Evaluating Orchard Performance and Practices from Packout Records

Ronald B. Tukey and R. Thomas Schotzko
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INTRODUCTION

The packinghouse keeps records of the fruit delivered by growers, and how it packed out and sold. While these records are intended to be an accounting by packers, they can also be used by growers to identify opportunities for improvement.

This is true because the relationship between yield and market quality and various production practices is known. Packout records measure the effectiveness of these practices. Therefore, they can be a valuable management tool.

In today's economic climate, growers cannot simply focus on costs and be assured of survival. Production decisions must consider returns as well as costs and should be based on a block-by-block evaluation to be most effective.

The first step in decision making is understanding the relationship between production practices and factors which influence returns. This publication outlines how differences in grade, fruit size, and cullage are related to production practices. Usually these differences are the result of a combination of factors. Comparing records between plantings and cultivars (varieties and strains) as well as between years can be very informative.

The next step is estimating the loss in returns due to the problem and calculating the cost of solving the problem. To be most effective, this evaluation must be done on a block-by-block basis. Application of this approach to units larger than individual blocks can lead to incorrect decisions and reduced returns.

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1 Several companion publications are available from Washington State University Cooperative Extension. They are "Red Delicious Cullage, Color, and Size: What They Mean to a Grower's Returns," EB 1216, 50 cents; "Using Packinghouse Records to Evaluate Your Orchard's Financial Performance," EB 1217, 50 cents; and "Effects of Fruit Size on Apple Growers' Packinghouse Door Receipts," EB 1324, 25 cents.
WHAT PACKOUT RECORDS SHOW

The following three components in the packout record can be used to evaluate performance:
1. The number of bins or weight of fruit delivered.
2. Number of boxes packed by grade and fruit size.
3. The amount culled.

Bins or Fruit Weight

Always compare records of the amount of fruit delivered against your receipts and picking records. Bins may be lost or not properly assigned.

If an effort is made to identify the source of the fruit down to the orchard or block and if the size of the block is known, bins or weight of fruit can be transformed into production per acre. Since different cultivars may be planted in several blocks, it is possible to make comparisons between cultivars, ages, blocks, and management practices when production records are carefully kept.

Grade

In red cultivars, the major factor in grade is fruit color. Well-colored fruit is placed in the premium extra-fancy category. Tolerance also exists for other factors, but usually these are less important, although there has been increasing emphasis on typiness in Red Delicious in recent years. Although growers usually want the premium which is paid for well-colored fruit, the cultural practices used to achieve a high proportion of well-colored fruit can result in lower production, smaller fruit size, and reduced cropping.

With yellow cultivars, factors other than color become more critical. Two of the most common problems are undesirable fruit shape and presence of russet, limb rub, and other surface blemishes. These are readily identified with specific production practices.

Fruit Size

Important aspects about fruit size that should be noted are:
1. The peak sizes.
2. The range of sizes within the lot of fruit.

Fruit size reflects tree vigor and productivity. It may also be an indicator of inadequate fruit thinning.

The range in fruit size can be as important as the average. Large and small fruit within the planting reflects mixed vigor either between trees or between limbs and branches within the tree. Excessively large fruit indicates suboptimal production. Excessively small fruit represents not only suboptimal production but also lower market prices.

Cullage

Analysis of the reasons for downgrading and cullage can show a variety of problems. The usefulness of this figure depends largely on the scope and detail of the cullage records. Two of the most common problems in red apples are small size and damage due to poor handling. Problems related to condition after storage and storage losses may also be important.

In yellow cultivars, surface blemishes are more significant. These may be related to bruising during harvest. They can also relate to pruning and training trees, pest control schedules, nutrition, and tree vigor. The value of the report depends on the amount of detail provided.

Occasionally, a crop has an unusual price range by size. Smaller fruit brings somewhat higher F.O.B. prices than larger fruit. This shift is caused by a very high proportion of large fruit in the crop. According to annual summaries of the Washington Growers Clearinghouse Association, it appears that this type of crop occurs once every 20 years or so.
SUGGESTED PERFORMANCE STANDARDS

It is both difficult and hazardous to suggest anything more than generalized performance standards for yield, grade, size, and cullage. Each orchard and planting differs. This may be the result of tree age and cultivars. It can also be the effect of orchard sites on tree vigor and temperatures. Further, minimum acceptable grade standards in any given warehouse will change from year to year depending on the supply of fruit and the market.3

The cullage, yield, and grade figures given below should be considered as guidelines. The intent is to provide figures against which growers can make comparisons. Ideally, objectives in terms of grade, cullage, and yield should be established for each orchard block. The guidelines will likely be adequate for some orchards, but not for others. Regardless of how appropriate the guidelines may be for individual blocks, the methods suggested for their use are valid and can be applied with any set of objectives.

Yield

Yield is commonly expressed in 35-pound loose boxes or in 25-box bins per acre. The industry has conversion factors for translating field boxes into packed boxes for each major variety. These factors vary slightly between growing districts. The conversion factors for Reds, Goldens, and Granny Smith are 0.72, 0.65, and 0.70, respectively. Multiply loose boxes by the appropriate conversion factor to get packed boxes. For example, 1,000 field boxes of Red Delicious converts to 720 packed boxes.

This is a useful generalized approximation. Keep in mind, however, that it is affected by amount of fruit in a bin, cullage, and the weight of each packed box.

To convert total production to yield per acre, it is necessary to determine actual acreage. Multiply the number of trees by the tree spacing and divide by 43,560 (square feet per acre). For 400 trees planted 20 by 20 feet, the calculation would be:

\[
\text{No. of trees x spacing} = \frac{400 \times 20 \times 20}{43,560} = 3.67 \text{ acres}
\]

See Table 1 for interpretation of various yields per acre.

High yield per acre can result from either large numbers of fruit or large fruit size. This is more readily seen using numbers of packed boxes.

Table 1: Yield levels and their suggested interpretation.

<table>
<thead>
<tr>
<th>Production per Acre</th>
<th>35-Lb. Loose Box</th>
<th>25-Box Bin</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 500</td>
<td>Under 20</td>
<td></td>
<td>Unprofitable but a good yield for 4-6 year old trees.</td>
</tr>
<tr>
<td>500-1,000</td>
<td>20-40</td>
<td></td>
<td>Average range for mature plantings. Profit/loss depends on fruit quality and market price.</td>
</tr>
<tr>
<td>1,000-1,500</td>
<td>40-60</td>
<td></td>
<td>A good desired average range.</td>
</tr>
<tr>
<td>Over 1,500</td>
<td>Over 60</td>
<td></td>
<td>Found from good plantings during the most productive years. Represents over-production on most older trees.</td>
</tr>
</tbody>
</table>

3This should not be confused with being "out of grade." Packing sheds will typically have minimum standards above the legally allowable minimums. Since they are above these minimums, sheds have the option of adjusting their own standards up or down depending on the circumstances surrounding each crop.
boxes. For 1,000 packed boxes per acre the number of fruit needed of different sizes would be:

- 80 count: 1,000 packs x 80 = 80,000
- 100 count: 1,000 packs x 100 = 100,000
- 125 count: 1,000 packs x 125 = 125,000

One of the limitations in producing high yields is the number of fruit which can be produced per acre. This is a limitation caused by the number of leaves and fruiting spurs which can be maintained in a fruitful condition.

Grade

With red cultivars, the dominant factor is the amount of good red color. With yellow cultivars, the dominant grade factors are fruit shape and freedom from surface blemishes such as russet, bruising, and limb rubs.

The percentage of fruit packed by grade rather than the total crop delivered to the warehouse is commonly reported. Failure to include culls and processors in this analysis can lead to misrepresentation of the total crop.

To add the amount of fruit which was culled to the packout, divide the pounds of fruit culled or processed by 42 pounds. This is the packed box equivalent of culls and processors. Adding this figure to the actual packed boxes allows you to calculate the percentage of the total crop which was packed. Multiply the number of boxes packed by 42 pounds (per box) to get total packed pounds. Not all fruit is packed to 42 pounds but the disparity is relatively minor.

Table 2 gives interpretations for percentages of the various grades by cultivars.

Fruit Size

Size is reported as box size counts, the number of fruit required to a packed box, usually 42 pounds in weight. The use of preformed trays between layers of fruit in the box has standardized the counts as:


Box size 100 is approximately a 3-inch diameter fruit. Each box size count up or down represents a difference of approximately ⅓ inch. Thus, a box size count of 125 would be of fruit about ⅛ inch smaller in diameter than 100s.

Most U.S. packers and markets desire fruit of a relatively large size, no smaller than 125s and no larger than 72s. This represents a range in fruit diameters, depending on fruit shape, from about 2¼ to 3¼ inches. Size 138s are usually sold for lower prices. Size 150s and smaller may be sold in plastic bags or simply culled. This cullage decision is economic and is generally made with the intention of getting the best returns for the grower.

Tree vigor and fruit thinning need to be adjusted to produce a high proportion of the crop in the range of 72s to 125s. With larger fruited cultivars such as Rome Beauty, there will be a tendency for more large fruit than with Red Delicious. Conversely, both Golden Delicious and Winesap are characteristically smaller in size. Table 3 offers some guidelines for size⁴.

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### Table 2: Suggested guidelines for grade and packout of apple cultivars.

<table>
<thead>
<tr>
<th>Percentages of Packed Boxes</th>
<th>Percentages of Total Production</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>XF</td>
<td>F</td>
</tr>
<tr>
<td>Super Red Color Sports:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>35</td>
<td>—</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>90</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>Standard Red Cultivars:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>45</td>
<td>—</td>
</tr>
<tr>
<td>65</td>
<td>35</td>
<td>—</td>
</tr>
<tr>
<td>75</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>Golden Delicious:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>55</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>65</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>75</td>
<td>25</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 3: Preferred size range for different cultivars.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Overly Large</th>
<th>Desired Range for 80% of Crop</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rome Beauty</td>
<td>Over 64s</td>
<td>72–113s</td>
<td>125s and under</td>
</tr>
<tr>
<td>Red Delicious</td>
<td>Over 72s</td>
<td>80–125s</td>
<td>138s and under</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>Over 88s</td>
<td>88–125s</td>
<td>138s and under</td>
</tr>
<tr>
<td>Winesap</td>
<td>Over 100s</td>
<td>100–138s</td>
<td>138s and under</td>
</tr>
</tbody>
</table>
COMMON CAUSES OF LOW RETURNS

Following are a number of reasons for low returns other than market price:

Low Yield
1. Low potential for yield due to old, weak, or missing trees or a high proportion of young non-bearing trees.
2. Alternate bearing resulting from inadequate or delayed fruit thinning.
3. Faulty pruning and training resulting in a small number of weak fruiting spurs.
4. Small fruit size resulting from inadequate vigor, pruning, or fruit thinning.
5. Inadequate fruit set as a result of inadequate pollination, due to poor location of pollenizers, low bee numbers, poor management, low bee activity, or low blossom vigor.
6. Frost damage due to lack of adequate cold protection.

Low Percentage of Extra Fancy Packout
1. Poor coloring cultivars (varieties or strains).
2. Warm season at harvest.
3. Inadequate light penetration due to poor pruning and tree training.
4. Poor fruit shape due to poor pollination and low seed count.
5. Fruit russet caused by mildew, cold, or improper spraying.
6. Injury from wind whip and limb rub or bruising in harvesting and handling.

Small Fruit Size
1. Low vigor of blossoms and spurs.
2. Loss of king bloom in the cluster.
3. Fruit set is from lateral bloom off previous season's growth.
4. Inadequate fruit thinning.
5. Cold season or cold fruit site.
6. Failure of fruit to drop after treatment with chemical thinners. Such pygmy fruit is seedless.
7. Heat or moisture stress.

Poor Fruit Shape
1. Fruit borne laterally on previous season's shoots (rather than on spurs).
2. Poor pollination weather.
3. Use of Amide (Napthaleneacetylamide) on Red Delicious as a chemical thinning material.
4. Inadequate hand thinning.

Bruising
1. Large bruises from rough picking and dumping of apples at harvest.
2. Smaller bruises from bouncing fruit in bins as it is hauled out of the orchard or to the warehouse.
3. More mature (softer) fruit.
4. Packing bruises associated with cold fruit and high moisture storage before packing.
Sunburn
1. Fruit directly exposed to the hot sun, particularly in young, more open, and less vigorous trees.
2. Change in branch angle or bending of the limb under a heavy weight of fruit.
3. Late hand thinning which removes the top fruit.
4. Excessive pruning during the summer exposing fruit to high heat.
5. Inadequate tree vigor resulting in sparse foliage and protection.
6. Bins of fruit left exposed to the hot sun at harvest time.

Bronzing of the Skin or “Buckskin”
1. High temperatures after red color has begun to develop causing the red pigment to oxidize into a rust color.
2. Cultivars differ in their susceptibility. Some strains are more susceptible than others.

Fruit Russet
1. Powdery mildew infection of young developing fruit.
2. Spray injury from high-velocity air blast and improper sprayer calibration.
3. Chemical burn.
4. Frost ring and cold weather.
5. Russet Ring virus.
6. High humidity and/or rain.
7. Cultivar.
8. Fruit exposure.
9. Insect damage (apple rust mites, thrips, etc.).

Bitter-Pit: A Physiological Disorder
1. Light fruit crop and excessive shoot growth late into the summer.
2. Associated with fruit on upright limbs in young trees and tops of older trees.
3. Heading the previous season’s shoots resulting in excessive shoot growth.
4. Delayed culling of susceptible fruit at harvest.

Water Core
1. Associated with susceptible cultivars, particular Red Delicious.
2. Late or delayed harvest.
3. Differences between seasons.

Stems Broken or Pulled
1. Improper training and supervision of pickers.
2. Low vigor resulting in weak, thin stems and an inadequate abscission zone.
3. Lateral fruit from previous season’s growth with long, thin stems.
4. Improper or excessive use of stop-drop sprays.

Insect and Disease Damage
1. Improper sprayer calibration and operation resulting in inadequate application and distribution of chemical.
2. Faulty timing of applications or inadequate pest control program.
CORRECTION OF YIELD AND PACKOUT PROBLEMS

Production levels and market quality are the result of a combination of factors. Differences between seasons due to weather, alternate bearing, or age of trees can have a significant effect on packout records. Since orchards usually follow a pattern, years are required to make major changes. Thus, comparison of records over a period of years is helpful to show trends and problems as well as needed improvements.

While the primary focus of attention is usually on poor areas and specific problems, careful consideration should be given to all plantings, even those with high performance because they may not be producing to their full potential. Slight changes can often cause a greater difference in superior plantings than is possible with poorer plantings.

Production, Fruit Number, and Size

High production results from both large numbers and large fruit sizes. Intermediate levels of production can be composed of either smaller numbers of fruit or smaller sizes.

Begin diagnosing problems of low production by looking at fruit number and size. Small numbers of fruit may be a result of an inadequate number of fruiting spurs in the orchard. If the fruit size is overly large, this may indicate excess vigor, since fruit size and vigor are directly related. A small crop of overly large fruit is characteristic of young trees which still have not come into full bearing.

Small fruit size may indicate low spur vigor or inadequate thinning if there is a large number of fruit. With a more moderate number of fruit, it may be associated with inadequate pruning. Pruning is needed to increase spur vigor and to renew spurs.

Another common situation is adequate fruit size but small fruit numbers. By checking your records, it may be possible to determine if this relationship is the result of bins of fruit lost in handling. Picking records can also help determine the cause. Another cause can be miscalculation of acreages. Half the trees in a 20-acre block may be Red Delicious, but this does not necessarily mean 10 acres of Red Delicious. Space is lost for roads, buildings, windbreaks, draws, and irregular terrain. Actual tree count and spacing can indicate considerably less than 10 acres.

Low yield may not reflect inadequate tree performance of the good trees but rather the existence of a large number of weak or missing trees, or young replants. Thus, the focus of attention can be shifted away from fertilizer and pruning to factors causing high tree loss or removal.

Fruit Size

The potential for large fruit size comes from strong spurs which produce large blossoms. Much of the potential size of the fruit is determined before and immediately after bloom. Spur vigor can be measured by the number and size of leaves below the blossom cluster for any given variety. The center (king) bloom is the largest and has the greatest potential to produce a large fruit. Blossoms adjacent to the king bloom are somewhat smaller while the blossoms furthest below the king bloom are the smallest.

Bloom on one-year-old spurs is the largest and most vigorous. Bloom size and ability to set and mature a fruit declines as the spur ages. Late bloom arising laterally off the previous season's shoot growth is usually the smallest. These blooms also produce the smallest fruit.
Vigor is closely associated with exposure to sunlight, the angle of the branch, and even the position of the spur on a branch. Upright limbs and branches are more vigorous. As they bend down toward the horizontal, they lose vigor. Downward hanging limbs or branches have little vigor.

A wide range of sizes in a crop represents mixed vigor in the orchard. Often the large fruit comes from the more vigorous upright growth in the tops of trees. Smaller fruit comes from the weaker lower branches and spurs.

To develop and maintain uniform large fruit size, use pruning and fertilizer to achieve a balance between shoot growth and fruiting within the orchard, within trees, and even within branches and limbs. Dormant pruning stimulates growth and promotes vigor. Summer pruning is less stimulative. Detailed pruning is needed to eliminate over-hanging limbs, older hanging branches, and older weak spurs.

Fruit Color and Grade
In red cultivars, the proportion of Extra Fancy, Fancy, and lower grades or culls is an indication of the amount of light reaching the various portions of the tree. Approximately 60-70% of full light is necessary to develop well-colored Extra Fancy fruit. Fruit making Fancy grade is associated with 40-60% of full light. With much less than 40% full light, fruiting spurs may become unproductive.

Poorly colored fruit is produced on the inside and lower portions of the tree when those portions receive insufficient light because of over-hanging limbs. The proportion of the crop with insufficient color to produce Fancy grade comes from spurs which may not continue to be productive.

Small size along with a high proportion of Extra Fancy fruit may also indicate problems. Small size may mean low tree and spur vigor. A high proportion of small Extra Fancy fruit may indicate that vigor has been reduced to achieve color (instead of using better pruning to improve color).

With yellow apples, differences in color are not reflected by grade. Fruit can range from intense yellow to a deep green and still be packed as Extra Fancy or Fancy. However, the intensity of green reflects vigor. For high levels of productivity, a light green fruit is desired. The precise shade of green differs between cultivars, regions, and seasons. Deep yellow is associated with low vigor and productivity. Even a pale yellow may be an indication of less vigor and productivity than desired for optimal production.

Sunburn
Fruit suddenly exposed to the direct rays of the sun can burn. While sunburn is associated with high heat during the late summer and early fall, damage can be held to a minimum through good management.

Fruit exposed to the sun throughout the growing season becomes acclimated. Removing the top fruit in a cluster or improper summer pruning suddenly exposes other fruit to the sun. Unless allowed to acclimatize slowly before high temperatures occur, the fruit will burn.

A heavy fruit load will slowly bend a branch, causing a change in exposure which can lead to sunburn. Timely propping can reduce sunburn. Alternatives are to stiffen the limb by shorter pruning and to thin the crop load to the strength of the limb, or to tie the branch up.

Reflected light can increase both light intensity and heat. Failure to
maintain a green cover crop or sod during hot weather increases the potential for sunburn. Even mowing a sod or cover crop before a period of heat increases the potential. Vigorous large leaves help minimize sunburn. Even irrigating over the trees or in the orchard during periods of high heat will reduce the potential for excessive sunburn.

**Buckskin or Bronzing**

This condition is associated with the early development of red pigment in the fruit, primarily Red Delicious. Under high heat, the pigment becomes oxidized into an orange-red. Even with good coloring weather later in the season, this orange-red is not masked.

The problem is associated primarily with warmer sites and certain cultivars. The problem can be minimized in the same way as with sunburn. Good tree vigor and large leaves, a well-irrigated sod, and an over-tree irrigation system operated during heat periods can reduce this problem.

**Poor Fruit Shape**

Shape which is not characteristic of the cultivar is a common cause for downgrading fruit. Shape is particularly critical with Golden Delicious where the standard for U.S. Extra Fancy requires the fruit to be “well-formed” rather than just “fairly well formed” as with red cultivars.

The failure of fruit to be regular and well shaped is commonly associated with a difference in the number and distribution of live seeds within the fruit. Developing seeds produce hormones which stimulate cell enlargement. The apple is divided into five cavities, each of which has a potential of producing two seeds—10 seeds per fruit.

There are many possible causes for a low complement of seeds. Most apples require cross-pollenization for fruit set. Poor cross-pollination between cultivars can be caused by:

1. Cold weather.
2. Low bee activity.
3. Inadequate pollen source.

Fruits which are produced from bloom borne laterally off the previous season’s growth are inferior. Adequate chemical or hand thinning should remove such fruit. Weak fruit can also develop from side bloom in a flower cluster borne on a spur. Since fruit that hangs freely from the spur is likely to be well formed, shape is affected by pruning and limb position as well.

**Fruit Russet**

There is limited tolerance for fruit russet, particularly with yellow or green-colored cultivars. With less red, russet is more obvious. The location and characteristics of the russet can be indicators of the cause.

A common cause of russet is a fungus disease called powdery mildew. It infects developing blossoms and fruit early in the season, causing russet in the stem and/or basin of the fruit. Later infections can cause a net-like russet over much of the fruit. Cold weather and frost at blossom time can also cause fruit russet.

Russetting may occur from spray injury. It can occur through the misapplication of chemicals just before or during hot weather. Some chemicals, when applied under slow drying conditions, can also cause russetting. Sprayers operated with high air velocities can severely injure fruit located too close to the sprayer.
Bruising
Probably no single factor causes greater crop loss than bruised fruit. In determining the cause of bruising, a distinction needs to be made between major and minor bruising. Major bruising causes the cells to crush. This not only causes a change in shape but results in a browning of the tissue. Minor bruising should not be confused with the size of the bruise. Rather it is a condition. The cells under the skin are displaced—disrupted but not crushed. They may become discolored, but sometimes clear over time.

Major bruising can be classified as large and small. Large bruises result from dropping fruit, most often into the picking bag and from the picking bag into the bin. This type of bruise is prevented only by careful supervision.

Small bruises of the major type can arise from:
1. Pressure of one fruit against another.
2. Pickers harvesting more than one fruit at a time.
3. Rough handling of bins of fruit in the orchard.
4. Rough-riding trailers hauling fruit to the warehouse. The road surface and suspension of the trucks and trailers can be critical.

Bitter-Pit
Bitter-pit is a physiological disorder of apples associated with low calcium in the fruit. It is associated with high tree vigor, excessive shoot growth, light fruit set, and moisture stress from high summer temperatures.

The incidence of bitter-pit can be reduced by a series of calcium sprays during the growing season and prompt cooling of fruit after harvest. Susceptibility to this disorder is reduced by cultural practices which increase spur development and fruit set. These practices include reduced pruning, reduced quantities of nitrogen, and more limb spreading.

Water Core
This is a common physiological disorder of Red Delicious, Winesap, and some other cultivars. The incidence of water core varies from season to season and is associated with warm days and cold nights at harvest time and/or overmaturity. Harvest as soon as the first symptoms are observed to minimize severity. Fruit with severe water core often breaks down in storage. The existence of water core in a crop shortens storage life.
SUMMARY

Orchards are composed of mixed plantings which vary in age and condition. Market returns are rarely equal to expectations. Invariably returns represent a lower grade and packout than desired.

Packout records provide valuable data to evaluate plantings, cultivars, and production practices. Almost all of the various measures used in sorting and grading fruit can be related back to cultural practices such as pruning, thinning, pest and disease control, or management of harvest operations.

Careful analysis of packout records can help explain problems that exist in the orchard. These are not always problems of low production, grade, fruit size, and cullage. Even high producing plantings and cultivars with high packout rates can be improved in their performance and returns. Careful review and interpretation can show where, what, and to what degree these problems deserve review.

The effectiveness of packout record analysis is improved substantially when applied to individual blocks. Packout record evaluation on a whole-orchard basis can only indicate what is wrong. It provides no information about where the problem occurs. Once the location of the problem is identified, calculation of enterprise costs and the loss in returns caused by the problem will provide information on the extent of the change in production practices desired.
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