desire to attach a 2-foot wire crossarm on or near the top of a

# SIX-FOOT STAKE TRELLISES

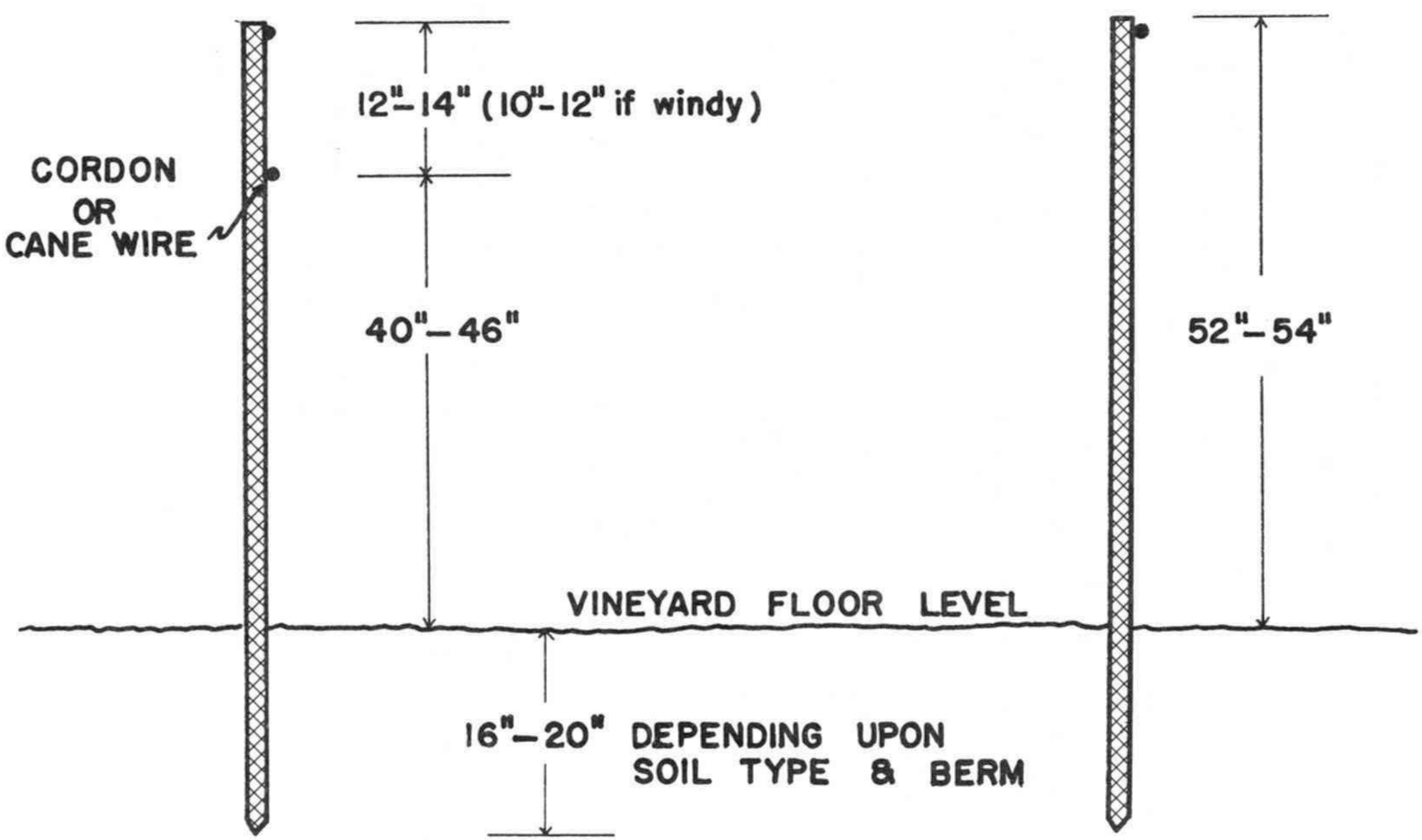



Fig. 4 2-WIRE VERTICAL

Fig. 5 1-WIRE VERTICAL

6-foot stake. Raisin drying and machine harvesting are still possible with such a design, but it requires close specifications on wire distance and careful harvesting procedures.

This crossarm provides additional foliage support for vigorous Thompson Seedless and is desirable in Muscat of Alexandria, which is susceptible to fruit sunburn.

The lower wire should be attached on the stake 16 inches below the crossarm for cordon-trained vines and 18 inches for cane-pruned vines. This places the cordon or cane wire approximately 36 to 38 inches from ground level, a minimum distance for efficient machine harvesting.

The raisin-type varieties, Thompson Seedless, Muscat of Alexandria, and Zante Currant, can also be trellised on 7-foot stakes as already described. However, row shading from the use of a 7-foot stake, with or without a "T" trellis, would eliminate the option to dry for raisins.

6. Alternating stake heights.

Alternating 5- or 6-foot stakes with 7-foot stakes is satisfactory in vertical wire support systems. Also, attaching crossarms only to alternating stakes is possible with 6- or 7-foot vine spacings if the wires are kept tight. However, attaching a crossarm on every stake to assure good support and to prevent wire sag is recommended in heavy foliaged vines.

End posts and anchors. A wide variety of acceptable end post materials are available, including steel, wood, and reinforced concrete. Post widths or diameters up to 6 inches have not caused difficulty with harvesters entering or leaving rows.

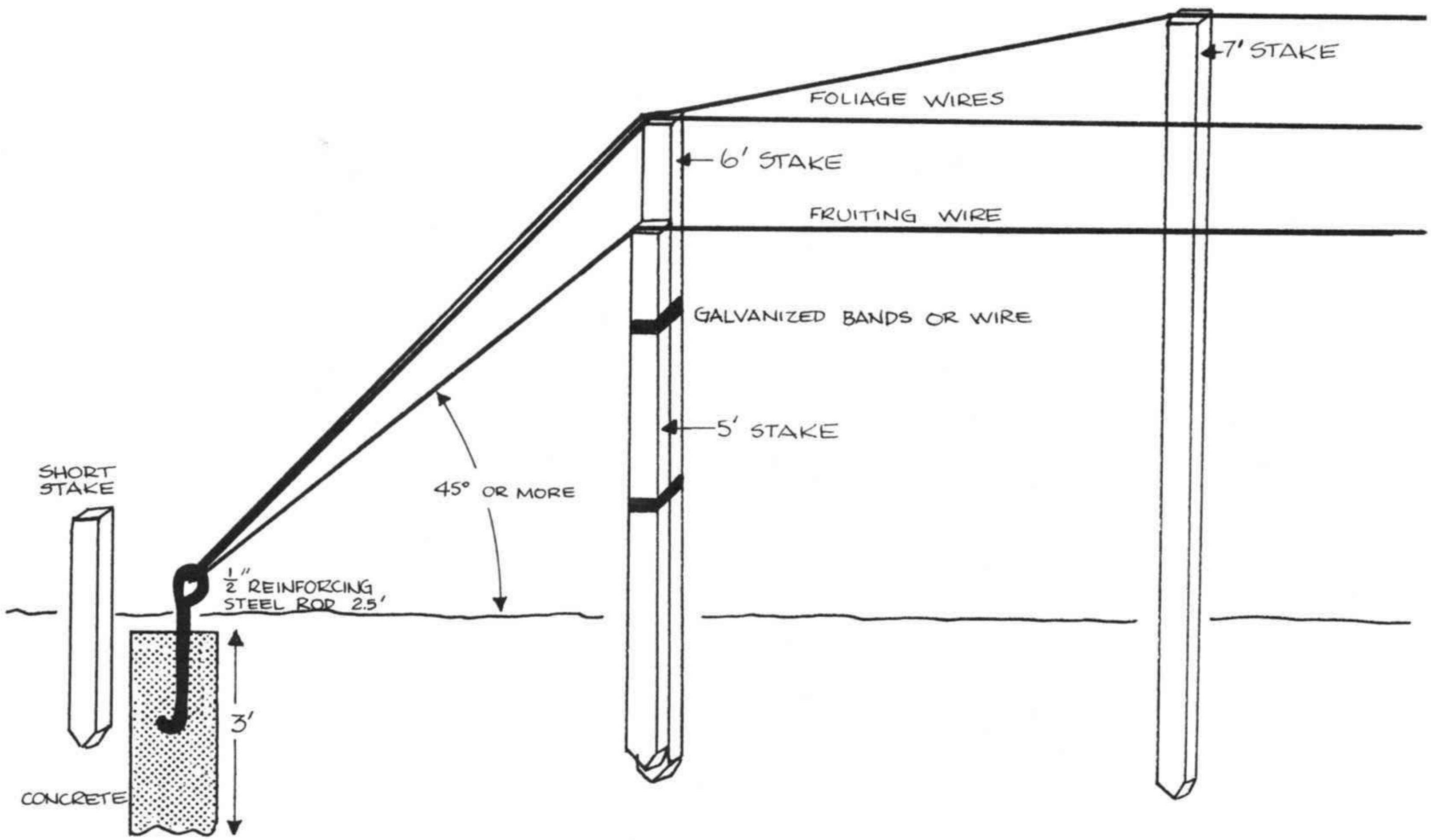
Some machine operators have complained of difficulty in entering and leaving rows when railroad ties, commonly up to 10 inches in width, were used. If used, install railroad ties sideways (narrow width facing the row) or use a half-tie, leaving only 18 inches of the shortened tie out of the ground.

When using end posts, space the first vine 8 feet or more from the post. This allows for complete machine fruit removal from the ends. Vines placed closer to the end posts should be trained away from the end posts.

End anchors or deadmen avoid the harvester interference problems encountered with end posts. The anchor may consist of a concrete deadman, a steel plate that is buried or augered in the soil, or a steel pipe or shortened post protruding 12 to 18 inches out of the soil.

Special attention must be given to design and installation of such anchors. It is quite important that the angle or incline of the wires from the anchor to the first stake is more than 45 degrees. If the angle is less than 45 degrees, the closure on the catching frame may not open properly and will bind on the wire when entering or leaving the row. Also, it is best to attach the wire to a double stake assembly as shown in Figure 6. Here, the deadman assembly is used as an example. This allows for a more secure

Fig. 6 - CONCRETE DEADMAN AND END STAKE ASSEMBLY



attachment for the bottom wire and absorbs the additional wire strain on the first stake.

A short marker stake outside of the deadman is also recommended to make the assembly boundary more visible to equipment operators.

Headland width. While the harvesters can turn in headlands of 16 to 17 feet with careful maneuvering, a minimum of 20 feet is suggested. For ease in turning, 24-foot headlands are desirable. In addition, transfer of the fruit from vineyard gondolas to the highway trucks requires a wider avenue of 36 to 40 feet every quarter or half mile or the provision for other suitable loading areas.

Row direction. In windy areas, orient the rows so that they are perpendicular to the wind rather than parallel. The outside rows take the brunt of the damage, protecting the remainder of the vineyard.

If the option of producing raisins is desired, orient the rows east and west. Remember that a lower trellis design is also necessary for raisin production as discussed under the trellis design section.

## VINE CONVERSION

Head-trained or low cordon-trained vines cannot be harvested mechanically with present machines. Conversion of these vines for mechanical harvesting is possible by retraining.

### Head-Trained Conversion

Factors to consider in conversion of head-trained, spur-pruned vines to bilateral cordon training for mechanical harvesting are as follows.

Age. Vigorous vineyards less than 10 years old will adapt and respond to conversion better than old ones. Old vines have been converted, but the economics of such a conversion is questionable.

Vine vigor. It is important that the vines are vigorous; low vigor vines should never be converted.

Trunks. Straight trunks that are in line with the row are necessary for conversion. Crooked vines that have trunks extending more than 8 inches out from the center of the row must be cut off about 12 inches above the ground and a new trunk formed from a shoot that develops from a water sprout or sucker. Train a vigorous shoot for the new trunk (Figure 7).

Head height. This varies somewhat, but the following guidelines can be used.

> If the original head is 6 to 12 inches lower than the proposed cordon wire, then conversion is easy. Select two strong canes, which are in line with the row, from the top of the vine. Wrap and tie these canes to the cordon wire. Cut off all the other arms extending from the trunk (Figure 8).
>
> The conversion of low-headed vines requires the selection of a cane that is well-positioned in relation to the stake. Train this

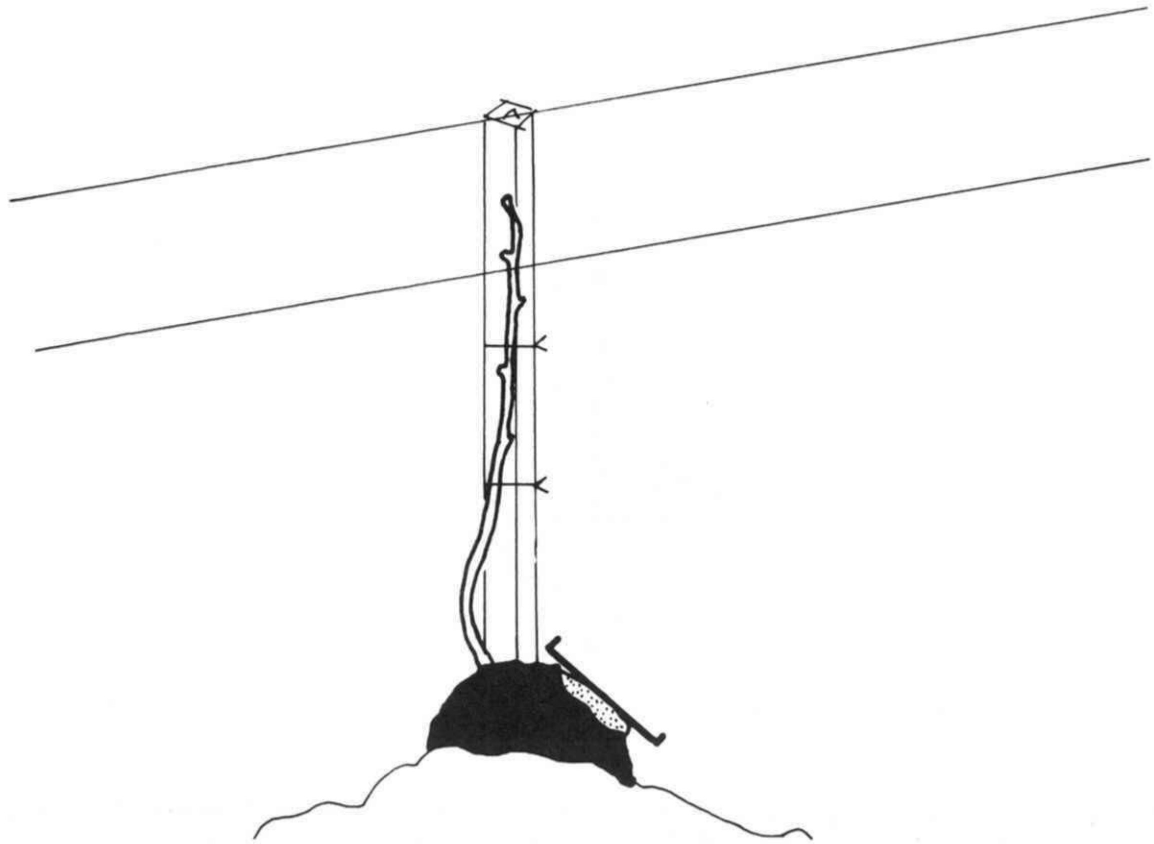


Fig. 7. Correcting vines with crooked trunks by retraining with a new shoot from the base.

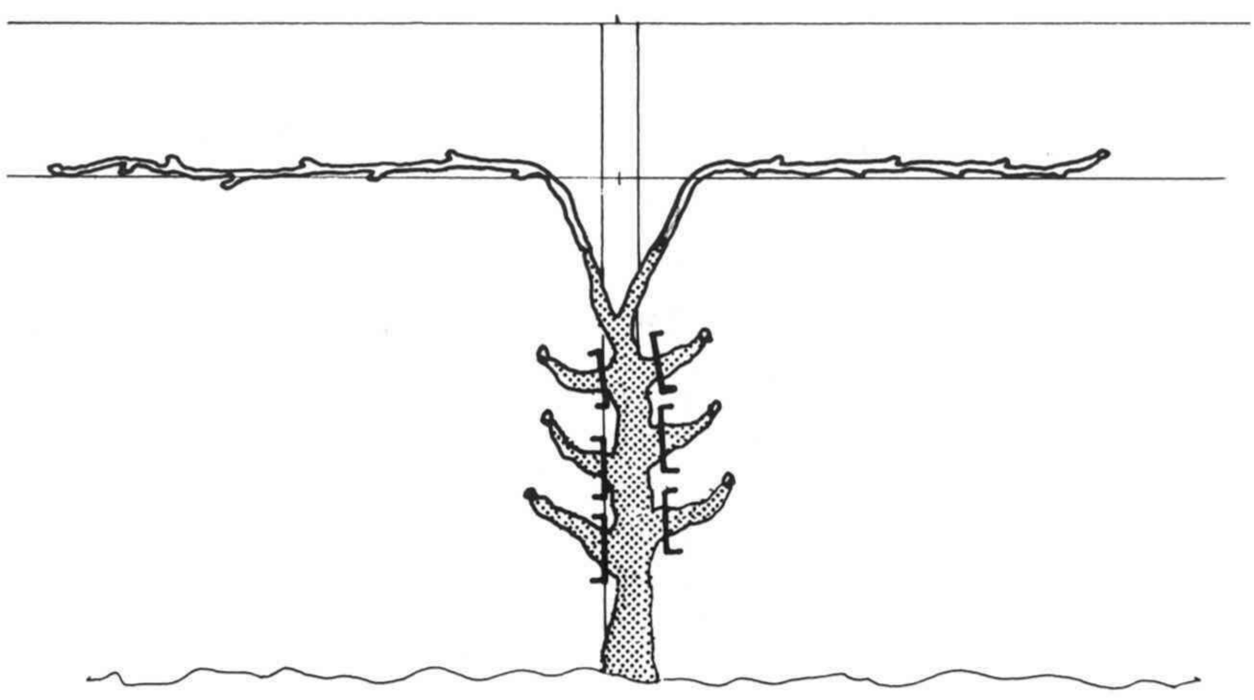


Fig. 8. Conversion of a vertically trained vine for machine harvest by developing a cordon with canes and cutting off the old arms.

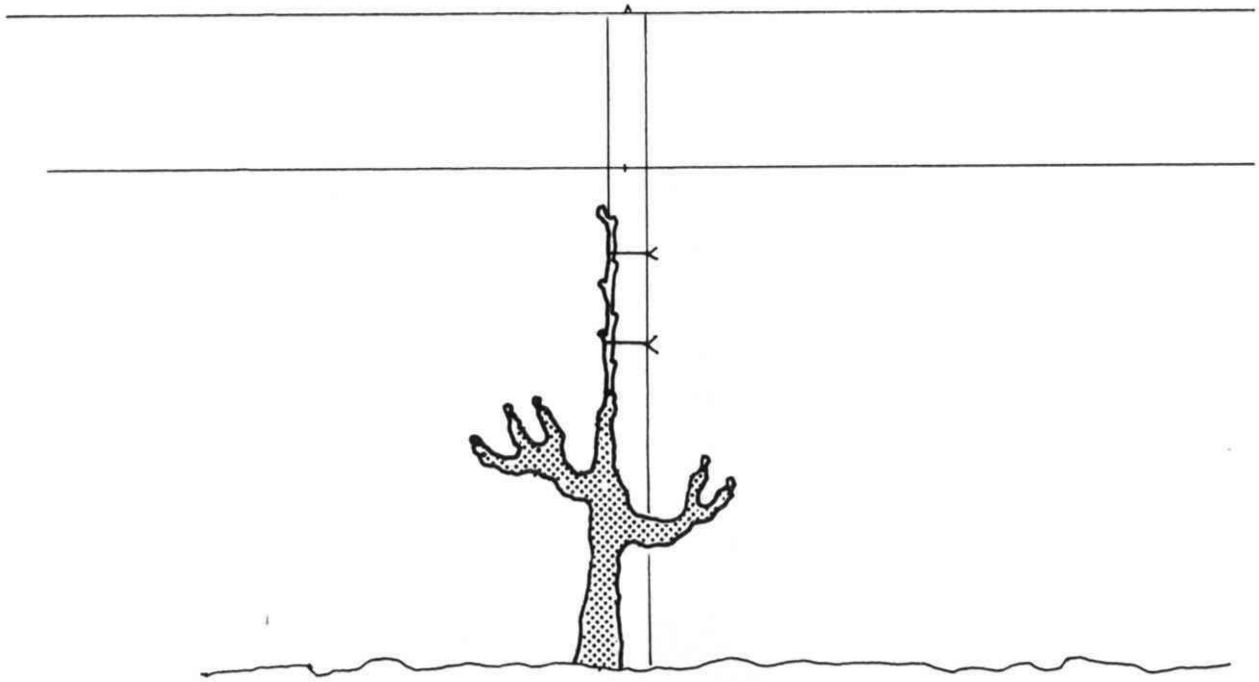


Fig. 9. Conversion of low head-trained vines for machine harvest the first year. A cane is tied from the stake to the cordon wire.

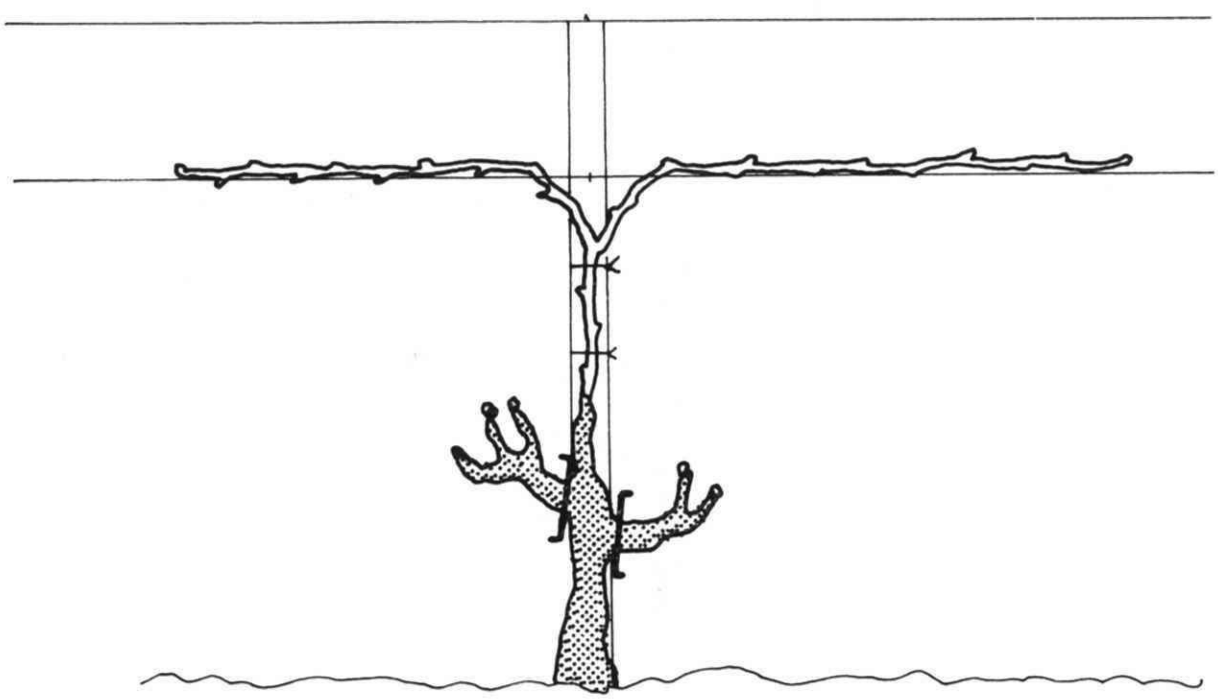


Fig. 10. Conversion of low head-trained vines for machine harvest the second year. Two canes are tied on the wire to develop the cordon and the arms are cut off.

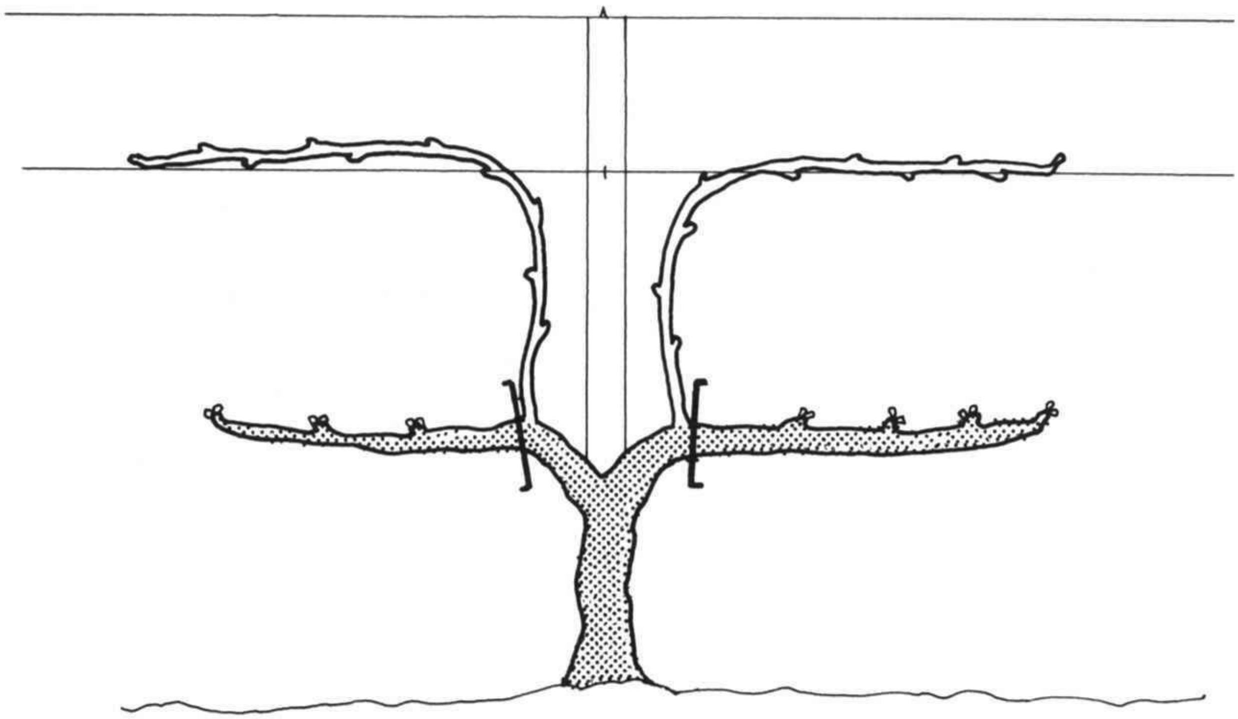


Fig. 11. Conversion of low-trained, high-vigor cordon vines for machine harvest by developing a new, higher level cordon. Two canes are selected for training on the wire and the old cordons are cut off.

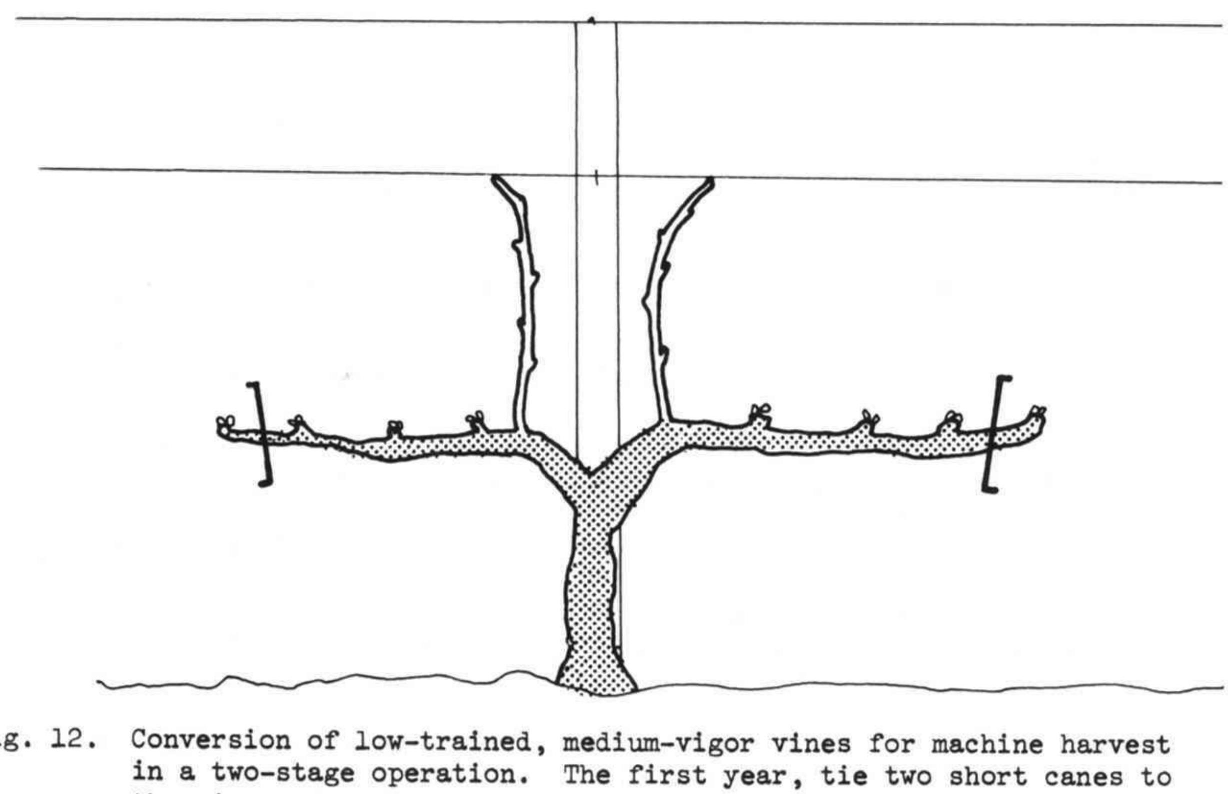


Fig. 12. Conversion of low-trained, medium-vigor vines for machine harvest in a two-stage operation. The first year, tie two short canes to the wire and cut off the terminal two spurs. Conversion is completed the second year.

cane up to within 4 to 6 inches of the cordon wire height. Select these canes 1 year before you plan to complete your conversion (Figure 9). In the spring, remove all the shoots from the selected cane except the terminal two or three shoots. Remove all the crop from these shoots. During the next dormant pruning, place two strong mature canes on the cordon wire and remove all arms (Figure 10).

High-headed vines (vertical cordon) require lowering of the height of the head. Cut the head back 1 year before conversion is completed. The height of the head should be 6 to 10 inches below the anticipated cordon wire. By cutting back the head, strong canes develop to complete the conversion the next dormant season.

Amount of fruiting wood. It is important not to over-crop a vine the first year after conversion. The number of buds retained on the cordon wire will vary somewhat according to variety. On most medium- to large-clustered varieties, eight buds per cane on the wire are sufficient for a good crop. If canes retained are too long, the buds in the center of the cane fail to push. Also, poor shoot growth will occur on long canes that are over-cropped, resulting in poor spurs to prune to the next winter.

Experiments with large-clustered varieties have shown that a converted vine with eight buds per cane (16 buds per vine) will produce as much as the head-trained vines did originally. However, if vines are very vigorous and high yields are needed to reduce vegetative growth, retain a spur or two on the lower portion of the trunks. This will delay full conversion an extra year and may not be desirable. It is always a good policy to leave fewer fruiting buds the year of conversion than were retained the year before the conversion.

## Raising a Low Cordon-Trained Vine

While most machines can handle vines as low as 36 to 40 inches, operators prefer the cordon to be 40 to 46 inches above the vineyard floor. Large-clustered varieties should have the cordon at a minimum height of 42 inches. Low cordons should be retrained to improve machine efficiency.

Steps to convert high vigor cordon vines are as follows (Figure 11).

1. Select one cane on each side of the stake for the new cordon. These canes should originate near the bend of the original cordon.

2. Tie these canes on the new cordon wire, retaining approximately eight buds per cane on the wire for next year's crop.

3. Cut off the old cordons just beyond the new canes retained.

4. Next spring, break out all the shoots that develop from buds located below the wire, retaining the eight buds on the wire for your crop.

5. Follow practices as you did for a newly developed cordon-trained vine.

Steps for conversion of medium-vigor, cordon-trained vines are as follows (Figure 12).

1. The first year, select a four- to six-bud cane on each side of the stake. Tie the canes vertically to the stake.

2. To improve vigor in the shoots that will produce the new cordon canes, remove the terminal two spurs. Prune the remainder of vine normally.

3. Next spring, select two strong shoots from each of the short canes and break out the remaining shoots. Removing the crop from these shoots will increase the vigor so that you can complete your conversion at the next dormant pruning.

4. During the following winter, select two new canes that are well-positioned and tie them onto the new cordon wire, again retaining eight buds per cane on the wire.

5. Cut off the old cordons just beyond the new cordon canes to complete conversion.

## Cane-Pruned Vines

Cane-pruned vines are more easily converted or adapted to machine harvesting than older spur-pruned vines.

In general, the revamping of single-wire, cane-pruned vineyards has involved some re-staking to eliminate poor stakes, to straighten the row, and/or to increase stake height. Machine operators prefer the fruiting wires at a minimum height of 44 inches, particularly if no overhead foliage support is used.

Improving machine accessibility. Crooked vines should be straightened as much as possible by heavy pruning. Large arms and multiple trunks pointing away from the vine row should be eliminated. It is suggested that misalignment of vines should not exceed 8 inches on either side of the stake or vine row.

Raising low vines. Vines headed low -- below 30 inches -- should have their heads raised to a height of 40 to 46 inches. This eliminates low clusters in the vine head and supports more fruit on the wire. This raising of the arms of the vines can be accomplished over 2 years to minimize yield losses. However, growers should anticipate some degree of yield loss during this retraining, since some fruiting canes may have to be sacrificed in favor of vine reshaping.

"T" trellised table grape vineyards. The canes are usually tied to wires on a horizontal or slanted crossarm in existing vineyards. Conversion for machine harvesting involves removing the crossarm entirely, or pivoting or reattaching it vertically onto the stake. The canes can then be tied to a single wire on top of the stake or onto wires attached vertically on the re-positioned crossarm.

## CONDITIONS FOR HARVESTING

### Under the Vine

The berm (ridge of soil in the vine row) must not be so high or wide as to interfere with the catching frame of the mechanical harvester. These requirements vary according to the harvester. For example, one harvester requires a berm that is no higher than 8 inches or wider than 26 inches. Another does not limit berm height, but specifies a minimum of 30 inches between the top of the berm and the fruiting area. The limitations are less strict on the newer harvester models.

The under-vine area should be kept free of trash and excessive weed growth.

### Area Between Rows

The vineyard floor should be flat, smooth, and firm to facilitate harvesting. A rough, uneven, or soft surface makes steering difficult and affects the efficiency of the harvester.

If the vines are hedged before harvest, the trimmings should be kept out of the area where they might interfere with the catching frame. If extremely heavy, they may require shredding before harvest.

### Obstructions in the Row

Since the harvester straddles the vines, the rows cannot be obstructed by power poles, guy wires, standpipes, air vents, etc. If such structures cannot be avoided, then two or three vines must be left out or pulled out on each side of the obstruction to allow the harvester to turn out and re-enter the row.

### Crop Maturity

Generally, the riper grapes harvest more easily, but this varies according to the variety. As the grapes mature, Thompson Seedless is progressively easier to harvest because of the development of an abscission layer between the capstem (pedicel) and the berry.

Overripe fruit, however, can be a disadvantage in certain varieties. Reduced harvestability has been experienced when the fruit begins shriveling or becomes "rubbery" from over-maturity. This is particularly true of the harder-to-harvest varieties, such as Ruby Cabernet, Carignane, and Grenache.

### Time of Day

Grapes usually harvest more easily at night through mid-morning -- 9 to 10 p.m. until 9 to 10 a.m. This may be due to a slightly more turgid, firm fruit condition at night.

### Soil Moisture Conditions

Grapes are more difficult to harvest if the vines are stressed for water. Time irrigation close enough to harvest to avoid stressed vines and the associated fruit wilting.

Cane Pre-Trimming

The interference of vine growth with harvesting can be minimized by mechanical pre-trimming or hedging. This practice is almost a necessity in highly vigorous vines, such as French Colombard. The trimming should be uniform and as high as necessary to expose the fruit zone, without removing potential fruiting wood for the next season.

"T" trellising has the advantage of reducing the proportion of foliage removed in trimming. It also allows for some protection of next year's renewal wood in cane-pruned vines.

Vine Tying

Adequate vine tying for fruit support is needed, especially in cane-pruned vines and young cordon-trained vines. Loose cane ends can sometimes hang too low for harvester recovery and tend to swing with the harvest mechanism. This contributes to reduced fruit removal and may result in an increase in vine breakage.

Coated wire ties can be used for light tying jobs, but should be secure; otherwise many will end up in the harvested fruit. Twine or vinyl tape should be used where heavy fruit loads are anticipated.

Aluminum cordon ties should not be used on the cordons or trunks. They are often harvested along with the fruit.

Slopes

Equipment. Nearly all the production models of the over-the-row grape harvesters are designed for operation while vertical - that is, where the stakes and vines are approximately at right angles to the level ground. Experience with the standard self-powered, over-the-row machines has demonstrated the ability to successfully harvest vines grown on side slopes with as much as 7 percent fall without machine conversion. Several manufacturers also offer harvester models designed for operation in vineyards of greater slopes. One of the machines is reported to handle side slopes up to 15 percent by the insertion of hydraulic rams to tilt the side striking mechanism to one side or the other as needed. Other models have a hydraulic ram on each wheel that self-levels the machine on side slopes.

Several models have been tried in California vineyards planted on rolling hillside lands where side slopes of 20 percent were encountered. Harvesting was accomplished without problems. Cost estimates of adding the self-leveling feature vary widely -- from $1500 to $5000 according to the figures available at this time.

It should be pointed out that the gondolas receiving grapes discharged by a harvester operating on rolling land should be low in profile. This is necessary to allow room for the side conveyor when the equipment is operating with the discharge to the high side of the sloping terrain.

Trellis. When vines are planted on rolling lands and the change in slope in the direction of the rows varies drastically, severe strain is placed on the staples holding the trellis wires. The low and high points in the row are always under tension from the vine load, which increases as the crop matures. Since the staples lose holding power in the stakes with continued exposure to the weather, the problem of staple loss during the machine harvesting operation is increased. Other means of attaching the wire to the stakes -- e.g., with wire straps or the use of slotted or perforated metal stakes -- may help resolve this problem.

Soil management. Where side slopes occur in vineyard plantings and cultivation is practiced down the rows, modified terraces will be established in time as the soil is gradually thrown to the low side, leaving the vine rows on the edges of the terraces. This practice tends to exaggerate the difference in elevation between adjacent rows and thus makes harvesting more difficult. Instead of cultivation, it might be best to retain the natural topography by using close mowing to control weed growth in the middles and herbicides in the vine row for annual weed control.

## HANDLING OF SPRINKLER SYSTEMS

The internal clearance of over-the-row harvesters varies from 6 3/4 to 7 1/2 feet. This is sufficient to clear the risers and heads of permanently installed sprinkler systems. These risers need to be rigidly supported to withstand the back pressure of the sprinkler so as not to distort the water distribution pattern. This is usually done by securely strapping the riser to the vine-supporting stake at that location.

Concern over the possibility of damaging the risers during machine harvesting has caused growers to use several methods of either avoiding harvester contact or protecting the riser in place. There is some danger of the sprinkler heads being broken off in the whipping action imparted to loosely held risers.

Rigid PVC risers have been protected by using a larger diameter PVC tubing as a collar. This gives rigidity, mechanical protection, and protection from weather. Channel-shaped steel or grooved wooden stakes offer a ready spot to nest the risers held in by tight strapping.

Instead of plastic, some growers use galvanized steel pipe for risers that are connected to the underground lateral by means of a short section of flexible polyethylene tubing. This represents an additional cost for material and installation.

Other growers are testing a method of removing the risers from the attachments to the stakes and laying them on the ground parallel to the row and close to the vines before harvesting. This is made possible by extending the flexible polyethylene connector to about 6 inches above ground to provide a bending point. Several designs of plastic clips have been tried to facilitate attachment and removal of plastic risers.

## FIELD CRUSHING

It is logical to consider field crushing as a continuation of the mechanical harvesting process, especially since most wine grape varieties are removed as single berries or parts of bunches with varying degrees of broken berries and juicing. Studies at the University of California, Davis, have shown that partial rupture of the fruit exposes the unprotected inner berry material and, as a consequence, cellular materials are released into the juice. Enzyme activity is induced by air contact or physical bruising, and microbiological activity may begin because of the availability of a sugar medium. Recent work at Davis using white grapes showed that removal of the stem materials from the must reduced total tannins and that, with skin contact time of 12 hours, significant amounts of cellular constituents were eluted into the juice. This rate of pickup into the free juice is increased with higher temperatures and by agitation. Thus, from the standpoint of the final quality of white wines:

1. The sooner the grapes are delivered to the winery, the juice separated, and fermentation started, the better the wine quality.

2. Field crushing and the introduction of 100 milligrams/liter $SO_2$ will delay browning for as long as 8 hours.

3. Blanketing the crushed grapes with $CO_2$ reduces wine color slightly, compared to air.

4. The lower the handling temperature, the better the quality.

5. Long holding times - in excess of 12 hours without the addition of $SO_2$ - can be expected to bring bacterial and yeast problems and to decrease wine quality.

The main advantage of field crushing and stemming is to permit the introduction and thorough mixing of an anti-oxidant fungistat, such as $SO_2$, to prevent juice browning and possible spoilage. Of secondary importance, since the number of stems recovered from the vines is often quite small, is the early removal of any stem parts from the must to minimize excessive tannin pickup.

The must may be accumulated in stainless steel tanks mounted on the harvester, or it may be pumped directly into a closed stainless steel gondola pulled by a tractor in the adjacent vine middle. With the first method, the tanks are discharged into a trailer-tanker for transport to the winery. With the second method, the closed gondolas are transferred to a flatbed truck by a fork-lift and hauled to the winery.

To date, field crushing and stemming have been used only by those wineries that produce varietal table wines. It is doubtful that the additional investment in crushing equipment and the extra care needed can be justified for the production of standard table wines or standard dessert wines, at least under the present economic situation.

## DELIVERY

Under the direction of the receiving winery, growers may help protect white table wines from browning (oxidation) by the application of $SO_2$ in one of several forms at harvest time. The stability of potassium metabisulfite has distinct advantages and may be applied at the rate of 5 to 6 ounces per ton on the bottom of the gondola at the beginning of harvest. Dispersion would come as the chemical dissolves in any juice in the bottom of the tank and the mixing resulting from gondola motion. It would be better to meter the potassium metabisulfite powder onto the harvested grapes as they pass on the cross-conveyor to the gondola. While dripping a 100 ppm $SO_2$ water solution (using an insulated plastic container fitted with a constant head delivery) onto the harvested grapes on the conveyor is quite convenient, losses of $SO_2$ might be excessive. Such losses depend on the length of time before receipt of the grapes at the winery, air and fruit temperature, as well as the condition of the fruit. Crushed berries would tend to fix more of the $SO_2$ than would sound berries.

Red table wines may also benefit from $SO_2$ applications in the field, primarily to discourage bacterial spoilage that might be expected at fruit temperatures higher than 80° F. if winery delivery is delayed as much as 24 hours.

It should be emphasized that the use of any $SO_2$ source for its bacteriostatic or anti-oxidant properties should be done only with the approval and guidance of the receiving winery. Too much $SO_2$ in the must can create difficult problems for the winemaker and should be avoided by following specific instructions in $SO_2$ use.

If field crushing and stemming are not practiced and $SO_2$ not introduced into the tanks of harvested grapes, then time and temperature become especially important factors in delivery to the winery. For white wine production, probably not more than 4 hours should elapse between time of harvest and time of delivery for those varieties that are subject to browning. Night or morning harvested fruit would offer more protection due to lower fruit temperatures.

Highway truck tanks are easily overloaded, especially if the harvested grapes are quite juicy. Besides the problem of overloading, there is also one of slopping juice over the tank sides on deceleration or sway of the truck. Tank covers offer some help in reducing spillage and also offer some protection from possible contamination. Baffles in the tanks would also reduce the possibility of spillage.