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Red Delicious Cullage, Color, and Size: What They Mean To an Apple Grower's Returns

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RED DELICIOUS CULLAGE, COLOR, AND SIZE: WHAT THEY MEAN TO AN APPLE GROWER'S RETURNS

By

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INTRODUCTION

With prospects of a rapidly increasing apple crop over the next several years, growers will need to become more sensitive to all factors that directly affect returns. This bulletin is designed to show the effects of cullage, color, and size on an apple grower's returns. Further, suggestions are offered as to the value gained by improving each of these factors.

Growers certainly know the direction of the economic effects of cullage, color, and size. Too often, however, the magnitude of these effects is left uncalculated.

The economic effects provided here are approximations to the actual effects on apple growers. Growers are encouraged to perform the same analysis on their own packout records. Variations in age of orchard and strain or variety of apple will lead to different rules of thumb.

We will also show that a trade-off exists between yield and cullage, yield and color, yield and size, and color and size. These comparisons are made to further show the effects of color, cullage, and size. This discussion is not meant to encourage growers to reduce yield. Growers with high yields, good color and size, and low cullage will certainly generate substantial receipts from the packinghouse. The purpose of the comparisons with yield is meant to show that some loss of yield to enhance color, size, or cullage may increase returns. Further, it shows that emphasis on yield to the detriment of color, cullage, or size will likely reduce grower returns.

Given the "rules of thumb" provided in our discussion, growers will be able to better evaluate their cultural practices in terms of returns as well as costs.

All examples and data in this publication are based on Red Delicious packout records and prices. The discerning grower or fieldman can perform the same analysis for other apple varieties.

CULLAGE

Cullage influences grower returns through its effect on the number of packed boxes per acre of production. The amount of the effect in terms of grower returns is best described through an example.

Table 1 shows two orchard blocks, Block A and Block B. Each block has a per-acre production of 1,000 field boxes. Block A produces a crop with lower cullage; 67.5% of its production grades Extra Fancy, 22.5% grades Fancy, and the remaining 10% are culls. Block B, on the other hand, has only 52.5% Extra Fancy and 17.5% Fancy. Thirty percent of Block B's fruit is culled.

Table 1: Cullage and Packout Percentages.

	Block A		Block B	
	Percent Packout	Percent of Production	Percent Packout	Percent of Production
Extra Fancy	75	67.5	75	52.5
Fancy	25	22.5	25	17.5
Culls				
TOTAL	100	100	100	100

Note also in Table 1 that both Block A and Block B have the same percent packout. In other words, both blocks have 75% of the packed fruit grading Extra Fancy; yet, only about half of Block B's total production falls into that category whereas over two-thirds of Block A's fruit grades out Extra Fancy.

Table 2 shows the net return to Block A and Block B given the packout percentages in Table 1. Since Block A has lower cullage, its production per acre results in an additional 125 packs of Extra Fancy fruit and 42 additional packs of fancy grade fruit above Block B's production. Block B has 7,000 more pounds of culls than Block A. Using prices taken from February, 1981, we calculated the returns shown in Table 2, assuming the same size distribution for both growers.[1/]

Multiplying through and adding those results, we get the gross returns to each block. Receipts from Block A are $6,399 while Block B receives $5,208. These are FOB returns. Adjusting for packing charges, Block A nets (receives from the packinghouse) $3,184, whereas Block B nets $2,677. Packing charges are based on $20 per bin incharge plus $3.22 per packed box of fruit. The net difference in this example between the two orchard blocks is about $653.

1/ All prices used here have been taken from Washington Grower's Clearinghouse bulletins, Washington Grower's Clearinghouse Association, Inc., P.O. Box 2207, Wenatchee, Washington.

Table 2: Estimates of the Effects of Cullage on Returns, 1980 Crop.[a/]

Block A	
563 packs XF @ $8.89	$5,005.07
187 packs F @ $6.89	1,288.43
3,500 lbs. culls @ 3¢	105.00
Gross	6,398.50
Packing Costs[b/]	3,215.00
Table 1: Cullage and Packout Percentages (cont'd).	
Net to Block A	$3,183.50

Block B	
438 packs XF @ $8.89	$3,893.82
145 packs F @ $6.89	999.05
10,500 lbs. culls @ 3¢	315.00
Gross	5,207.87
Packing Costs	2,677.26
Net to Block B	$2,530.61

Difference per Acre: $652.89
Each Percentage Point Decline is Worth $33

[a/] Assumes yield of 1,000 field boxes. February 1981 prices.
[b/] $20 per bin incharge plus $3.22 per packed box.

Since there is a 20 percentage point difference in cullage between Block A and Block B, we can divide the difference per acre by 20 to determine the average value of each percentage point (abbreviated hereafter as VPP). As indicated in Table 2, each percentage point decline in cullage is worth about $33. Therefore, given prices from February, 1981, a grower who is able to reduce cullage by 5 percentage points would realize an additional $165 per acre. That represents the amount of money that the grower could afford to spend to reduce the cullage rate and be no worse off than before.

Since conditions change from year to year, it is also of value to utilize prices from different years. Table 3 shows the effect that cullage has on returns, given prices quoted on January 26, 1982. The only difference between Table 2 and Table 3 is that prices have changed. With the new prices, Block A receipts are $7,186 while Block B receipts are $5,976 per acre. After deducting packing costs, Block A nets $3,596 per acre, whereas Block B is netting $3,007 per acre, a difference of $589. Therefore, each percentage point decline is worth about $29 given January, 1982 prices and an average yield of 1,000 field boxes per acre.

Table 3: An Estimate of the Effects of Cullage on Returns, 1981 Crop.

Block A	
563 packs XF @ $9.69	$5,455.46
187 packs F @ $8.32	1,555.84
3,500 lbs. culls @ 5¢	175.00
Gross	$7,186.31
Packing Costs[b/]	3,590.00
Net to Block A	$3,596.31
Block B	
438 packs XF @ $9.69	$4,244.22
145 packs F @ $8.32	1,206.40
10,500 lbs. culls @ 5¢	525.00
Gross	$5,975.62
Packing Costs	2,968.76
Net to Block B	$3,006.86

Difference per Acre: $589.45
Each Percentage Point Decline is Worth $29

a/ Assumes yield of 1,000 field boxes, January, 1982 price.
b/ $20 per bin incharge plus $3.72 per packed box.

Since yield also affects the VPP of cullage, we calculated net returns for each block at three different yield levels. Table 4 shows the effect for the February, 1981 prices. At 750 field boxes per acre, Block A nets $489 per acre more than Block B. The average VPP of cullage at 750 field boxes is $24.

At 1,000 field boxes, there is a $653 per acre difference and $33 VPP of cullage. For 1,250 boxes per acre, the difference is $817 and the average VPP of cullage is $41.

Table 4: Net Returns per Acre Using February, 1981 Prices.

Yield	Block A	Block B	Difference	VPP of Cullage
Field Boxes	$	$	$	$
750	2,389	1,900	489	24
1,000	3,184	2,531	653	33
1,250	3,980	3,163	817	41

Yield Effect on VPP of Cullage

Note that as yield increases, the VPP increases. The increase in VPP is about $3 for every 100 field boxes of yield so that the average VPP for a yield of 850 field boxes would be about $27 per percentage point. At a yield of 650 field boxes per acre, the average VPP of cullage is about $21. At 1,100 field boxes per acre, the average VPP would be about $36. With this information and knowledge of his yield, a grower could quickly calculate a rough estimate of what he would have gained through increased returns had he been able to reduce his cullage rate for the 1980 crop.

Table 5 contains the same information as Table 4, using prices taken from January, 1981. Note that although prices were higher across the board in 1982 compared to 1981, the actual differences are somewhat less. But the average VPP is about the same for both years at the different yields. Here again, a grower with an 850-box yield could figure that each percentage point reduction in cullage would be worth about $25.

Table 5: Net Returns per Acre Using January, 1982 Prices

Yield	Block A	Block B	Difference	VPP of Cullage
Field Boxes	$	$	$	$
750	2,699	2,258	441	22
1,000	3,596	3,007	589	29
1,250	4,497	3,759	738	37

The $3 change in VPP for every hundred field boxes of yield seems to hold for both years. It appears that as long as prices do not differ too widely from those of 1981 and 1982, a reasonable approximation for evaluating effects of cullage would be to use a 1,000-field-box yield as the starting point and a $30 VPP. Then a grower with 600 field boxes per acre would receive an additional $18 for each percentage point reduction in cullage. This grower would receive an additional $90 per acre if he could reduce his cullage by 5 percentage points. (See Table 6 for average figures at different levels of production.) The following example shows the calculations to get the VPP of $18.

Example: Calculating value per percentage point of cullage.

Yield: 600 boxes

Base Yield:	1,000
Actual Yield:	600
Difference:	400

Difference in Hundreds of Boxes:	4
Times Changes in Value/100 Boxes:	$ 3
Total Effect of 400 Boxes	$12

Example (continued):

Base Value	$30
Less Effect of Yield	$12
Value/Percentage Point of Cullage at 600 Boxes/Ac.	$18

Table 6: Economic Value of Cullage at Different Yield Levels.

Yield/Ac.	VPP of Cullage
	$
600	18
700	21
800	24
900	27
1,000	30
1,100	33
1,200	36
1,300	39
1,400	42
1,500	45

While many growers will likely do much better than 30% cullage, there are a significant number who, for one reason or another, do have cullage rates this high. The effects of cullage on net returns from 30 acres of Red Delicious for the 1981 prices range from $14,670 to $24,510 depending upon yield. Using the 1982 prices, the range of differences was $13,230 to $22,140 on a 30-acre orchard. This represents the total amount of money that could be spent to reduce cullage in Block B to an overall rate of 10% and be no worse off than at 30% cullage. Table 7 shows the difference in returns.

Table 7: Difference in Returns Between Block A and Block B from 30 Acres Caused by High Cullage.

Yield	Feb. 1981 Prices	Jan. 1982 Prices
Field Boxes	$	$
750	14,670	13,230
1,000	19,590	17,670
1,250	24,510	22,140

Cullage vs. Yield

Another way to look at cullage is to estimate the amount of yield per acre that one can afford to give up to reduce that cullage and still have the same level of income. Figure 1 provides two such estimates using the February, 1981 prices. The line labeled Block A in Figure 1 shows the amount of production needed to generate a given level of net returns per acre. Block B's line compares its production to net returns per acre. Block A with 10% cullage and 750 boxes of yield per acre receives approximately $2,400. To achieve that same level of income, Block B, with 30% cullage, must produce 962 field boxes per acre, a difference of 212 boxes. Therefore, Block B could be thinned an additional 194 field boxes of production per acre to reduce cullage and still generate the same income as Block A with its 10% cullage. On the average, this works out to be approximately 10 field boxes of production per acre for each percent of cullage.

The dotted lines in Figure 1 are positioned to represent total economic production costs of $3,500 per acre.[2/] To cover these costs, Block A must produce about 1,009 field boxes per acre. To achieve the same level of income, Block B must produce 1,383 field boxes per acre. Block B must have another 284 field boxes per acre to get the same returns as Block A with its 10% cullage. At this yield level, the trade-off between yield and percent cullage is approximately 14 field boxes for each percentage point.

Using prices from January, 1982, the relationship is somewhat different. Figure 2 provides those relationships. The lines in Figure 2 have the same meaning as Figure 1. At 750 field boxes per acre, Block A is generating approximately $2,700 per acre while Block B, to achieve the same level of income, must produce 898 field boxes per acre, a difference of 184 boxes. On the average, this is about 7.5 field boxes per percentage point. Using $3,600 as the total economic production costs, Block A needs production of 1,000 field boxes per acre, whereas Block B needs 1,197 field boxes. This is a difference of 197 field boxes, an average per percentage point of about 10 field boxes. While the differences are not as large for the 1981 crop, substantially more yield is still required from Block B at 30% cullage to achieve the same income levels as Block A at 10% cullage.

Summary

While it is difficult to say precisely what the effect may be, it does appear that, given the prices existing in February, 1981 and January, 1982 for culls as well as fresh market fruit, and a 1,000 field box yield, a reasonable VPP of cullage is $30.

[2/] Axford, Martin, et al. 1979 Apple Enterprise Budget for North Central Washington. EM 4499. September, 1979. Cooperative Extension, Washington State University, Pullman, Washington.

The cost figures were rounded upward to adjust for cost changes that have occurred since then.

Figure 1

Relationship Between Cullage and Yield--1980 Crop

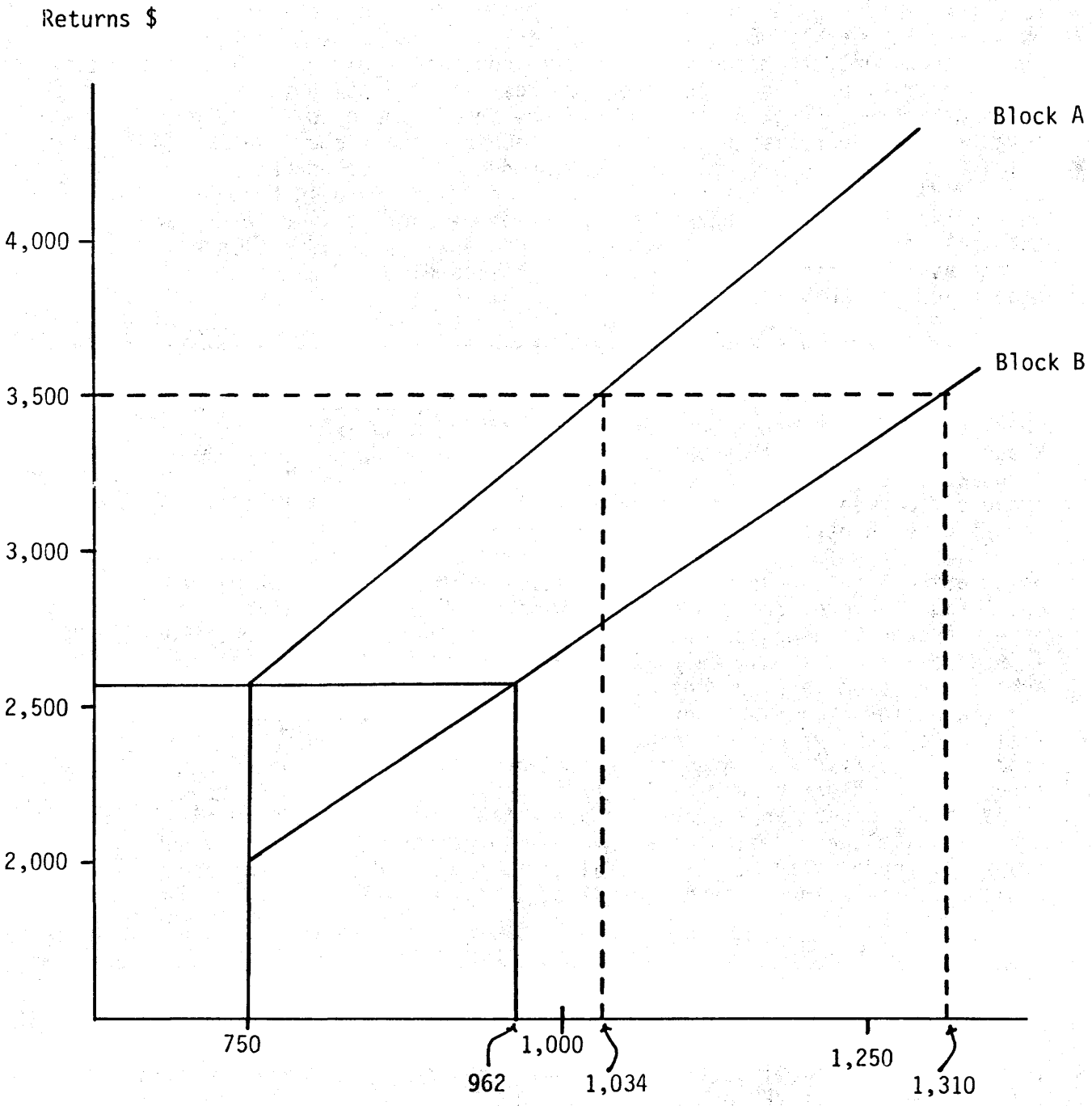
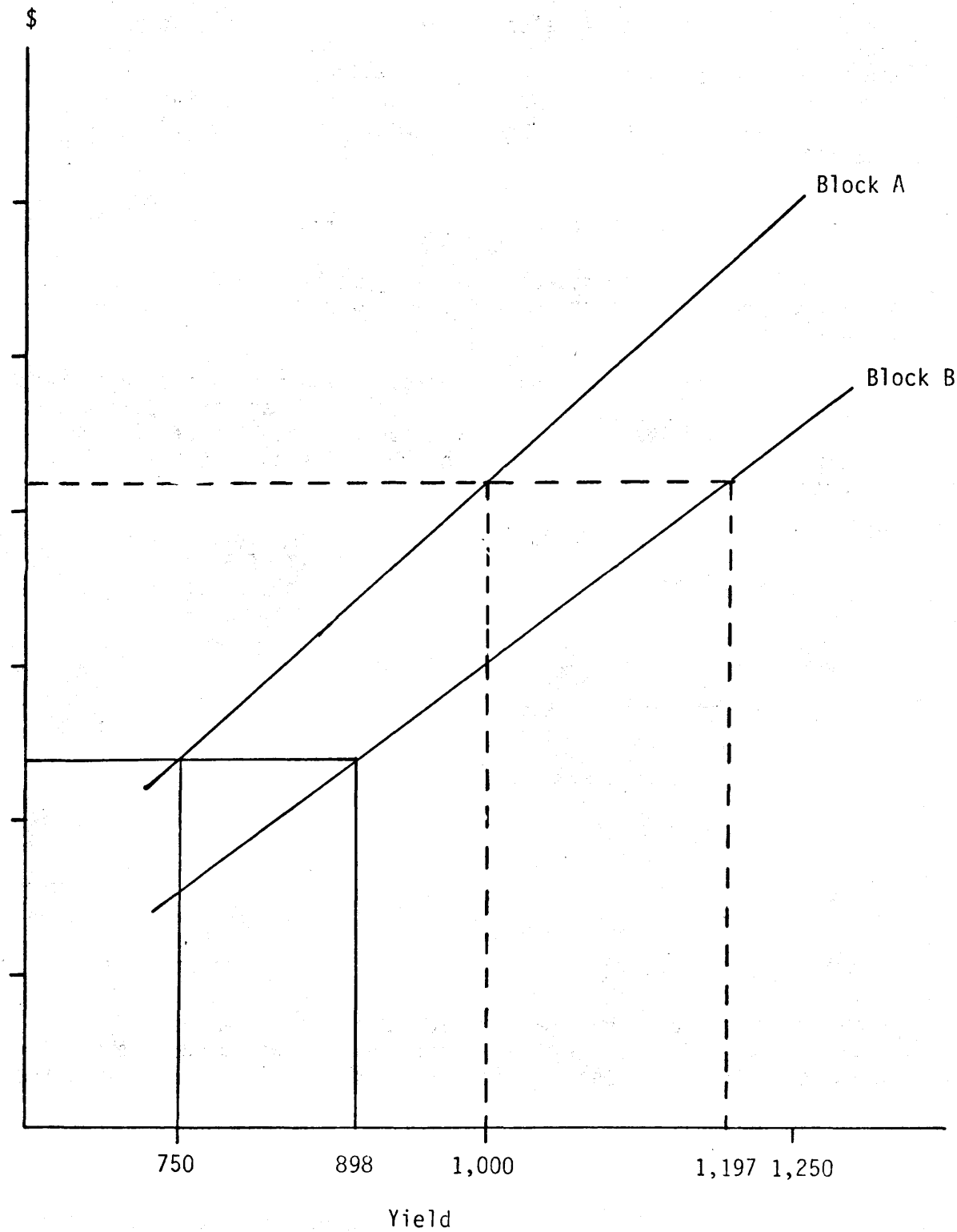


Figure 2
Relationship Between Cullage and Yield
January 1982 Prices



For each 100 field boxes of yield change from 1,000 field boxes, the average VPP changes by about $3. The VPP increases as yield increases and declines when yields decline.

In a very rough sense, it also appears that each one cent per pound increase in the price of culls seems to reduce the average VPP by $1 to $1.50. If the value of culls increased to 7¢ per pound from 5¢, the VPP would decline from $30 to $27 at a 1,000-box yield. Conversely, if the price of culls dropped to 3¢ per pound, the VPP at a 1,000-box yield would be $33.

EFFECT OF COLOR ON RETURNS

Growers have long recognized that having well-colored fruit enhances their returns. This section evaluates how much effect color has on grower receipts.

Table 8 again shows two orchard blocks. These blocks have different amounts of fruit in fresh market grade classifications. Cullage is held constant at 10%. Block A, in this example, has 60% of production grading Extra Fancy while Block B has 81%. At the same time, Block A produces 30% Fancy while Block B has only 9% Fancy fruit. The 21 percentage point difference between Block A and Block B in the Extra Fancy grade fruit is made up by Block A in Fancy grade fruit. In other words, all we have done is downgraded 21% of Block A's fruit from Extra Fancy and held the cullage of both blocks at 10%.

Table 8: Example Grades for Block A and Block B.

	Block A		Block B	
	Percent Packout	Percent of Production	Percent Packout	Percent of Production
Extra Fancy	67	60	90	81
Fancy	33	30	10	9
Culls		10		10
Total	100	100	100	100

Table 9 shows the prices received for the fruit from each block for each year. Here we use the same price base as was used in the cullage examples. The difference in the current discussion results from the fact that Block A has a lower percentage of Extra Fancy fruit. Both blocks have the same size distribution and same yield per acre as well as the same cullage.

Table 9: FOB and Cull Prices.

	Block A	Block B
1982		
Average price/packed box	$ 8.60	$ 9.09
Culls--$/ton	60.00	60.00
1981		
Average price/packed box	$ 10.54	$ 10.90
Culls--$/ton	100.00	100.00

The VPP for Extra Fancy Fruit, 1980 Crop

Table 10 shows the effects of color on returns to the blocks using the prices from February, 1981. These returns have had packinghouse charges deducted. These charges include a $20 bin charge plus $3.22 per packed box for packing. We can see the net returns to the grower at each level of yield.

The right-hand column in Table 10 shows the difference between the two blocks on a per-acre basis. In this case, the VPP for each additional point of Extra Fancy fruit ranges from $13 to $22. In other words, the difference in returns between Block A and Block B at 750 field boxes caused by the 21 percentage point difference in Extra Fancy fruit gives an average VPP of approximately $13.

Table 10: Effect of Color on Net Returns per Acre--February, 1981, Prices.

Yield	Block A	Block B	Difference
Field Boxes	$	$	$
750	2,507	2,784	277
1,000	3,340	3,708	368
1,250	4,178	4,637	459

Value per Percentage Point Ranges from $13 to $22.

The dollar amounts in the difference column in Table 10 represent the amount the grower would receive if he could increase the amount of Extra Fancy fruit produced by 21 percentage points. In other words, at a 1,000 field box yield, Block A would receive an additional $368 per acre if the amount of Extra Fancy fruit increased from 60% to 81%. The owner of Block A could spend up to $368 per acre to get that increase in Extra Fancy fruit.

Yield and VPP of Extra Fancy Fruit, 1980 Crop

The effect of color on returns changes as yield changes. Based on Table 10, the difference in returns between Block A and Block B increases about $36 for every 100-box increase in yield. At 1,100 field boxes per acre, Block B receives $404 per acre more than Block A. At 900 field boxes per acre, the difference would be $332 ($368 - $36).

The $36 per 100 box change in yield is based on the 21 percentage point difference in Extra Fancy fruit. On a percentage point basis, the average VPP is about $18 at a 1,000-field-box yield ($368 ÷ 21).

As yield changes by 100 boxes, the VPP of Extra Fancy fruit changes about $2.00 so that for 900 field boxes per acre the average VPP would be $18 - $2.00, or $16.00. At 1,100 boxes per acre, the average VPP of Extra Fancy fruit would be about $20.00.

The following example will show how growers can use this information. A grower produces 800 boxes per acre and 65% of this fruit grades Extra Fancy. What would he gain by increasing his percentage of Extra Fancy from 65% to 75%. At 800 field boxes per acre, the average VPP is $14.00 ($18.00 - $4.00). Increasing the amount of Extra Fancy fruit 10% will increase his per-acre returns by $140 (10 x $14.00). (The appropriate percentage to use in making this calculation is the percent of total production that grades Extra Fancy.)

VPP of Extra Fancy Fruit, 1981 Crop

Table 11 provides the same set of estimates using prices from January 1982. Note that the difference in the effect of color on the 1981 crop is less than for the 1980 crop. In this case, the average VPP has declined by $3 to $6, depending upon the level of production. However, it is still possible to make the same analysis as for the 1980 crop.

In the 1981 crop, the average VPP at 1,000 field boxes is approximately $13.00. Yield per acre changes the VPP at a rate of about $1. At a 900-box yield, the average VPP point is approximately $12.00. At 800 field boxes per acre, it would be approximately $11.00.

While these are rough estimates, they still are useful as a guide for evaluating the effect that color can have on returns. So, if a grower wants to increase the percent of his total production that grades extra fancy by 5 percentage points, we could argue that the increase of 5 percentage points in color is worth approximately $65 per acre to the grower at 1,000 field boxes per acre.

Table 11: Effect of Color on Net Returns per Acre--January, 1982 Prices.

Yield	Block A	Block B	Difference
Field Boxes	$	$	$
750	3,371	3,574	203
1,000	4,490	4,760	270
1,250	5,616	5,954	338

Value per Percentage Point Ranges from $10 to $16.

Economic Effects from 30 Acres

Table 12 shows the effect of color as it is averaged across a 30-acre block. Using February, 1981 prices, the difference for the blocks ranges from approximately $8,310 to almost $14,000, depending on yield. For the 1981 crop (January, 1982 prices), the difference ranges from $6,100 to approximately $10,000. These figures represent the maximum amount of money that could be spent to increase the amount of Extra Fancy fruit from 60% of total production to 81% in Block A and still be no worse off than at the 60% level. To the extent that the increase in Extra Fancy fruit is achieved for less than the expected increase in returns the grower is increasing returns more than costs.

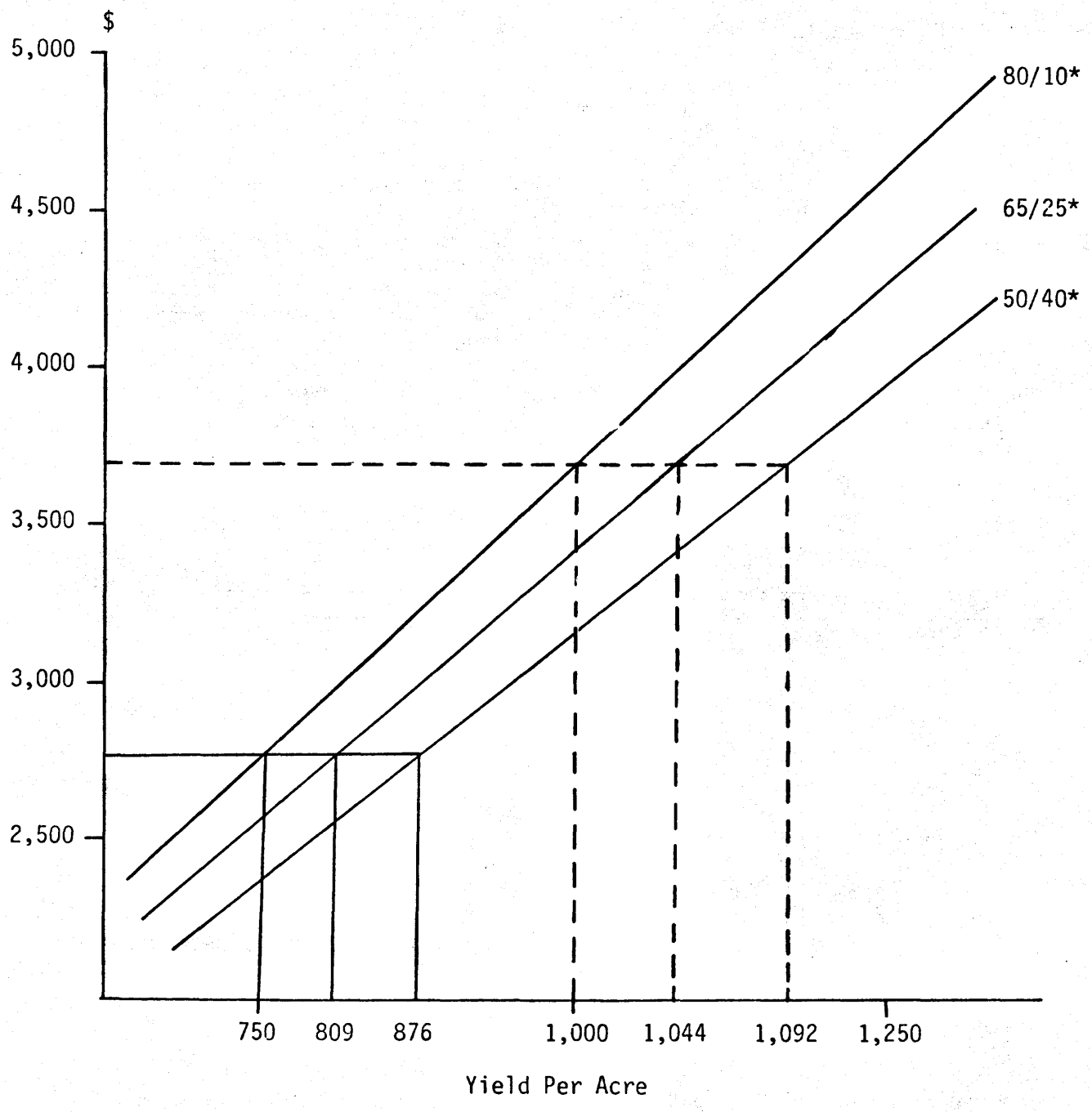
Table 12: Difference in Returns from Block A and Block B Assuming 30 Acres Each.

Yield	1981	1982
Field Boxes	$	$
750	8,310	6,090
1,000	11,040	8,100
1,250	13,770	10,140

The Trade-Off Between Color and Yield

As in the analysis of cullage, we can look at the trade-off between color and yield. Figure 3 shows that comparison using the February, 1981 prices. A grower who has 80% Extra Fancy, 10% Fancy (represented by the 80/10 curve in Figure 3), and 10% culls receives about $2,770 when his orchard yields 750 field boxes per acre. As the amount of Extra Fancy fruit declines, yield must increase to offset the loss of color. Given 65% of total production grading Extra Fancy and 25% Fancy (65/25 curve), holding cullage constant at 10%, 809 field boxes are required to generate grower returns of $2,770. This is a difference of 59 field boxes per acre, or looking at it another way, an average of about 4 field boxes (59 divided by 15) per percentage point of Extra Fancy fruit.

Figure 3
Relationship Between Color and Yield
February 1981 Prices



*Percent of extra fancy fruit/percent of fancy fruit. Based on total production per acre. Cullage held constant at 10 percent.

If only 50% of the total production per acre is Extra Fancy and 40% is Fancy, a grower needs 876 field boxes to generate returns of $2,770, a difference of 126 field boxes per acre. The trade-off between the 80/10 and the 50/40 in terms of field boxes is over 4 field boxes per percentage point. In other words, a grower with 50% of his total production grading Extra Fancy and 40% Fancy could afford to give up 4 field boxes of production per acre for each percentage point increase in the amount of Extra Fancy fruit.

Figure 4 makes the same comparison as Figure 3 using prices from January, 1982. Going from 80/10 (85% XF and 10% F) Fancy to 65/25 requires an additional 33 boxes per acre to maintain the same level of net receipts to the grower at the 750-box yield. In this case, the trade-off between yield and color is about 2 field boxes per percentage point.

For the grower who has 50% of his total production per acre grading Extra Fancy and 40% Fancy, the additional production needed to maintain the same level of income is 69 field boxes per acre for a total of 819 field boxes, or an average of 2.5 field boxes per percentage point of Fancy fruit. Note that the differences for the January, 1982 prices are narrower than from the January, 1981 prices. This indicates a smaller price differential for color for the 1981 crop compared to the 1980 crop.

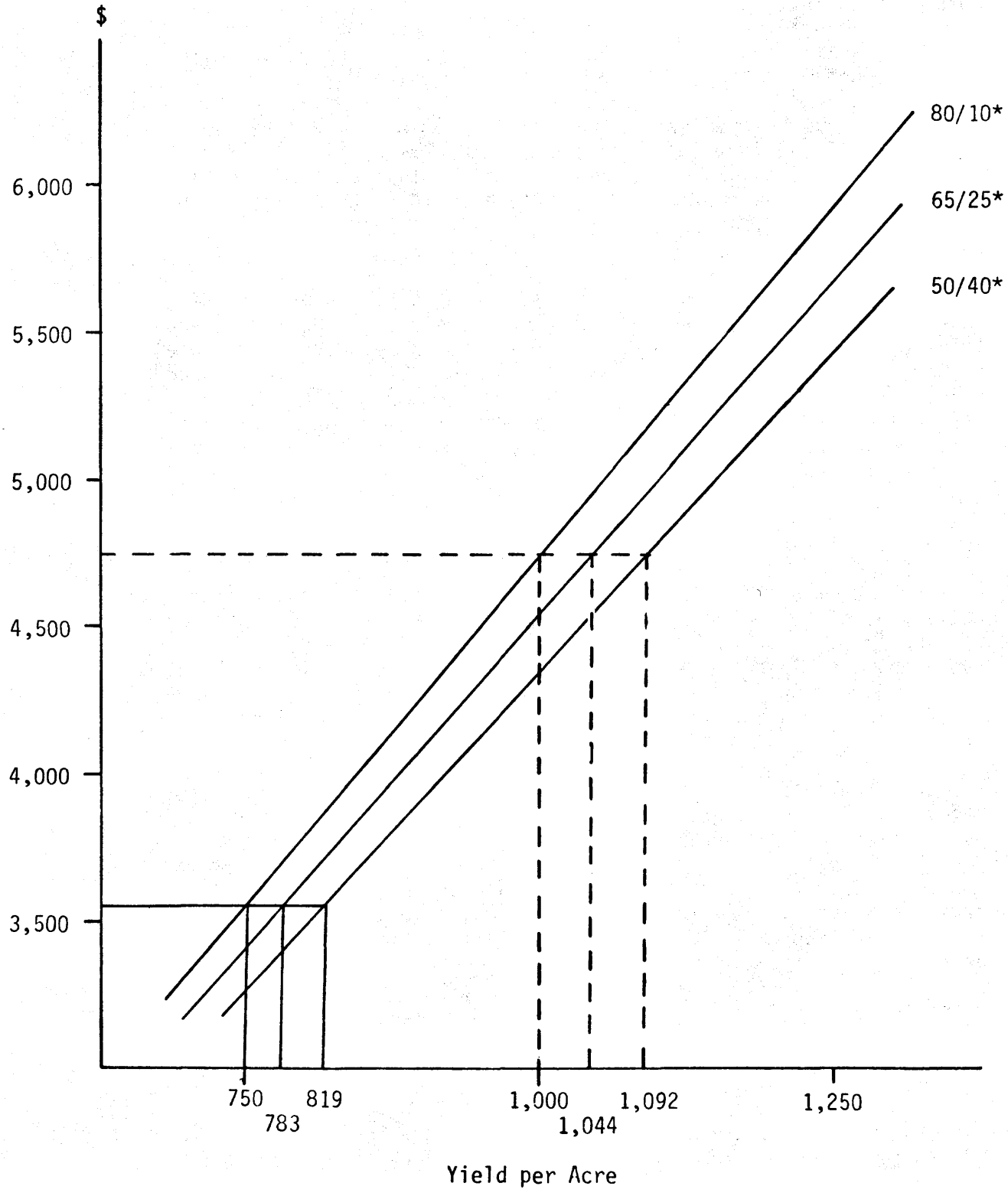
Summary

As a rule of thumb then, it seems that each percentage point change in the amount of total production that grades Extra Fancy is worth about $13 per point at a 1,000-field-box yield. The average VPP of Extra Fancy changes approximately $1 for each 100-box change in the level of yield. Comparing yield and color, the trade-off appears to be about 3 field boxes per acre for each percentage point change of Extra Fancy fruit produced.

The grower who is in a position to increase the percentage of Extra Fancy fruit can use the rule of thumb to determine the increase in returns he might reasonably expect from increasing expenditures on appropriate production activities. For example, a grower estimates that more extensive pruning would increase the amount of Extra Fancy fruit by 8% or 9% (remember that we are looking at total production rather than fresh production; i.e., percent packout). The grower also estimates that the increased pruning will cost another $30 per acre above what he normally spends. Using a VPP of Extra Fancy of $13 means that his returns will increase $104 to $117 per acre. In this case the grower would earn $74 to $87 per acre from the increased pruning.

In practice, many factors affect color. However, as long as the grower can estimate costs and produce the change in Extra Fancy fruit, he can calculate an estimate of the effect of any change in adjusted returns (increased returns less increased costs).

Figure 4
Relationship Between Color and Yield
January 1982 Prices



*Percent of extra fancy fruit/percent of fancy fruit. Based on total production per acre. Cullage held constant at 10 percent.

SIZE

Size is becoming an increasingly important element in the pricing of Red Delicious apples. Pricing for the 1981 crop ranged anywhere from $6 to $7 FOB per packed box for size 138 and smaller to $20 or more for size 72s and larger. This wide range of prices caused by size has a substantial impact on grower returns. Taking the same Block A and Block B and adding a third block, we have 3 blocks with the fruit size distributions shown in Table 13. Block A has by far the poorest distribution of size. Its fruit peaks on 125s and almost 75% of the fruit is 125s and smaller.

Table 13: Fruit Size Distributions.

	Block A	Block B	Block C
	$	$	$
71s/lgr.	0.1	2.0	3.4
80/88	5.1	13.5	19.3
100	9.1	16.8	22.4
113	16.1	21.0	20.6
125	25.3	16.1	15.4
138	24.0	16.5	9.8
150s/sml.	20.3	14.1	9.1

Block B is somewhat better. Fruit from that block peaks on size 113. However, it still has a tendency to have a substantial amount of small fruit. Nearly 47% of the fruit are size 125 or smaller.

Block C, on the other hand, approaches the size distribution guidelines that have been suggested elsewhere.[3/] Block C fruit peaks on 100s and only has 34% 125s and smaller. On the other hand, Block C has over 22% of the fruit in size 88s and larger. While even Block C does not meet the suggested size standards, its crop has much more fruit in the size categories that receive the highest prices than either Block A or Block B.

Table 14 shows the FOB packed box returns for fruit from the three blocks. These prices are adjusted for both size and grade. All three blocks have the same percent Extra Fancy and the same level of cullage so that the only thing that changes is the difference in size as we go

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3/ See, for example, Bartram, Dick, "Panel-Growing Red Delicious Apples of the Desired Size and Shape in Washington." Proceedings, 1981. Washington State Horticultural Association, pp. 32-36, or Schotzko, R. T., and R. B. Tukey, Using Packinghouse Records to Evaluate Your Orchard's Financial Performance, CES, Washington State University, EB 1217, 1983.

from Block A to Block B to Block C. Each block has 72% Extra Fancy, 18% Fancy, and 10% Culls. The prices used in the color and cullage discussions are used here also.

Table 14: FOB Packed Box Returns.[a/]

	Block A	Block B	Block C
	$	$	$
February, 1981	8.30	8.75	9.05
January, 1982	9.54	10.74	11.63

a/ Adjusted for size and grade.

Note that in February 1981, (the 1980 crop had a relatively good size) there is only about a 75¢ per packed box difference between Block A and Block C while for the 1981 crop, which tended to be somewhat smaller, there is a $2.09 per packed box FOB price difference between Block A and Block C. These are average differences and are caused by the fact that Block C produces substantially more fruit in the larger size categories.

Estimating the total returns per acre at different yields and subtracting the packinghouse charges for 1980, again using the $20 per bin incharge plus the $3.22 per packed box packing charge, we get the grower receipts from each block at different yield levels shown in Table 15. Given the prices from February, 1981, none of the three blocks earned enough to cover all economic production costs at a 750-box yield.[4/] Cash flow is covered and part of the return on investment, but certainly not all of it.

Table 15: Grower Receipts per Acre, February, 1981 Prices.[a/]

Yield	Block A	Block B	Block C
Field Boxes	$	$	$
750	2,339	2,592	2,761
1,000	3,115	3,453	3,678
1,250	3,896	4,318	4,600

a/ Based on fruit size distribution in Table 13.

4/ Cooperative Extension, Washington State University, periodically estimates and publishes apple production costs per acre. These studies include all economic costs of production. Copies of these studies can be obtained at the county offices of Cooperative Extension. Also see footnote 2.

Block B and Block C begin to cover all economic production costs at a 1,000-box yield. Block C is clearly profiting from producing good size. At the 1,250-box level, all three blocks are covering economic production costs plus earning a profit. Keep in mind that prices were low for the 1980 crop and many growers did not make a profit, but Table 15 should indicate that given a reasonable size distribution, a grower could still have made a profit even though prices were down.

Table 16 provides the same information as Table 14, but it is based on prices for January, 1982. Packing charges were increased by 50¢ per packed box to reflect the increase in packing costs between 1981 and 1982. At the prices shown earlier in Table 14, only Block A is not making a profit at the lowest yield. Block B and Block C are able to cover expenses, both cash and non-cash, and have good return on investment.

Table 16: Grower Receipts per Acre, January, 1982 prices.[a/]

Yield	Block A	Block B	Block C
Yield Boxes	$	$	$
750	2,808	3,484	3,985
1,000	3,740	4,640	5,308
1,250	4,678	5,804	6,638

[a/] Based on fruit size distributions in Table 13.

Table 17 shows the effect on grower receipts between the different blocks, each with 30 acres, given the prices from February, 1981. Just going from Block A which peaks on 125s to Block B which peaks on 113s, generates a substantial difference in returns. Increasing crop size by two peak sizes from 125s to 100s, has an even greater impact on the difference in returns with Block C receiving nearly $17,000 more at the 1,000-box level.

Table 17: Differences in Returns Caused by Size, Assuming 30-Acre Blocks, February, 1981 Prices.

Yield	A-B	A-C	B-C
Field Boxes	$	$	$
750	7,590	12,660	5,070
1,000	10,140	16,890	6,750
1,250	12,660	21,120	8,460

Table 18 shows those same differences using the prices from January, 1982. The effect of the small-sized crop is immediately obvious. Even at low yield levels, the difference between peaking on 125s and 110s is more than the amount of difference at 1,250 field boxes between Block A and Block C from the 1980 crop. At 1,250 boxes per acre, Block C nets from the packinghouse nearly $60,000 more than Block A. Even if the two years were averaged and compared to the effect of color in either year, it is obvious that size may now be a more important factor in determining grower returns than color.

Table 18: Difference in Returns Caused by Size, Assuming 30-Acre Blocks, January, 1982 Prices.

Yield	A-B	A-C	B-C
Field Boxes	$	$	$
750	20,280	35,310	15,030
1,000	27,000	47,040	20,040
1,250	33,780	58,800	25,020

Size vs. Yield

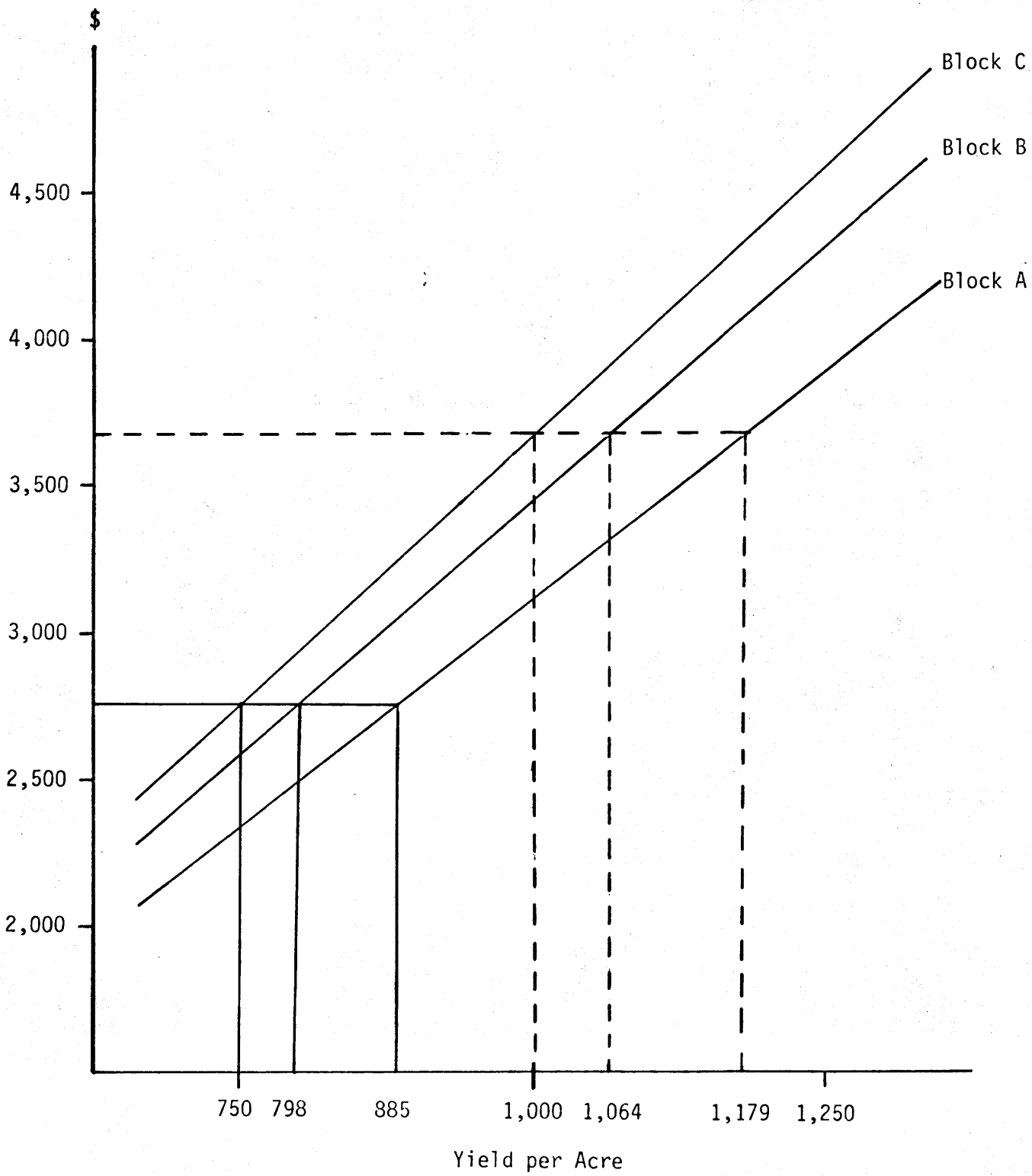
Figure 5 makes the comparison between size and yield among the three blocks. The curves in Figure 5 relate the yields each block must have to receive different levels of returns from the packinghouse. The curve labeled Block A is based on Block A's size distribution in Table 13 and the prices in Table 14. Block B's curve is based on its size distribution and prices from Tables 13 and 14, respectively. The same is true for Block C.

At a yield of 750-field-boxes per acre, Block C's returns are approximately $2,750 per acre using the February, 1981 prices. Block B, to generate that same level of receipts, must produce 798 boxes and Block A, 885 boxes. The difference between Block A and Block C is 135 field boxes per acre or over 5 bins. Block A can afford to give up 135 boxes of yield to get the better size distribution and achieve the same returns as Block C.

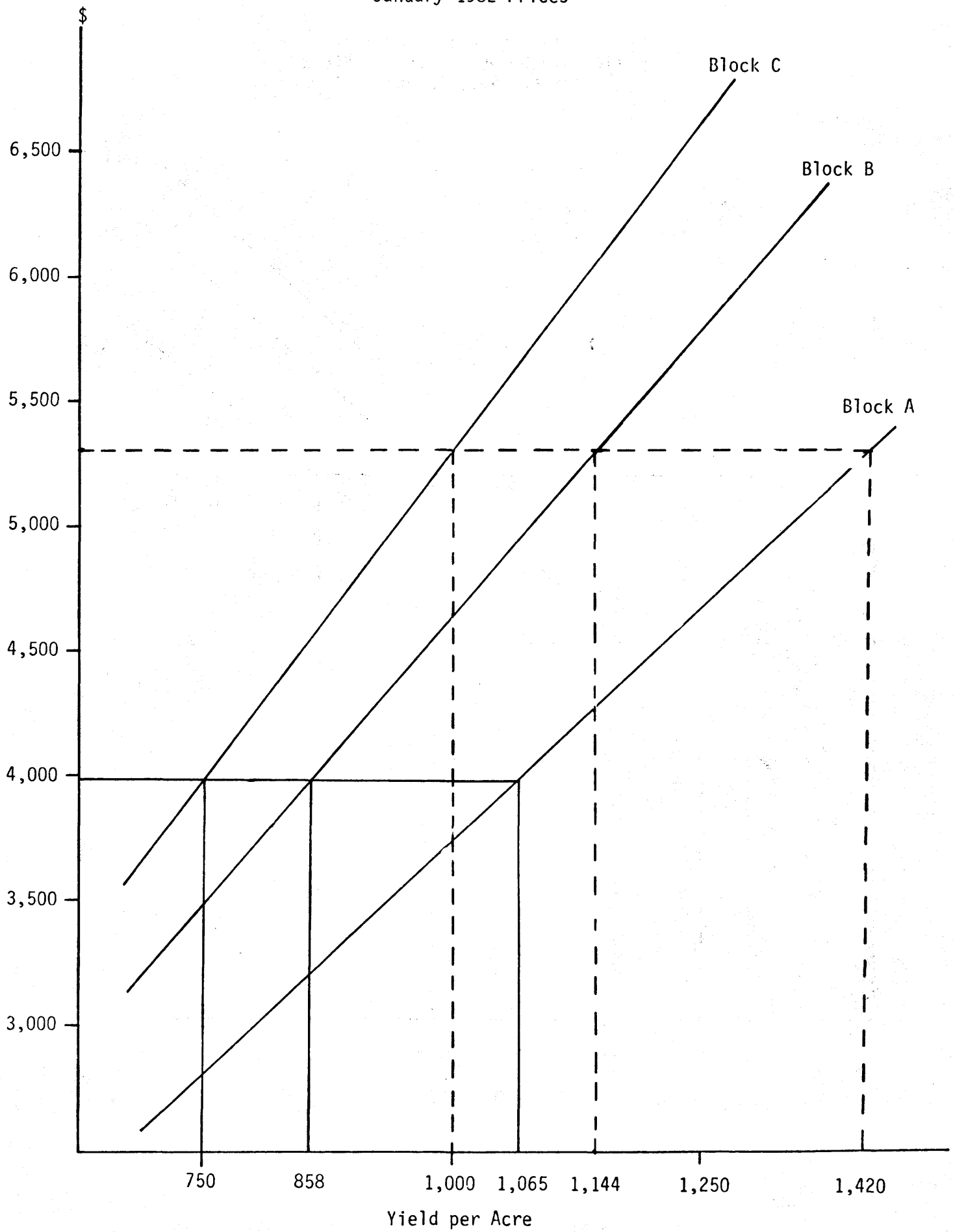
At 1,000 field boxes per acre, Block C is earning approximately $3,700 per acre. To achieve the same level of returns, Block B must produce 1,064 field boxes per acre and Block A, 1,179 field boxes per acre. In other words, Block A could afford to give up 179 field boxes of production per acre to get that size and still have the same returns as Block C--in this case, approximately 90 field boxes per one peak size.

The effect of size on the 1981 crop is much more dramatic than for the 1980 crop. Block C, at 750 field boxes per acre, is netting nearly $4,000 per acre and Block B, peaking on 113s, would need another 108 field boxes per acre or over 4 bins to get the same returns as Block C. Block A would need 315 field boxes per acre, or 12.5 bins to earn

Figure 5
Relationship Between Size and Yield
February 1981 Prices



Relationship Between Size and Yield
January 1982 Prices



as much as Block C at 750 field boxes per acre. In other words, given the difference in size distributions between Block C and Block A, Block A must produce 1,065 field boxes per acre to generate the same returns from the packinghouse that Block C gets with 750 field boxes per acre. These relationships are shown in Figure 6.

These relationships do not take into consideration the fact that Block A will have higher production expenses, if for no other reason than higher harvest costs. These differences in costs of production have not been taken into consideration. All we have noted here is the comparison of receipts from the packinghouse.

At a level of 1,000 field boxes of production, Block B needs nearly 6 bins additional production per acre to achieve the same level of receipts as Block C and Block A must have an additional 420 field boxes per acre, or nearly 17 bins to generate the same returns from the packinghouse.

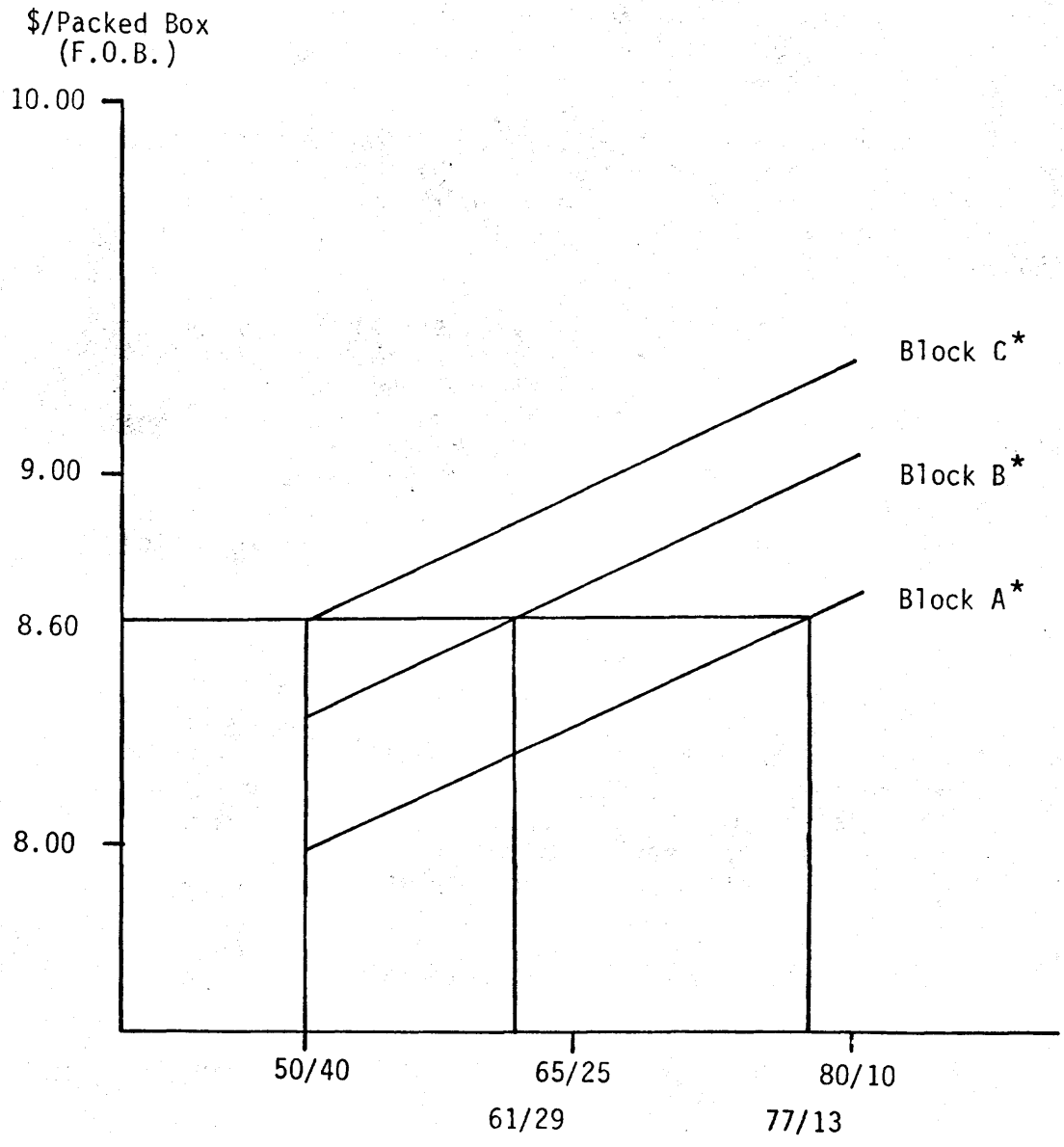
Obviously, the effect of size was somewhat exaggerated for the 1981 crop because of the small average fruit. However, these figures indicate that growers can afford to give up a significant amount of production per acre to increase size and be at least no worse off than they were before. In fact, if we take into consideration the reduced harvest costs, growers would likely be better off because of the reduced production costs and still have the same level of receipts, implying a better net return to the grower after deducting production expenses.

COMPARING SIZE TO COLOR

Up to this point, we have made comparisons between cullage and yield, color and yield, and size and yield. The purpose of these comparisons was to stress the economic value of each factor relative to yield. There is an economic balance within horticultural production guidelines. Stressing any one factor (color, size, cullage, yield) to the detriment of others will likely mean reduced returns for the grower.

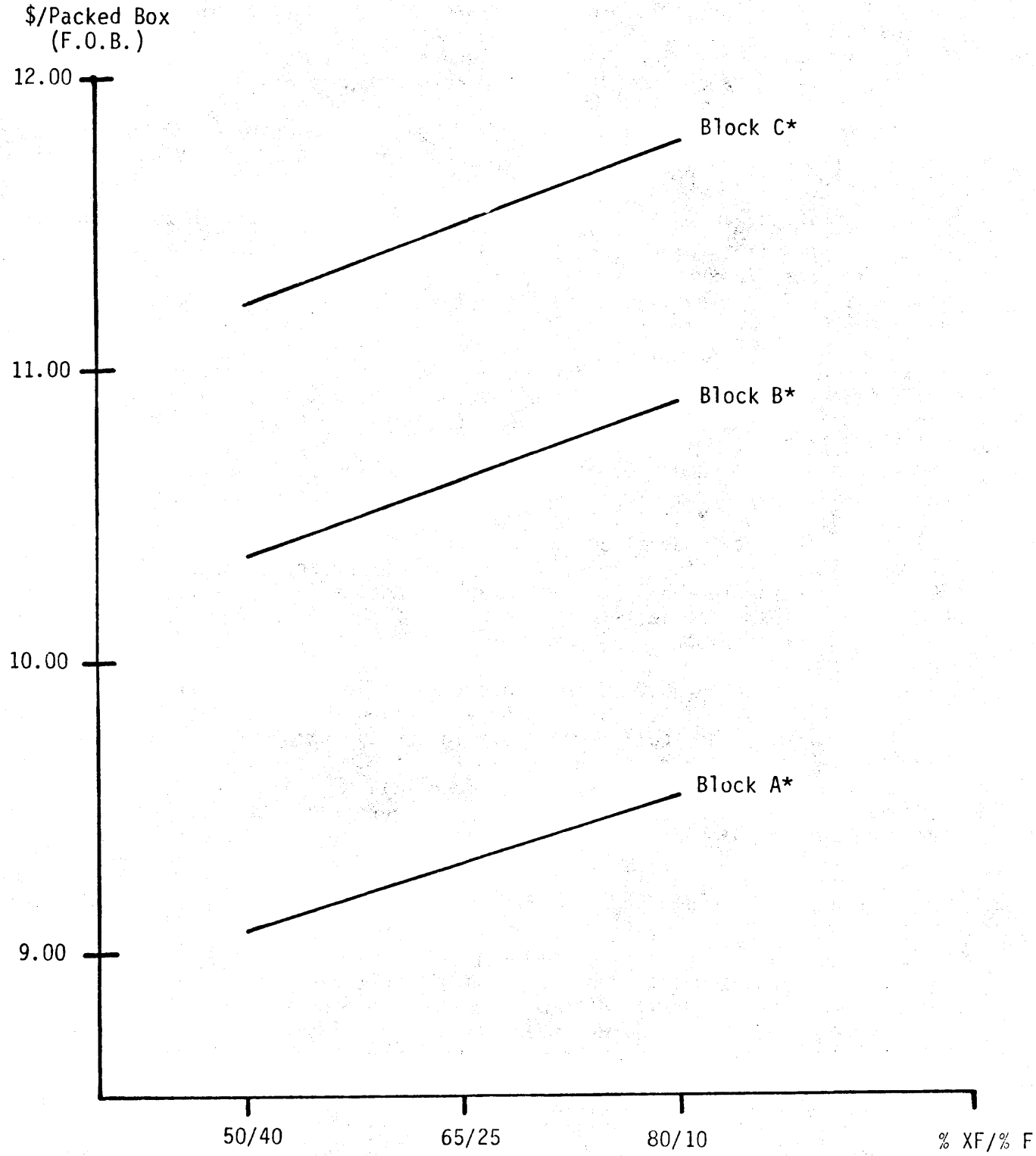
A similar analysis can be made of the economic tradeoff between color and size. To the extent that there is a tradeoff in horticultural practices as to their impact on size and color, there is value in looking at the economic tradeoff between size and color. Figure 7 shows that tradeoff. The vertical axis represents FOB price per packed box. The horizontal axis represents the proportion of yield that grades Extra Fancy. The numbers 50/40, 65/25, etc., indicate the percent of fruit grading Extra Fancy/Fancy. Yield has been held constant at 1,000 field boxes. Cullage is kept at 10% for each block. As we move along a given curve (Block C for example), we are relating the FOB returns associated with increasing color, given a constant size distribution. Each curve (Block A, Block B, and Block C) is based on the appropriately labeled size distribution in Table 13. Block A's curve is based on the size distribution peaking on 125s, Block B's curve on 113s, and Block C's curve on 100s.

Figure 7
1980 Comparison of Size and Color



*Block C's fruit peaks on 100s. Block B's on 113s, and Block A's on 125s. Cullage is set at 10 percent. Based on February, 1981 prices.

Figure 8: 1981 Comparison of Size and Color



*Block C's fruit peaks on 100s. Block B's on 113s and Block A's on 125s. Cullage is set at 10 percent. Based on February, 1981 prices.

Given Block A's size distribution (peaking on 125s) and 50% Extra Fancy fruit and 40% Fancy, the FOB returns per pack will be about $8.00. At 80% Extra Fancy, the FOB returns are $8.60.

We can use these curves to make comparisons among our three blocks. At 50% Extra Fancy and peaking on 100s, Block C's FOB returns are $8.60 per packed box. For Block B to generate the same FOB price, requires 61% Extra Fancy fruit, a difference of 11 percentage points.

Block A must have 77% Extra Fancy fruit to get an FOB price of $8.60. Block A must have over 50% more fruit grading Extra Fancy than Block C to generate the same FOB returns.

If we were to draw a horizontal line out from $9.00, we could determine the tradeoff between Block C and Block B. It would show the necessary increase in the percentage of Extra Fancy fruit needed from Block B to offset the impact that the larger sized fruit from Block C have on FOB price.

At $9 FOB, it is not possible for Block A to offset the effect of fruit size in Block C through increased color. Block A would have to have over 100% of its production making Extra Fancy grade.

Figure 8 shows the same type of information as Figure 7. As we move up the individual curve, for example, we are showing the average price per packed box FOB as it relates to different levels of production grading Extra Fancy. So at 50% Extra Fancy, Block A with fruit peaking on 125s is averaging slightly over $9.00 per packed box FOB. At 80% Extra Fancy, Block A is averaging approximately $9.50 per packed box FOB. Similar statements can be made about the curve for Block B and the curve for Block C.

The interesting thing about this figure is that it shows how the economic effect of size in the 1981 crop overwhelmed the economic effect of color. It was physically impossible to achieve enough color in Block A to have the same returns in Block C with its larger fruit. In the exceptional crop year like 1981, Red Delicious strains that tend to have poor color but good size would have generated better returns than the better coloring strains that yielded small fruit.

COMBINING THE EFFECTS OF CULLAGE, COLOR, AND SIZE

Up to this point, we have discussed individual factors and how they relate to returns and the economic trade-off that can occur between each of the factors and yield as well as the economic trade-off between color and size. So we have a pretty good idea of what the individual effects are on returns; but what happens when these effects are combined. In the following discussion, we will go through an example using three orchard blocks, each with a different yield level, each with a different packout of Extra Fancy, Fancy, and Cull fruit, and each with a different size distribution. Then we will calculate returns using February, 1981 prices.

Table 19 shows the description of the crops grown in the three blocks. Block A has an average yield of 750 field boxes. Block B's yield is 1,000 boxes, and Block C's 1,250 boxes. Of Block A's fruit, 52.5% grades out Extra Fancy, 17.5% is graded Fancy and it has a 30% cullage rate. Block B has 67% of its fruit graded Extra Fancy, 22.5% Fancy, and 10% culls. Block C has the same cullage as Block B, but Block C has 81% of its fruit grading Extra Fancy and only 9% Fancy. The third part of Table 19 shows the number of packs per acre in each grade and the pounds of culls that are sorted out at the packinghouse.

Table 19: Demonstration of Combined Effects of Cullage, Color, Yield, and Size.

	Block A	Block B	Block C
Yield (Field boxes per acre)	750	1,000	1,250
Grade Distribution			
Extra Fancy	52.5%	67.5%	81%
Fancy	17.5%	22.5%	9%
Culls	30%	10%	10%
Packout			
Extra Fancy (packed boxes)	328	563	844
Fancy (packed boxes)	109	187	94
Culls (pounds)	7,875	3,500	4,375
Weighted Prices per Packed Box[a/]			
Extra Fancy ($)	8.89	9.32	9.58
Fancy ($)	6.89	7.19	7.40
Culls (¢/lb.)	3	3	3

a/ Prices prevailing during February, 1981.

Block A still has the size distribution that was associated with it in the size discussion. The fruit from Block A peaks on 125s. Block B's fruit peaks on 113, and Block C's fruit peaks on 100. Price of Culls is in cents per pound and is constant for all three orchard blocks.

The last set of information is the fresh prices paid for the fruit from each block. These are prices that prevailed during February of 1981 so they are for the 1980 crop. The prices are calculated in such a way as to take into account the effect of size as well as color.

Table 20 shows the gross FOB receipts from the combined effects of size, cullage, color, and yield. FOB receipts for Block A are $3,903, gross receipts are $5.20 compared with Block B's $6.70, and Block C's $7.13 per field box.

Table 20: Gross Receipts per Acre from Combined Effects of Cullage, Color, Yield, and Size.

	Block A	Block B	Block C
	$	$	$
Extra Fancy	2,916	5,247	8,086
Fancy	751	1,345	696
Culls	236	105	131
Total	3,903	6,697	8,913
$/Field Box	5.20	6.70	7.13

Table 21 shows the packing cost for each grower using the charges for the 1980 crop. The incharge is set at $20 per bin and packing charges are assessed at a rate of $3.22 per packed box. Because there was an increasing yield and an increasing amount of packed fruit, total packing costs as we go from Block A to Block B to Block C, increases. Note, also, that the cost per field box increases as we go from the weak block to the better blocks. Although Block C has an additional 10 bins of production per acre, its packout is such that total packing charges per field box are no higher than Block B's. Block A's fruit quality, on the other hand, is so weak that the owner actually pays some 53¢ per field box less than the owner of Block B to have his fruit handled, stored, and packed.

While packing costs per field box decline as quality of fruit declines, the reverse is true when costs are calculated on the basis of packed boxes. In this example, charges per packed box are 30¢ more for fruit from Block A than for either Blocks B or C. The variation in quality and volume between the fruit from Blocks B and C are not great enough to cause any difference in packing costs per packed box.

Table 21: Packing Costs, per Field Box, and per Packed Box.

	Block A	Block B	Block C
	$	$	
Incharge ($20/bin)	600	800	1,000
Packing Charges ($3.22/packed box)	1,407	2,415	3,020
Total Cost/Acre	2,077	3,215	4,020
Cost/Field Box	2.68	3.21	3.22
Cost/Packed Box	4.59	4.29	4.29

Table 22 shows the net returns per acre for each block. The FOB receipts are taken from Table 20 and packing charges from Table 21 to get the net returns for each block. Block A is receiving less than $2,000 per acre in returns from the packing shed. Block B brings in nearly $3,500, a sufficient amount to cover all economic costs of production. Block C has done even better than Block B. Block B's earnings from the packinghouse are nearly $4,900 per acre. On a field-box basis, Block A is receiving approximately $2.53 per field box--nearly a dollar less than Block B. Block C's returns per field box are another 43¢ greater than Block B.

Table 22: Net Returns per Acre by Block.

	Block A		Block B		Block C
	$		$		$
FOB Receipts	3,903		6,697		8,913
Packing Charges	2,007		3,215		4,020
Net to Grower	1,896		3,482		4,893
Returns/Field Box	2.53		3.48		3.91
Net Difference/Acre ($)		1,586		1,411	
Difference in Net Returns Between Block A and Block C from 30 Acres				$89,910	

The difference in receipts per acre between Block A and Block B are $1,586. The difference between Block C's and Block B's receipts is $1,411.

The difference in net returns between Block A and Block C from the production of 30 acres of Red Delicious is almost $90,000.

It is obvious that even in a year such as 1980 when prices declined because of the record crop, the grower who is able to produce high quality fruit as in Block B or Block C will be able to make a profit. It is blocks like A with high cullage, poor color, and poor size that will not likely be able to withstand the effects of the increased production that is going to occur in the next few years.

SUMMARY AND CONCLUSIONS

It is obvious from the foregoing discussion that a grower can increase returns substantially by reducing cullage, increasing color, and increasing size. It should also be obvious now that the best returns are generated by orchard blocks that achieve good size with a high percentage of Extra Fancy fruit and low cullage. Yield is also very

important, however, emphasizing yield (or any other single factor) at the expense of any of the other factors will likely cause reduced returns.

The VPP of fruit grading Extra Fancy is approximately $13 per acre. The VPP of cullage is about $30 per acre while increasing peak size one size increases receipts per acre by several hundred dollars.

Increasing the size distribution from peak size 125s to peak size 113s is worth nearly $340 per acre. The difference between peak size 113s and peak size 110s at a yield of 1,000 field boxes per acre is $225 per acre and those effects are based on 1980 crop prices.

The declining price differential between Fancy and Extra Fancy Red Delicious that seems to be occurring implies that the industry is producing a smaller percentage of Fancy fruit. This has probably come about through breeding new varieties, super sports for example, as well as learning how to handle the varieties and strains in an orchard setting.

In the future, it appears that the better growers must spend more time concentrating on size and cullage. Cullage is often influenced by weather; however, any cullage above and beyond weather effects should be kept to a minimum. Following the suggestions of university and industry personnel to make sure sprayers are properly calibrated and the appropriate amount of active ingredients is applied at the right time is critical to minimizing cullage.

Weather also influences size. Yet, growers do have some influence on size. Tree vigor is one such influence. More vigorous trees will tend to bear larger fruit than less vigorous trees.

Producing large, well-colored fruit and having good yields with low cullage will not guarantee success in the orchard business. Cost of production and prices are also important. However, the grower who is unable to produce such fruit will find it difficult to stay in business.