Profitability of Different Apple Orchard Systems in the Eastern United States
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Preface

Predicting the costs and returns of apples over a long period of time requires a huge amount of data. Without the dedicated researcher, who has taken data over a 10 to 15 year period of time, an analysis of this type could not be completed. Furthermore, apple growers can not make proper decisions without sound advice. Therefore, the authors gratefully acknowledge the following researchers for their dedication: Drs. David C. Ferree, Donald C. Elfving, Stephen S. Miller, and Loren D. Tukey.

Special appreciation is extended to Marilyn Baehr, who provided assistance in the analysis, to Mary Jo Weaver who typed the report, and to Ron Slonaker and Dave Davis who provided valuable information on costs. We also extend thanks to the review committee at the Pennsylvania State University consisting of Dr. Jay Harper, Dr. George Greene and Mr. Roland Freund and to the review committee at West Virginia University consisting of Professor Kendall Elliott and Dr. Alan Collins.

It is because of our sincere commitment to the concern for the eastern apple grower that we initiated this study. Apple growers and taxpayers, alike, have provided private, federal, and state dollars to produce this report. We estimate that the data represents approximately 4.7 scientific man-years and 1.3 years of support or about $800,000 dollars from public funds and approximately another $80,000 from grower support in three states and Canada. Research is a wise investment for apple growers who need to be competitive in a global market.

Richard C. Funt
March 1992
Foreword

Using This Information on Your Farm

The information in this bulletin reflects a whole-farm analysis of costs and returns. Costs of materials and products are listed in Appendix A. Yields and packout for the analysis of each cultivar and system were estimated, based on records from the results of university research (Appendix B). Annual summations of costs and returns per year were calculated (Appendix C) and an internal rate of return (IRR) analysis was used to determine a rate of return on investment over the first 15 years of apple production. The appendices (A, B, and C) show the values used to derive the costs and returns that are estimated over a 15-year period, with year zero used for preparing the soil for planting.

The costs in this analysis do not include fumigation, irrigation, frost protection, or tile drainage. A land charge of $2,000 per acre is used in the cost of year zero and as a return in year 15 in the IRR analysis. An annual land rental or interest charge is not included. All equipment, labor, material, and overhead costs are included. The price received for apples is based on the 1985 through 1989 seasons for fresh and processing markets.

Growers can use this information to consider which orchard system may provide the highest rate of return over the first 15 years of orchard life. Growers, who have several years of data can compare their records to the appendix tables. However, each grower has a unique set of resources, a unique management style, and a different level of risk. Therefore, growers should use this information as a guide only. If a grower requires a higher level of analysis for cultivars and systems or an analysis that differs from those used in this study, additional information is necessary.

Farm size (total acres per farm) can make a difference in costs. In this study, farm size was a factor in returns on investment. Therefore select the tables in Appendix C which show the farm size that is nearest to your present tree fruit acreage. There were no differences in yield or packout for different farm sizes.

Personal computers and specific software packages can be helpful to individual growers or groups of growers to find answers to more specific questions. This software should be available by early 1993.
Profitability of Different Apple Orchard Systems in the Eastern United States

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Introduction

Apple growers produce and market a crop that requires a large investment in labor, equipment, and chemicals. Success in the orchard is a combination of good management and sound business practices. Eastern apple growers are faced with domestic and foreign competition for a larger share of fresh and processing markets. To reduce the risk of making mistakes in planting new orchard systems, considerable information is required.

High density systems using dwarfing rootstocks have been planted because of reported higher yields early in the life of an orchard, improved fruit size and color, easier pruning and harvesting and lower costs per unit. Intensive modern orchards require a large initial investment, increased management skills, good soil and site selection and high quality trees to obtain high early returns. Making a positive return with standard rootstocks was difficult in the late 1980’s because fruit was generally smaller and poorly colored. Yields were frequently lower. (Ricks, 1991).

In recent years, horticulturists from Europe have explained new technologies and different orchard systems, which have demonstrated the potential for high yields. Making a positive return with standard rootstocks was difficult in the late 1980’s because fruit was generally smaller and poorly colored. Yields were frequently lower. (Ricks, 1991).

Objectives

The objectives of this study were to:
1) examine alternative orchard systems suitable for eastern growers for the 1990’s.
2) develop annual costs and returns for the initial 15 years of orchard production which reflect “typical” orchard management and cultural conditions.
3) demonstrate the relative profitability of several cultivars, systems, and farm sizes.

Orchard and Farm Descriptions

Four different orchard systems were chosen for an economic analysis:
1) free standing central leader system having 141 trees per acre (T/A)
2) modified slender spindle, individually staked, having 340 T/A
3) palmette four wire trellis, having either 605 or 726 T/A
4) modified slender spindle, individually staked with one wire support, having either 605 or 726 T/A.

Farm sizes of 40, 80, and 160 acres (A) were chosen to demonstrate the effect of cost. These farms had 30, 60, and 120 A producing fruit, such as apples, peaches, or cherries, where the same equipment is used. Production of apples for both the fresh and processing markets was evaluated for each density. York Imperial and Golden Delicious were selected for the processing analyses. Golden Delicious and Red Delicious were selected for fresh market analyses. Growers should select the best rootstock for a given site and the spacing/system that gives the highest return based on excellent management skills. Suggested rootstocks and spacings are listed in Table 1.

Cost estimates

Total annual costs were calculated over a 16 year period of time for each cultivar and system. The year of preparation was considered as year ‘zero’ and the first year was the year of planting. Annual costs included labor for both supervisory (owner, operator) and field workers plus a management charge of 10 percent (%) based upon the number of total hours of labor. Harvesting costs...
increased on a per bushel basis with farm size (Table 2). Labor rates were determined from national wages paid in late 1990 (Ohio Ag. Statistics, 1990) and are shown in Table 3. All apples were hand harvested. Labor was also included for bin distribution and transportation of fruit to a processor, packing plant or refrigerated storage.

The estimates of labor required for establishing the orchard and installing a support system were based on previous reports and included the use of a tree planter capable of planting at the rate of 200 trees per hour (Funt, 1979). Labor requirements for winter and summer pruning and training were developed from records at the Ohio Agricultural Research and Development Center (Ferree, 1990; Appendix A, Tables 9 to 14). A hydraulic ladder was used for pruning from year 8 to year 15 for trees in the 141 T/A system. In the preparation and establishment years all farms used the same size equipment for renting the same size equipment for cultivation and planting (Appendix A, Table 8).

A land cost value of $2,000 per acre was used. The same value was used as a salvage (return) value at the end of the different production periods of 5, 10, and 15 years.

Overhead costs, based on a farm size of 40, 80, or 160 A were estimated. These costs are those that are applied across the farm and can

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### Table 1. Description of Different Orchard Systems.  

<table>
<thead>
<tr>
<th>Trees/acre</th>
<th>System</th>
<th>Rootstock</th>
<th>Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>141</td>
<td>Free Standing Central Leader</td>
<td>M.7 or Spur type/MM111</td>
<td>16‘x24’</td>
</tr>
<tr>
<td>340</td>
<td>Modified Slender Spindle</td>
<td>MARK or M.26</td>
<td>8’x16’</td>
</tr>
<tr>
<td>605</td>
<td>Palmette Trellis</td>
<td>MARK or M.9</td>
<td>6’x12’</td>
</tr>
<tr>
<td>605</td>
<td>Modified Slender Spindle</td>
<td>MARK or M.9</td>
<td>6’x12’</td>
</tr>
<tr>
<td>726</td>
<td>Palmette Trellis</td>
<td>MARK or M.9</td>
<td>5’x12’</td>
</tr>
<tr>
<td>726</td>
<td>Modified Slender Spindle</td>
<td>MARK or M.9</td>
<td>5’x12’</td>
</tr>
</tbody>
</table>

1Trees are spaced in the row at 16’ and 24’ between rows, etc. Mature trees are approximately the same height as in the row spacing.

### Table 2. Harvesting Cost Per Bushel For Different Farm Sizes, 1990.  

<table>
<thead>
<tr>
<th>Farm Size</th>
<th>Market</th>
<th>40A²</th>
<th>80A³</th>
<th>160A⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processed</td>
<td>$0.86</td>
<td>$0.91</td>
<td>$1.05</td>
<td></td>
</tr>
<tr>
<td>Fresh</td>
<td>$0.92</td>
<td>$0.97</td>
<td>$1.11</td>
<td></td>
</tr>
</tbody>
</table>

1Derived from Appendix A, Tables 15 and 21.  
2Does not include housing or crew leader charge.  
3Includes housing charge but no crew leader charge.  
4Includes housing and crew leader charge.

### Table 3. Labor and Benefits for Late 1990.  

<table>
<thead>
<tr>
<th></th>
<th>Supervisory:</th>
<th>Hourly:</th>
<th>Pruning/Grading:</th>
<th>Piece rate²:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$9.52/hour</td>
<td>6.15/hour</td>
<td>5.06/hour</td>
<td>Processed: $0.50/bushel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fresh: $0.56/bushel</td>
</tr>
</tbody>
</table>

1Includes benefits at 20%, 16% and 15% for supervisory, hourly and pruning/grading labor, respectively.  
2Total cost per bushel for harvesting apples includes benefits as shown in Appendix A, Table 15.  

Nutrients and pesticides were applied annually (Appendix A, Table 4). The cost of wind machines, irrigation, and storage for processed apples were not included. The cost of storage for fresh market apples was subtracted from the price received (Appendix A, Table 16, 19 and 20). It was assumed that fifty percent of all apples, after the first two years of production, were held in long term storage with half of the stored apples (25% of total) in controlled atmosphere storage. All apples produced during the first two years were sold immediately at harvest.
not be specifically charged to a particular enterprise (Appendix A, Tables 2 and 3).

**Return estimates**

Yield and fruit size estimates for the different systems and cultivars were based on long term records from Dr. Loren Tukey, The Pennsylvania State University, Dr. David Ferree, The Ohio State University, Dr. Stephen Miller, USDA-AFRS at Kearneysville, WV; and Dr. Don Elfving, Simcoe Station, Canada. Modifications were made to estimate dropped and culled fruit and shrinkage of fruit in storage (Appendix B, Tables 1 to 12). A five-year moving average was used to provide a more conservative yield curve and to make the data from various locations more comparable. Adjustments were made to lower the estimated yields for the first one or two years of production since a five-year moving average will increase yields mathematically. It will also underestimate yields in the last two years; therefore, these were also adjusted.

Apple prices, received by growers, were obtained from reports of the Federal State News Service 1985 through 1989 for both fresh market and processing apples. Any blemished or russeted fruit were considered juice apples. A Golden Delicious strain having a low amount of russetting was considered for both markets. Fruit, left in the field or unfit after storage, were considered to be culls/shrink and received no returns. Since fruit from the first two years of production were considered to be harvested and sold immediately, they had the lowest percentage of drops or culls/shrink. As yields increased, a higher number of drops or culls/shrink fruit would occur, regardless of the system or farm size. Fifty percent of the fruit were sold as tray packs (72 to 125 size) in a 42-pound box as U.S. Combination Extra Fancy/Fancy grade. The remaining fruit were packed into 12-3-pound film bags as U.S. Fancy or better grade. All fruit in the 2 1/4 to 2 3/4 inch diameter range were sold as U.S. Fancy in film bags.

**Internal Rate of Return**

The internal rate of return (IRR) analysis is a discounted cash flow method used to compare the cost and return streams over the expected life of fruit crops (Funt, 1986). It is particularly useful where annual costs and returns occur at different volumes in different years. Decisions made at planting, regarding tree density, interest rates, markets, and system of culture, can affect the return over the life of the crop. It is understood that all monies received for a system are reinvested in the same system.

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**Table 4. Tractor and Sprayer Size for 40, 80, or 160 Acre Orchard, 1990.**

<table>
<thead>
<tr>
<th>Tree Density (Trees/Acre)</th>
<th>FARM1</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40A</td>
<td>80A</td>
</tr>
<tr>
<td>141</td>
<td>55D/2 w. cab</td>
<td>65D/2 w. cab</td>
</tr>
<tr>
<td></td>
<td>45D/4</td>
<td>45D/4</td>
</tr>
<tr>
<td></td>
<td>450/4</td>
<td>450/4</td>
</tr>
<tr>
<td>340</td>
<td>55D/2 w. cab</td>
<td>65D/2 w. cab</td>
</tr>
<tr>
<td></td>
<td>45D/4</td>
<td>45D/4</td>
</tr>
<tr>
<td></td>
<td>450/4</td>
<td>450/4</td>
</tr>
<tr>
<td>605, Trellis, Spindle</td>
<td>45D/2 w. cab</td>
<td>55D/2 w. cab</td>
</tr>
<tr>
<td></td>
<td>28D/4</td>
<td>28D/4</td>
</tr>
<tr>
<td></td>
<td>100 Gal.</td>
<td>300 Gal.</td>
</tr>
<tr>
<td>726, Trellis, Spindle</td>
<td>45D/2 w. cab</td>
<td>55D/2 w. cab</td>
</tr>
<tr>
<td></td>
<td>28D/4</td>
<td>28D/4</td>
</tr>
<tr>
<td></td>
<td>100 Gal.</td>
<td>300 Gal.</td>
</tr>
</tbody>
</table>

1All equipment depreciated at 15, 12 or 10 yr. life on 40, 80 and 160 A farm, respectively.
245D tractor needed for forklift and bin removal. A 45D/4 is a 45 horsepower diesel tractor with power to all four wheels.
Investment appraisal of future costs and returns must take into account the timing by the process of discounting. Simple interest would make $110 next year from $100 invested at 10% rate of return. The same process can be done in reverse (discount) in order to bring some future amount back to the present. The process of discounting for time is based on the concept that the same amount of money received today is worth more than it would be tomorrow. A ten percent return received early on an investment is better than 10% return received on the same investment at a later time. Receiving $1,000 five years from now would be worth $621 today at 10%. Investments grow based on the compounding effect (interest on interest). When investments are returned early they can be reinvested in the enterprise or at a new higher performing investment. This is better than continuing to pay interest on borrowed money for a later return.

No one can predict a specific year when crop yields might be reduced severely. However, yields and packout estimates from a region over a period of 5 to 15 years provide the best long term expectations. Certainly, if hail affects an orchard investment of $1,500 as compared to $5,000 there is a lower amount of loss. Again, judgments made at planting as to soil, site, and risk of hail should be considered in the long term risk of large investments.

In this study, total annual costs and total annual returns for each system and farm size for each year were computed. One year of preparation prior to planting was included. Yields and packout, based on the best available data, were estimated. A five-year moving average was used to account for sharp upward or downward yield fluctuations. An internal rate of return analysis was conducted as a measure of relative profitability. A personal computer using Lotus 1-2-3 software (2:2) was used to calculate the IRR (Appendix C, Tables 1 to 18). Apple growers, who have data similar to that used in this study, can make decisions about future plantings. However, many growers will need additional assistance from their own records of past performance and data from their local research station about different cultivars and systems. Software such as Market Model, may be helpful to growers (Funt, 1989).

A sensitivity analysis was conducted to answer some specific questions such as 1) what if apple prices increase as they did in 1989 and 1990? 2) what if my costs can be reduced? 3) what if prices for trees and support systems can be reduced? Such an analysis over the life of the planting can assist growers in establishing economic priorities and in deciding where to place their efforts in management. The sensitivity analysis indicates those areas that are more highly susceptible to greater reductions or increases in the relative profitability over the life of the orchard.

### Results

#### Costs

Apples require a large initial investment in land preparation, trees, support systems, labor, and equipment. These costs occur several years before the trees bear fruit. In the early bearing years, the trees are small and immature and the number of fruit per tree is much less than in later years. Planting more and smaller trees per acre can increase total yields. However, more trees per acre require a higher investment in both trees and support systems.

The unsupported free standing system with 141 T/A had the lowest establishment cost and the lowest average cost per tree (Table 5). This system had the lowest equipment labor requirement, but it also had the lowest yield (Figures 1 and 2). It had lower yields than other systems during the first five years.

The 340 T/A, modified spindle system had a higher average cost per tree than the 141 T/A system because of a single stake used for initial training. It had the fewest average number

<table>
<thead>
<tr>
<th>Item</th>
<th>141</th>
<th>340S</th>
<th>605T</th>
<th>605S</th>
<th>726T</th>
<th>726S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees/Acre and Orchard Systems³</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trees</td>
<td>$663</td>
<td>$1598</td>
<td>$3116</td>
<td>$3116</td>
<td>$3739</td>
<td>$3739</td>
</tr>
<tr>
<td>Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>—</td>
<td>442</td>
<td>1205</td>
<td>1008</td>
<td>1213</td>
<td>1075</td>
</tr>
<tr>
<td>Labor</td>
<td>—</td>
<td>52</td>
<td>301</td>
<td>230</td>
<td>308</td>
<td>249</td>
</tr>
<tr>
<td>Equipment</td>
<td>—</td>
<td>71</td>
<td>14</td>
<td>71</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Labor³</td>
<td>22</td>
<td>44</td>
<td>65</td>
<td>65</td>
<td>76</td>
<td>76</td>
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<tr>
<td>Equipment</td>
<td>28</td>
<td>56</td>
<td>84</td>
<td>84</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>Rodent Control</td>
<td>56</td>
<td>136</td>
<td>242</td>
<td>242</td>
<td>290</td>
<td>290</td>
</tr>
<tr>
<td>Total Cost/Acre⁴</td>
<td>$769</td>
<td>$2328</td>
<td>$5084</td>
<td>$4759</td>
<td>$5796</td>
<td>$5542</td>
</tr>
<tr>
<td>Avg. Cost/Tree</td>
<td>$5.45</td>
<td>$6.65</td>
<td>$8.40</td>
<td>$7.87</td>
<td>$7.98</td>
<td>$7.63</td>
</tr>
</tbody>
</table>

¹All costs are rounded to nearest dollar and are not discounted.
²T= 4 wire palmette; S=staked slender spindle.
³All systems planted with tree planter at 200 trees/hour.
⁴Does not include overhead, land charge or interest on operating expenses.
of hours of pruning (Figure 3). As a measure of efficiency this equals 30 bushels produced per hour of pruning for Golden Delicious, while other systems ranged from 25 bushels in 141 T/A, to 23 bushels in 605 T/A and 21 bushels in 726 T/A. Yields and fruit size were higher in the 340 T/A system during the first five years of production than the 141 T/A system.

Palmette trellis systems, consisting of 605 and 726 T/A, had a higher cost per tree than the spindle systems. The 605 T/A trellis had a higher cost per tree than the 726 T/A trellis because it had the same trellis system, but fewer trees. In the early years the 726 T/A trellis system had the greatest number of hours of pruning and training of all systems. The trellis and spindle systems had similar yields and fruit size and had the highest production of all systems in the first five years.

Of the higher density systems, the 726 T/A spindle system had the lowest average cost per tree. In the early years the 726 and 605 T/A spindle systems had fewer average hours of pruning than the same tree density on trellis. However, after the eighth year, the spindle systems had more hours of pruning per year than the trellis system. The Spur Red Delicious cultivar had 35 to 40% fewer hours of pruning than either York Imperial or Golden Delicious, regardless of the system.

As the number of trees and rows increased per acre, the hours of equipment usage for pesticide applications increased. As tree size decreased, smaller sized and less expensive equipment was used. The net effect of total cost for a tractor and sprayer is shown in Figure 4.

**Influence of Farm Size on Costs**

The 40 A farm had fewer hours of equipment use per year which increased the cost per hour (Figure 5). However, the 40 A farm was compensated somewhat by having a 15-year straight line depreciation schedule as compared to 12 and 10-year depreciation schedules for the 80 and 160 A farms, respectively.

As farm size increased, the per acre cost of a tractor and sprayer decreased. As tree size decreased (density increased), smaller tractors and sprayers could be used at a lower cost per hour than in low density systems.

The 160 A farm had a 53 percent lower total annual overhead cost than the 40 A farm (Figure 6). Certain costs, such as taxes and toilet rental,
did not vary greatly from farm to farm. However, the expense of a pickup truck was approximately $24 per acre for the 160 A farm and $75 per acre for the 40 A farm.

The harvest labor cost was lower for the 40 A farm (Table 2). Local labor could be hired to harvest the crop and there would be no housing cost. Both the 80 and 160 A farms would provide housing. Since the 160 A farm would require additional management during harvest an additional management fee was charged. The total harvest costs per bushel are derived from Appendix A, Tables 15 and 21.

**Returns**

The value of an apple crop is dependent upon the yield, grade, size, and price received which differs among cultivars and markets. The average fresh and processing market prices used in this study were some of the lowest obtained by eastern growers in many years. Fresh market prices per pound were higher than those for processing.

The 141 T/A unsupported free standing system had the lowest total returns (Appendix C, Tables 1 to 18). The high density supported systems with 605 and 726 T/A had the highest total returns. The higher density spindle systems had the highest percentage of large fruit and yields in the first five years of production. The high density systems were only slightly higher in yield as compared to the other systems in the last several years of production. These higher and earlier returns are essential to long term profitability.

The lowest net return over a 15 year period was with York Imperial on the high density trellis system. The modified slender spindle system with 340 T/A had the highest net return per bushel for York Imperial and Red Delicious, and for Golden Delicious on a 40 A farm for processing. The 605 T/A spindle system had the highest net return per bushel for Golden Delicious, excluding the 40 A system for processing (Tables 6 and 7). Processing cultivars had lower net returns than fresh market cultivars.
Internal rate of return

Annual summations of costs and returns over many years do not take into consideration the effect that time has on investments. To provide a measure for differences among systems or cultivars, a one percent or greater difference in the rate of return is considered to be significant. If a difference is less than one percent, the system or cultivar comparison would be considered to be the same. This consideration is especially true when long term economic studies are conducted because of the many biological variables that cannot be totally and accurately predicted.

The highest internal rate of return was for the 340 T/A modified spindle system for 10 years of orchard life (Tables 8 and 9). The 141 T/A free standing system had the lowest rate of return except for Red Delicious with the 726 T/A trellis system. Generally, the 605 and 726 T/A systems had rates of return intermediate to those of 141 and 340 T/A.

Apples for fresh market had a higher internal rate of return than processing fruit 10 years after planting. The highest rate of return was for fresh marketed cultivars in the 340 T/A system. Generally, in the first 10 years Golden Delicious had a higher rate of return for fresh marketed apples than Red Delicious except for the 141 T/A system. Golden Delicious had a higher rate of return than York Imperial for processing. This can be attributed to the fact that Golden Delicious come into bearing earlier and with higher yields than either cultivar. When Golden Delicious is compared to either cultivar at 15 years of production the rates of return are nearly equal in most cases.

There were no significant differences between an 80 and a 160 A farm within the same system and cultivar. The 40 A farm had a lower rate of return than either the 80 or 160 A farm because it had a higher total cost, particularly for equipment and overhead.

Higher internal rates of return were obtained with 15 years of production than with 10 years of production because the initial, non bearing costs, had been paid and annual costs were lower than annual returns in the later years (Tables 10 and 11). In the higher priced cultivars and earlier producing systems, annual returns exceeded annual costs much earlier (second or third year of production) and to a greater extent than in lower priced cultivars and later producing systems (Figure 7). Furthermore higher internal rates of return were obtained over 15 years when all returns were increased by 10%. In 1989 and 1990, prices for processing apples increased by 17%. While

![Figure 5. Cost per hour for tractor and sprayer for different farm sizes and different orchard densities. (Source: Appendix A, Table 7)](image)

![Figure 6. Estimated overhead costs per acre for 40, 80, or 160 acre farms, Eastern U.S. (Source: Appendix A, Table 2)](image)
Table 6. Net Returns\(^1\) per Bushel of Apples for Processing for Different Orchard Systems and Farm Sizes\(^2\), 1990.

<table>
<thead>
<tr>
<th>Trees/A System</th>
<th>York Imperial Processed</th>
<th>Golden Delicious Processed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40A</td>
<td>80A</td>
</tr>
<tr>
<td>141</td>
<td>$0.03</td>
<td>$0.28</td>
</tr>
<tr>
<td>340</td>
<td>0.16</td>
<td>0.41</td>
</tr>
<tr>
<td>605 trellis</td>
<td>0.08</td>
<td>0.21</td>
</tr>
<tr>
<td>605 spindle</td>
<td>0.03</td>
<td>0.27</td>
</tr>
<tr>
<td>726 trellis</td>
<td>0.07</td>
<td>0.33</td>
</tr>
<tr>
<td>726 spindle</td>
<td>0.11</td>
<td>0.37</td>
</tr>
</tbody>
</table>

\(^1\)Net returns per bushel (42 lbs.) over 16 year period including one year of preparation before planting.
\(^2\)A 40, 80, or 160 A farm has 30, 60 or 120 A of fruit crops, respectively.

Table 7. Net Returns\(^1\) per Bushel of Apples for Fresh Market for Different Orchard Systems and Farm Sizes\(^2\), 1990.

<table>
<thead>
<tr>
<th>Trees/A System</th>
<th>Golden Delicious Fresh</th>
<th>Red Delicious Fresh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40A</td>
<td>80A</td>
</tr>
<tr>
<td>141</td>
<td>$0.68</td>
<td>$0.95</td>
</tr>
<tr>
<td>340</td>
<td>1.63</td>
<td>1.96</td>
</tr>
<tr>
<td>605 trellis</td>
<td>1.69</td>
<td>1.91</td>
</tr>
<tr>
<td>605 spindle</td>
<td>1.64</td>
<td>1.97</td>
</tr>
<tr>
<td>726 trellis</td>
<td>1.55</td>
<td>1.92</td>
</tr>
<tr>
<td>726 spindle</td>
<td>1.65</td>
<td>1.93</td>
</tr>
</tbody>
</table>

\(^1\)Net returns per bushel (42 lbs.) over 16 year period including one year of preparation before planting.
\(^2\)A 40, 80, or 160 A farm has 30, 60 or 120 A of fruit crops, respectively.

Table 8. Internal Rate of Return for Processed Apples 10 Years after Planting\(^1\), for Different Orchard Systems and Farm Sizes, 1990.

<table>
<thead>
<tr>
<th>Trees/A System</th>
<th>York Imperial Processed</th>
<th>Golden Delicious Processed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40A</td>
<td>80A</td>
</tr>
<tr>
<td>141</td>
<td>-9.9</td>
<td>-6.3</td>
</tr>
<tr>
<td>340</td>
<td>-6.4</td>
<td>-3.6</td>
</tr>
<tr>
<td>605 trellis</td>
<td>-9.4</td>
<td>-6.6</td>
</tr>
<tr>
<td>605 spindle</td>
<td>-8.3</td>
<td>-5.4</td>
</tr>
<tr>
<td>726 trellis</td>
<td>-8.6</td>
<td>-6.2</td>
</tr>
<tr>
<td>726 spindle</td>
<td>-7.9</td>
<td>-5.2</td>
</tr>
</tbody>
</table>

\(^1\)A land cost of $2,000 per acre was added in year zero and a land salvage (return) value of $2,000 per acre was added in year 10.

Discussion

The costs and returns in this study reflect the eastern apple region which has a unique climate for production as well as a major portion of the U.S. population for markets. Eastern growers face strong domestic and foreign competition. Supplies of fresh market apples are high and are expected to remain so during the 1990's. Current production costs are about 30% of total costs and are comparable to another earlier report (Table 12). The other major cost is packing, which accounts for about 35% of the cost of a 42 pound box of fruit. Harvesting, storage, and marketing make up the remaining costs. During the 1980's, labor, packaging, transportation, and marketing costs grew faster than farm prices for raw commodities. The differences between the percentage of total costs allocated to packing between 1984 and 1990 are a result of rising packing costs. At 340 T/A on an 80 A farm producing Spur Red Delicious based on 15 years of production, a 42 pound box will cost about $7.18 at the farm. In Washington, using a 60 to 80% packout, costs are $7.88 to $9.17 per packed box (Nordahl 1990). Because of the large amount of fixed costs involved with production, packing and storage, growers will need to reduce costs per unit by increasing yields per acre and packout. Their present management/operational skills and less intensive orchard systems will need to be improved to be competitive. No one can predict the future, a 10% or greater increase for processing apple prices will increase the rate of return by 2.2 to 2.9% over 15 years. However, the gap between fresh and processing prices, assuming no increase in price for fresh and a 10% rise in processing apples, is still about 5.5 to 11.8%.
Many studies have shown the advantages of increasing tree density on early yields of apple orchards (Ferree et al., 1989). Few studies have shown yield and packout data over an extended period of time. Each system has its own rootstock, spacing, and training and pruning practices designed to optimize returns, and it is the management system as a whole that must be considered when economic comparisons are made. As yields in this study increased in all systems and cultivars, the percentage of large sized apples decreased. Fruit size dropped from between 77 and 87 percent large fruit in the early years to between 61 and 71 percent in the later years. Low yield potential can be due to small fruit size, faulty pruning and training, and old, weak or missing trees. Tree loss due to collar rot and/or fireblight can be a problem with certain scion/rootstock combinations. The greatest reduction in revenue is due to tree loss (Funt et al., 1987). In this study, five percent of the trees in each system were replaced in the second year. In Ohio, on six rootstocks grown for a 13 year period, tree loss was 7, 19, 16, 37 and 53% on seedling, MM111, M7, MM106, M9, and M26, respectively. Each planting differs in yield, grade and size due to tree age, cultivar, site and temperature. Size and grade will vary from year to year.

Most packers desire fruit no smaller than 125s and no larger than 72s (2 3/4 to 3 1/4 inches). The major factor in grade is fruit color. In Washington, a desired average yield is 833 to 1250 bushels (42 lbs) per acre for red color sports of Delicious, with 76% extra fancy grade, 5% culls and 62% extra fancy and 5% culls for Golden Delicious (Tukey and Schotzko, 1988). However, 470 to 480 packed boxes per acre at 60% packout is considered average in Washington (Nordahl, 1990).

### Table 9. Internal Rate of Return for Fresh Market Apples 10 Years After Planting1, for Different Orchard Systems and Farm Sizes, 1990.

<table>
<thead>
<tr>
<th>Trees/A System</th>
<th>Golden Delicious</th>
<th>Red Delicious</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40A</td>
<td>80A</td>
</tr>
<tr>
<td>141</td>
<td>2.2</td>
<td>4.9</td>
</tr>
<tr>
<td>340</td>
<td>9.1</td>
<td>11.5</td>
</tr>
<tr>
<td>605 trellis</td>
<td>6.2</td>
<td>8.5</td>
</tr>
<tr>
<td>605 spindle</td>
<td>7.5</td>
<td>9.9</td>
</tr>
<tr>
<td>726 trellis</td>
<td>5.3</td>
<td>7.6</td>
</tr>
<tr>
<td>726 spindle</td>
<td>6.1</td>
<td>8.5</td>
</tr>
</tbody>
</table>

1 A land cost of $2,000 per acre was added in year zero and a land salvage (return) value of $2,000 per acre was added in year 10.

### Table 10. Internal Rate of Return for Processed Apples 10 and 15 Years after Planting, Plus a 10 Percent Increase in Returns For Different Orchard Systems1, 1990.

<table>
<thead>
<tr>
<th>Trees/A System</th>
<th>York Imperial</th>
<th>Golden Delicious</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Processed</td>
<td>Processed</td>
</tr>
<tr>
<td></td>
<td>10Yrs</td>
<td>15Yrs</td>
</tr>
<tr>
<td>141</td>
<td>-6.3</td>
<td>2.8</td>
</tr>
<tr>
<td>340</td>
<td>-3.6</td>
<td>3.9</td>
</tr>
<tr>
<td>605 trellis</td>
<td>-6.6</td>
<td>1.6</td>
</tr>
<tr>
<td>605 spindle</td>
<td>-5.4</td>
<td>2.2</td>
</tr>
<tr>
<td>726 trellis</td>
<td>-6.2</td>
<td>2.5</td>
</tr>
<tr>
<td>726 spindle</td>
<td>-5.2</td>
<td>2.9</td>
</tr>
</tbody>
</table>

1 Internal rates of return for 80 acre farm, 10 years and 15 years of orchard life, plus 10 percent increase in returns over 15 years.

### Table 11. Internal Rate of Return for Fresh Market Apples 10 and 15 Years After Planting, Plus a 10 Percent Increase in Returns For Different Orchard Systems1, 1990.

<table>
<thead>
<tr>
<th>Trees/A System</th>
<th>Golden Delicious</th>
<th>Red Delicious</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10Yrs</td>
<td>15Yrs</td>
</tr>
<tr>
<td>141</td>
<td>4.9</td>
<td>12.2</td>
</tr>
<tr>
<td>340</td>
<td>11.5</td>
<td>15.7</td>
</tr>
<tr>
<td>605 trellis</td>
<td>8.5</td>
<td>13.4</td>
</tr>
<tr>
<td>605 spindle</td>
<td>9.9</td>
<td>14.4</td>
</tr>
<tr>
<td>726 trellis</td>
<td>7.6</td>
<td>13.1</td>
</tr>
<tr>
<td>726 spindle</td>
<td>8.5</td>
<td>13.7</td>
</tr>
</tbody>
</table>

1 Internal rates of return for 80 acre farm, 10 years and 15 years of orchard life, plus 10 percent increase in returns over 15 years.
In this study, all systems were averaging 61 to 71% 2\% to 3\% fruit size, but it was assumed that the combination grade of extra fancy-fancy was only 50 percent due to eastern growing conditions. Culls and shrink ranged from 2.0 to 3.4\% in the first five years of production and 4.2 to 4.8\% for 15 years of production for all systems and cultivars.

Yields in the first five years ranged from 257 bushels per acre per year in the 141 T/A system to 407 bushels per acre in the 726 T/A. Over 15 years of production the average yields of all systems and cultivars ranged from 389 to 731 bushels per acre per year, in the 141 T/A to 726 T/A systems, respectively. All systems and cultivars were able to reach 1,000 to 1,400 actual bushels per acre at least one year over the 15 year period. In a 1985 New York survey, average yields for trees on seedling rootstocks vs those on size-control-ling rootstocks were 417 and 796 bushels per acre, respectively (Stiles, 1991). Also in New York, several orchard systems were compared for ten years. Both Empire and Spur Red Delicious had the highest cumulative yields on a 389 T/A Y-trellis system using an M26 rootstock. This was 35\% greater yield than the 605 T/A slender spindle system using M9 rootstock. (Robinson, et al., 1991).

In a Washington study, cost and return estimates were made with different systems and trees per acre. The slender spindle system with 808 T/A had a positive gross margin (returns greater than costs) in the third year and a payback period of 6.8 years at a return of 0.12 cents per pound. In this study the trellis and spindle systems with 605 and 726 T/A for fresh market had a positive return in year four. However, the first yield was expected in the third year in the east rather than in year two in Washington. This study and the Washington study had a similar six to seven year pay back period (Geldart, 1989).

In previous studies using an internal rate of return analysis, returns on investment between fresh and processing cultivars were similar to those in this study (Funt, et al. 1979). Processing cultivars had no return over 9 years and 2 to 11\% for 18 years of production. Fresh cultivars had a 12 to 13\% rate of return for the first nine years and 12 to 23\% for 18 years of production. These were based on a typical Pennsylvania fruit farm having 67 A of fruit.

In this study, with an 80 A farm and a 10-year investment, the top five cultivars and systems were fresh marketed Golden Delicious at 340, 605 or 726 T/A or Red Delicious at 340 T/A (Figure 8). These ranged from an 8.5 to an 11.5\% rate of return which is higher than a current rate of a certificate of deposit at local banks. The bottom five were York Imperial on trellis at 605 T/A or 726 T/A, spindle at 726 T/A or free standing at 141 T/A or Golden Delicious on trellis at 726 T/A for processing. These ranged from -4.8 to -6.6\%.

For an 80 A farm and a 15-year investment, the top five cultivars and systems were fresh marketed Golden Delicious on spindle at 340, 605 or 726 T/A or on trellis at 726 T/A and Red Delicious on spindle at 340 T/A (Figure 9). These ranged from 13.1 to 15.7\% rate of return. The bottom five cultivars and systems were processed Golden Delicious on trellis at 605 or 726 T/A and on spindle at 726 T/A or York Imperial at 726 T/A on spindle or 605 T/A on trellis. They ranged from a negative 1.6 to a positive 2.5\% rate of return.

The small farm of 40 A had higher equipment and overhead costs than 80 or 160 A farms. Generally, the smaller farm had a 2.3 to 2.8\% less rate of return than the 80 A farm. The 40 A farmer would need a 10\% greater return to receive a similar rate of return as an 80 or 160 A farmer. The grower should be aware of costs and try to develop market niches where higher prices can com-

![Figure 7](https://example.com/image7.png)

**Figure 7.** Rate of return for ‘Golden Delicious’ at 340 trees/acre, both fresh and processing markets, 15 years of production for different farm sizes, 1990.
pensate for higher costs. Orchardists with larger farms may wish to decrease their current acreage to compensate for increased acreages of high labor requirement systems just to maintain the same labor force. Maintaining a quality, well trained labor source is important with high investments where early returns are essential.

Yield and price differences among cultivars may change over time or may go up and down, depending upon supply. A poor choice of cultivar limits the potential success of an operation. The size of the planting is also a factor. In Oregon, a 30 A planting was more efficient than either a 12 A or a 50 A farm. The cost per box was lowest for the medium-sized operation over a 10-year study of apple and pear orchards. The small sized farm had higher yields but also had higher costs per acre. The large farm had lower yields than the other farms but had the lowest cost per acre (Westwood, 1978). Some of the same principles have been illustrated in this study; however, without farm yield data to prove different production rates on different farm sizes, we assumed that all farms would have similar yields and packout.

Sensitivity analyses

Apple growers want to know the best strategies to maximize returns and minimize costs. When using today’s personal computers and software, analysts ask ‘what if’ questions. The first question in this study was, “what if a grower could reduce all costs over the life of the orchard by 10%”? If all costs are decreased by 10% then a 2.2 to 2.3% increase in the rate of return would occur for fresh marketed Golden Delicious and a 2.6 to 3.0% increase


<table>
<thead>
<tr>
<th>Item</th>
<th>NY1</th>
<th>PA, WV, Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Total Cost</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Production</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>Harvesting</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>Storage</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Packing</td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>Marketing</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>


2Based on Spur Red Delicious, costs over 15 years, film bags, and average cost of regular and controlled atmosphere storage. Percentages were rounded to nearest whole number.

### Figure 8. Top five and bottom five orchard systems, 10 years after planting, using an internal rate of return for an 80 acre farm, 1990. (Source: Tables 10 and 11)

### Figure 9. Top five and bottom five orchard systems, 15 years after planting, using an internal rate of return for an 80 acre farm, 1990. (Source: Tables 10 and 11)
for Golden Delicious for processing (Tables 13 and 14). However, if costs are 10% higher, a similar response occurs but the rate of return decreases. The difference between fresh and processing rates of return is due to the ratio of costs and returns. With fresh apples having a higher return, the influence of costs increasing or decreasing is smaller. The difference between increasing or decreasing is smaller.

Fresh apples having a higher return, the influence of costs and returns are greater than the rate of return decreases. The difference between fresh marketed Golden Delicious are more sensitive to a 10% reduction in both costs and returns than those for processing.

“What if a grower could reduce the cost of trees and support systems by 10%?” Then, there would be a range of +0.1 to +0.5% increase in returns among systems for processing and a range of +0.1 to +0.7% among systems for fresh marketed Golden Delicious. The 340 T/A modified spindle system, the 605 T/A systems and 726 T/A systems have a greater positive return than the 141 T/A free-standing system since the higher densities have higher total costs for trees and support systems. It appears that this is a significant factor and it should be a consideration for growers.

“What if a frost occurs early in the life of the orchard?” A frost (no crop) in year four would cause no loss over 15 years of production for the 141 T/A system since there is very little revenue generated at this time (Table 15). However, since the 340, 605 and 726 T/A system would be bearing earlier than the 141 T/A a reduction in the rate of return would range from 0.7 to 1.6% for fresh marketed apples and 0.4 to 0.8% for processing apples. Again fresh marketed Golden Delicious are more sensitive than those for processing because of the higher price received. The 726 T/A trellis system would be affected more than other systems.

“What if a frost occurs in a mature planting?” A frost or no yield in year eight would result in a large reduction in the rate of return for all systems (ranging from 1.8 to 2.7%). Orchards with larger and early production, such as the 726 T/A trellis system, are less affected than the other systems, either when fruit is marketed fresh or for processing. Golden Delicious for processing are less affected than fresh marketed apples. If a frost occurs in both years four and eight, the reduction is additive and a 2.0 to 3.4% reduction occurs for fresh marketed apples while a 1.6 to 2.2% reduction occurs for processed apples.

The sensitivity analyses were conducted using the 141 T/A free standing system, 340 T/A spindle system and the 605 and 726 T/A trellis systems. The high density 605 and 726 T/A spindle systems would be very similar in the sensitivity analyses to the trellis system because costs and returns are similar. For

---

**Table 13. Sensitivity Analysis for a 10 Percent Increase or Decrease in Costs and Returns for Fresh Marketed Golden Delicious Apples, 80 Acre Farm, 1990.**

<table>
<thead>
<tr>
<th>Factor</th>
<th>141</th>
<th>340</th>
<th>605T¹</th>
<th>726T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in Internal Rate of Return</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+10% Costs</td>
<td>-2.2</td>
<td>-2.2</td>
<td>-2.3</td>
<td>-2.2</td>
</tr>
<tr>
<td>-10% Costs</td>
<td>+2.2</td>
<td>+2.3</td>
<td>+2.2</td>
<td>+2.3</td>
</tr>
<tr>
<td>+10% Returns</td>
<td>+2.4</td>
<td>+2.6</td>
<td>+2.6</td>
<td>+2.5</td>
</tr>
<tr>
<td>-10% Costs and -10% Returns</td>
<td>-0.4</td>
<td>-0.5</td>
<td>-0.3</td>
<td>-0.3</td>
</tr>
<tr>
<td>-10% Trees and Support Costs</td>
<td>+0.1</td>
<td>+0.4</td>
<td>+0.7</td>
<td>+0.7</td>
</tr>
</tbody>
</table>

¹Analyzed for trellis system, which would be similar to spindle system at same density.

---

**Table 14. Sensitivity Analysis for a 10 Percent Increase or Decrease in Costs and Returns for Processed Golden Delicious Apples, 80 Acre Farm, 1990.**

<table>
<thead>
<tr>
<th>Factor</th>
<th>141</th>
<th>340</th>
<th>605T¹</th>
<th>726T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in Internal Rate of Return</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+10% Costs</td>
<td>-3.1</td>
<td>-3.1</td>
<td>-2.7</td>
<td>-2.6</td>
</tr>
<tr>
<td>-10% Costs</td>
<td>+2.9</td>
<td>+3.0</td>
<td>+2.7</td>
<td>+2.6</td>
</tr>
<tr>
<td>+10% Returns</td>
<td>+2.8</td>
<td>+2.9</td>
<td>+2.7</td>
<td>+2.6</td>
</tr>
<tr>
<td>-10% Costs and -10% Returns</td>
<td>-0.1</td>
<td>-0.2</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>-10% Trees and Support Costs</td>
<td>+0.1</td>
<td>+0.5</td>
<td>+0.5</td>
<td>+0.5</td>
</tr>
</tbody>
</table>

¹Analyzed for trellis system, which would be similar to spindle system at same density.
example, the cost of trees for a 605 T/A trellis system and a 605 T/A spindle system are exactly the same. The cost of the support system is $197 per acre less for a spindle system than for the trellis. When this is put into the investment for 15 years of production ($197 of $31,000), there is essentially no difference. When comparing the 605 T/A trellis system to the 726 T/A trellis system, the difference in the rate of return would be approximately the same as comparing the 605 T/A spindle system to the 726 T/A spindle system.

**Conclusions**

Long term yield and packout records of several researchers in the eastern U.S. and Canada were used to compare the profitability of new orchard systems. Yields were earlier and higher for the 605 and 726 T/A system than other systems. Cumulative yield is positively related to tree density in the first 10 years. The 605 and 726 T/A spindle systems had annual returns exceeding annual costs in year four. They had a pay back period between years six and seven. However, these systems had higher establishment costs and the highest number of hours of pruning and equipment use over the 15 years of production. It is the management of the system as a whole (soil, site, spacing, pruning, etc.) that is important in achieving early returns.

The free standing central leader system having 141 T/A had the lowest rate of return over 15 years of production as compared to the other systems. It had the lowest yields early in the life of the orchard. The 340 T/A modified spindle system had the highest rate of return. Generally, the 605 and 726 T/A systems had rates of return intermediate to those of 141 and 340 T/A.

Apples for fresh market had higher internal rates of return than for processing. Prices received per pound ranged from $.12 to .16 for fresh apples and $.077 to $.088 for processing for large sized fruit. The highest rate of return was for fresh marketed Golden Delicious in the 340 T/A system particularly in the first 10 years of production. Golden Delicious produced earlier and higher yields than Spur Red Delicious or York Imperial. When Golden Delicious is compared to either cultivar at 15 years of production the rates of return are nearly equal in most cases.

The 40 A farm had a lower rate of return than either the 80 or 160 A farm. It had higher overhead and higher per hour equipment costs. There were no significant differences in rates of return between an 80 or 160 A farm. The 40 A farm requires a 10% greater return to receive a similar return as an 80 or 160 A farm. If a manager of a 160 A farm wants to decrease farm size due to technological change if it occurs many years after establishment. A grower also has greater flexibility to decrease farm size to 80 A and receive a similar rate of return. However, total revenue may decrease.

When all costs are decreased, the increase in returns is higher for processing cultivars than fresh marketed cultivars. If costs increase 10% the relationship is reversed. Reducing the cost of trees and support systems in high density systems by 10% can increase returns by 0.5 to 0.7%. If there is no crop due to frost in year four, high density fresh marketed apples have a higher reduction in rate of return than those for processing. However, if there is a frost in year eight, the 726 T/A system has a smaller reduction in returns than the 141 T/A system.

A system with the potential for an earlier return in the life of the orchard, such as the 340, 605, or 726 T/A system, is preferred to one which has a higher return later in life. The earlier return system allows a grower to take advantage of a change in consumer demand or technological change if it occurs many years after establishment. A grower also has greater flexibility to reduce farm size to 80 A and receive a similar rate of return. However, total revenue may decrease.

When all costs are decreased, the increase in returns is higher for processing cultivars than fresh marketed cultivars. If costs increase 10% the relationship is reversed. Reducing the cost of trees and support systems in high density systems by 10% can increase returns by 0.5 to 0.7%. If there is no crop due to frost in year four, high density fresh marketed apples have a higher reduction in rate of return than those for processing. However, if there is a frost in year eight, the 726 T/A system has a smaller reduction in returns than the 141 T/A system.

A system with the potential for an earlier return in the life of the orchard, such as the 340, 605, or 726 T/A system, is preferred to one which has a higher return later in life. The earlier return system allows a grower to take advantage of a change in consumer demand or technological change if it occurs many years after establishment. A grower also has greater flexibility to reduce farm size to 80 A and receive a similar rate of return. However, total revenue may decrease.

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When all costs are decreased, the increase in returns is higher for processing cultivars than fresh marketed cultivars. If costs increase 10% the relationship is reversed. Reducing the cost of trees and support systems in high density systems by 10% can increase returns by 0.5 to 0.7%. If there is no crop due to frost in year four, high density fresh marketed apples have a higher reduction in rate of return than those for processing. However, if there is a frost in year eight, the 726 T/A system has a smaller reduction in returns than the 141 T/A system.

A system with the potential for an earlier return in the life of the orchard, such as the 340, 605, or 726 T/A system, is preferred to one which has a higher return later in life. The earlier return system allows a grower to take advantage of a change in consumer demand or technological change if it occurs many years after establishment. A grower also has greater flexibility to reduce farm size to 80 A and receive a similar rate of return. However, total revenue may decrease.

**Table 15. Internal Rate of Return for a Complete Crop Loss in Year 4, Year 8 or Both Years 4 and 8 for Different Orchard Systems for Fresh Marketed and Processed Golden Delicious Apples, 80 Acre Farm, 1990.**

<table>
<thead>
<tr>
<th>Year of Crop</th>
<th>141</th>
<th>340</th>
<th>605T&lt;sup&gt;1&lt;/sup&gt;</th>
<th>726T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Change in Internal Rate of Return</strong></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Fresh Yr 4</td>
<td>0.0</td>
<td>-0.7</td>
<td>-1.3</td>
<td>-1.6</td>
</tr>
<tr>
<td>Yr 8</td>
<td>-2.0</td>
<td>-2.7</td>
<td>-2.1</td>
<td>-1.8</td>
</tr>
<tr>
<td>Yr 4 &amp; 8</td>
<td>-2.0</td>
<td>-3.4</td>
<td>-3.4</td>
<td>-3.4</td>
</tr>
<tr>
<td>Processed Yr 4</td>
<td>-0.0</td>
<td>-0.4</td>
<td>-0.6</td>
<td>-0.8</td>
</tr>
<tr>
<td>Yr 8</td>
<td>-1.6</td>
<td>-2.3</td>
<td>-1.7</td>
<td>-1.4</td>
</tr>
<tr>
<td>Yr 4 &amp; 8</td>
<td>-1.6</td>
<td>-2.7</td>
<td>-2.3</td>
<td>-2.2</td>
</tr>
</tbody>
</table>

<sup>1</sup>Analyzed for trellis system, which would be similar to spindle system at same density.
in management decisions. The medium density of 340 T/A would appear well suited to growers who have large acreages (probably 80 acres or more). The spindle or trellis system would be suitable for growers located where land is limited, such as metropolitan areas. Growers who have limited farm size (40 acres) and are located near metropolitan areas can provide high quality select fruit for niche markets. Establishing a reputation for quality, understanding costs, and responding to market demands will provide long-term benefits.

References


Appendix A

Overhead, Material Costs and Product Prices
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Table 1. Cost of Trees and Materials for Different Orchard Systems in the First Establishment Year.

<table>
<thead>
<tr>
<th>System</th>
<th>Trees/Acre</th>
<th>System Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Standing</td>
<td>141</td>
<td>$4.70 each</td>
</tr>
<tr>
<td>trees—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified Slender Spindle</td>
<td>340</td>
<td>$4.70 each</td>
</tr>
<tr>
<td>Trees—</td>
<td></td>
<td>$1.30 each</td>
</tr>
<tr>
<td>Conduit—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T/A—Trellis</td>
<td>605 or 726</td>
<td>$5.15 each</td>
</tr>
<tr>
<td>Trees—</td>
<td></td>
<td>$6.00 each</td>
</tr>
<tr>
<td>Posts—8' 4&quot;—(32)</td>
<td></td>
<td>$0.02/ft.</td>
</tr>
<tr>
<td>—8' 3&quot;—(112)</td>
<td></td>
<td>$3.80 each</td>
</tr>
<tr>
<td>Wire—(14,600)</td>
<td></td>
<td>$0.02/ft.</td>
</tr>
<tr>
<td>Anchors—(32)</td>
<td></td>
<td>$6.00 each</td>
</tr>
<tr>
<td>Ties—(1815)</td>
<td></td>
<td>$35.00/1000</td>
</tr>
<tr>
<td>Wire vise—(16)</td>
<td></td>
<td>$3.00 each</td>
</tr>
<tr>
<td>Modified Slender Spindle</td>
<td>605 or 726</td>
<td>$5.15 each</td>
</tr>
<tr>
<td>Trees—</td>
<td></td>
<td>$5.00 each</td>
</tr>
<tr>
<td>Post—8' 4&quot;—(32)</td>
<td></td>
<td>$0.45 each</td>
</tr>
<tr>
<td>—8' 3&quot;—(32)</td>
<td></td>
<td>$3.80 each</td>
</tr>
<tr>
<td>Bamboo—6'</td>
<td></td>
<td>$0.25/lb actual</td>
</tr>
<tr>
<td>Wire—(7200 ft.)</td>
<td></td>
<td>$0.25/lb actual</td>
</tr>
<tr>
<td>Wire vise—(16)</td>
<td></td>
<td>$0.15/lb actual</td>
</tr>
<tr>
<td>Ties—(2178)</td>
<td></td>
<td>$0.65/lb actual</td>
</tr>
<tr>
<td>For all Systems(^1)</td>
<td></td>
<td>$16.00/ton</td>
</tr>
<tr>
<td>Lime—</td>
<td></td>
<td>$0.33/lb actual</td>
</tr>
<tr>
<td>Nitrogen—</td>
<td></td>
<td>$0.33/lb actual</td>
</tr>
<tr>
<td>Phosphorus—</td>
<td></td>
<td>$0.25/lb actual</td>
</tr>
<tr>
<td>Potassium—</td>
<td></td>
<td>$0.15/lb actual</td>
</tr>
<tr>
<td>Grass seed</td>
<td></td>
<td>$0.15/lb actual</td>
</tr>
</tbody>
</table>

\(^1\)In year zero, 3 tons of lime and 0-50-100 pounds actual phosphorus and potassium per acre are worked into the soil. A fescue is sown at the rate of 25 lb. per acre.

Table 2. Estimated Overhead Costs per Acre for Different Farm Sizes\(^1\), 1990.

<table>
<thead>
<tr>
<th>Item</th>
<th>40A</th>
<th>80A</th>
<th>160A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>$17.00</td>
<td>$12.00</td>
<td>$10.12</td>
</tr>
<tr>
<td>Telephone, postage</td>
<td>21.25</td>
<td>13.12</td>
<td>9.06</td>
</tr>
<tr>
<td>Accounting</td>
<td>8.75</td>
<td>5.62</td>
<td>4.06</td>
</tr>
<tr>
<td>Pickup</td>
<td>75.18</td>
<td>42.69</td>
<td>23.9</td>
</tr>
<tr>
<td>Building &amp; Shop</td>
<td>43.12</td>
<td>25.62</td>
<td>23.75</td>
</tr>
<tr>
<td>Roads &amp; Signs</td>
<td>18.75</td>
<td>11.87</td>
<td>7.81</td>
</tr>
<tr>
<td>Toilet Rental</td>
<td>3.00</td>
<td>3.00</td>
<td>2.25</td>
</tr>
<tr>
<td>Taxes</td>
<td>37.50</td>
<td>37.50</td>
<td>37.50</td>
</tr>
<tr>
<td>Education</td>
<td>17.50</td>
<td>13.75</td>
<td>9.38</td>
</tr>
<tr>
<td>Total/Acre/Year</td>
<td>$242.05</td>
<td>$165.17</td>
<td>$127.84</td>
</tr>
</tbody>
</table>

\(^1\)Indicates a farm having 40, 80, or 160 A with 30, 60 and 120 A of fruit crops.
Table 3. Estimated Overhead Costs per Acre for Different Farm Sizes¹, 1990.

<table>
<thead>
<tr>
<th>Item</th>
<th>Costs Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40A</td>
</tr>
<tr>
<td>Electricity</td>
<td>$680</td>
</tr>
<tr>
<td>Telephone, postage</td>
<td>850</td>
</tr>
<tr>
<td>Accounting</td>
<td>225</td>
</tr>
<tr>
<td>Pickup</td>
<td>3007</td>
</tr>
<tr>
<td>Building &amp; Shop</td>
<td>1725</td>
</tr>
<tr>
<td>Roads &amp; Signs</td>
<td>750</td>
</tr>
<tr>
<td>Toilet Rental</td>
<td>120</td>
</tr>
<tr>
<td>Taxes</td>
<td>1500</td>
</tr>
<tr>
<td>Education</td>
<td>700</td>
</tr>
<tr>
<td>Total/Farm/Year</td>
<td>$9,557</td>
</tr>
</tbody>
</table>

¹Indicates a farm having 40, 80 or 160 A, with 30, 60 and 120 A of fruit crops.


<table>
<thead>
<tr>
<th>Pesticide¹</th>
<th>Price/unit</th>
<th>Standard Planting²</th>
<th>Intensive Planting³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fresh (60% of full rates)³</td>
<td>Processing (60% of full rates)³</td>
</tr>
<tr>
<td>Asana XL (gal)</td>
<td>$96.72</td>
<td>3.6 oz</td>
<td>3.6 oz</td>
</tr>
<tr>
<td>Benlate 50DF (lb)</td>
<td>14.02</td>
<td>1.5 lb</td>
<td>—</td>
</tr>
<tr>
<td>Captan 50 W (lb)</td>
<td>1.58</td>
<td>19.5 lb</td>
<td>9.8 lb</td>
</tr>
<tr>
<td>Carzol 92SP (lb)</td>
<td>22.37</td>
<td>9.6 oz</td>
<td>9.6 oz</td>
</tr>
<tr>
<td>Copper Sulfate (lb)</td>
<td>0.79</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Dimethoate 400 (Cygon)</td>
<td>27.00</td>
<td>14.4 oz</td>
<td>14.4 oz</td>
</tr>
<tr>
<td>Dodine 65W (lb)</td>
<td>5.41</td>
<td>14.4 oz</td>
<td>14.4 oz</td>
</tr>
<tr>
<td>Guthion 35W (lb)</td>
<td>3.52</td>
<td>4.8 lb</td>
<td>—</td>
</tr>
<tr>
<td>Lannate 1.8L (gal)</td>
<td>33.85</td>
<td>6.0 pt</td>
<td>—</td>
</tr>
<tr>
<td>Lime (lb)</td>
<td>.02</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>NAA (Stik) (oz)</td>
<td>5.68</td>
<td>4.8 oz</td>
<td>4.8 oz</td>
</tr>
<tr>
<td>Nova 40W (oz)</td>
<td>14.07</td>
<td>15.0 oz</td>
<td>15.0 oz</td>
</tr>
<tr>
<td>Oil (gal)</td>
<td>2.26</td>
<td>4.8 gal</td>
<td>4.8 gal</td>
</tr>
<tr>
<td>Omite 6EC (gal)</td>
<td>68.52</td>
<td>28.8 oz</td>
<td>4.4 oz</td>
</tr>
<tr>
<td>Parathon 15W (lb)</td>
<td>1.08</td>
<td>10.8 lb</td>
<td>—</td>
</tr>
<tr>
<td>Penncap-M (gal)</td>
<td>18.84</td>
<td>6.0 pt</td>
<td>5.4 pt</td>
</tr>
<tr>
<td>Streptomycin 17W (lb)</td>
<td>7.60</td>
<td>3.6 lb</td>
<td>3.6 lb</td>
</tr>
<tr>
<td>Sulfur 92W (lb)</td>
<td>0.22</td>
<td>—</td>
<td>21.0 lb</td>
</tr>
<tr>
<td>Calcium Chloride (lb)</td>
<td>0.15</td>
<td>18.0 lb</td>
<td>24.0 lb</td>
</tr>
<tr>
<td>Solubor (lb)</td>
<td>0.60</td>
<td>4.0 lb</td>
<td>4.0 lb</td>
</tr>
<tr>
<td>Total Cost/Yr</td>
<td>$284.91</td>
<td>$230.14</td>
<td>$132.77</td>
</tr>
</tbody>
</table>

¹Where trade names are used, no discrimination toward similar products is implied nor intended.
²Assume lime ($8/A), potassium ($7.50/A), herbicide ($46.46/A), nitrogen and other nutrients ($11.00/A) would give a total of $358/A and $303/A per season for standard fresh and processing blocks, respectively and $206/A and $218/A for intensive fresh and processing blocks, respectively.
³Based on tree-row-volume calculations for trees 12 ft high, 16 ft wide and spaced 16 ft x 24 ft.
⁴Based on tree-row-volume calculations for trees 6 ft high, 6 ft wide and spaced 6 ft x 12 ft.
⁵Based on tree-row-volume calculations for trees 9 ft high, 8 ft wide and spaced 8 ft x 16 ft.
Table 5. Estimated Hours of Equipment Use for Different Farm Sizes\textsuperscript{1}, Having Fruit Crops, 1990.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>40A</th>
<th>80A</th>
<th>160A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor 85D\textsuperscript{2}</td>
<td>0</td>
<td>0</td>
<td>700</td>
</tr>
<tr>
<td>Tractor 65D (55D)\textsuperscript{3}</td>
<td>250</td>
<td>500</td>
<td>400</td>
</tr>
<tr>
<td>Tractor 45D (28D)\textsuperscript{3}</td>
<td>150</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>Airblast Sprayer</td>
<td>140</td>
<td>275</td>
<td>530</td>
</tr>
<tr>
<td>HydraLadder</td>
<td>0</td>
<td>0</td>
<td>400</td>
</tr>
<tr>
<td>Herbicide Sprayer</td>
<td>40</td>
<td>80</td>
<td>160</td>
</tr>
<tr>
<td>Mower</td>
<td>90</td>
<td>160</td>
<td>250</td>
</tr>
<tr>
<td>Front Rear Fork Lift</td>
<td>150</td>
<td>260</td>
<td>480</td>
</tr>
<tr>
<td>Fertilizer Spreader</td>
<td>15</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Subsoiler</td>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

\textsuperscript{1}A 40 A farm has 30 A, an 80 A farm has 60 A, and a 160 A farm has 120 A of fruit.
\textsuperscript{2}A 65D is a tractor with a diesel motor with a capacity of 65 horse power.
\textsuperscript{3}A 65D and 55D are used the same number of hours/farm, but the smaller tractor is used in intensive systems.

Table 6. Equipment Hours\textsuperscript{1} Required for Pesticide and Growth Regulator Application per Year in Different Orchard Densities, 1990.

<table>
<thead>
<tr>
<th>Years</th>
<th>141 T/A</th>
<th>340 T/A</th>
<th>605 T/A</th>
<th>726 T/A\textsuperscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1</td>
<td>2.0</td>
<td>2.3</td>
<td>3.1</td>
<td>3.1</td>
</tr>
<tr>
<td>2</td>
<td>2.8</td>
<td>3.4</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>3</td>
<td>4.9</td>
<td>5.7</td>
<td>7.1</td>
<td>7.1</td>
</tr>
<tr>
<td>4</td>
<td>5.3</td>
<td>6.3</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td>5</td>
<td>5.6</td>
<td>6.6</td>
<td>8.2</td>
<td>8.2</td>
</tr>
<tr>
<td>6</td>
<td>5.9</td>
<td>7.0</td>
<td>8.7</td>
<td>8.7</td>
</tr>
<tr>
<td>7</td>
<td>6.2</td>
<td>7.3</td>
<td>9.1</td>
<td>9.1</td>
</tr>
<tr>
<td>8</td>
<td>6.3</td>
<td>7.4</td>
<td>9.2</td>
<td>9.2</td>
</tr>
<tr>
<td>9</td>
<td>5.3</td>
<td>6.4</td>
<td>8.2</td>
<td>8.2</td>
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<tr>
<td>10</td>
<td>5.1</td>
<td>6.2</td>
<td>8.0</td>
<td>8.0</td>
</tr>
<tr>
<td>11</td>
<td>5.6</td>
<td>6.6</td>
<td>8.2</td>
<td>8.2</td>
</tr>
<tr>
<td>12</td>
<td>6.3</td>
<td>7.4</td>
<td>9.2</td>
<td>9.2</td>
</tr>
<tr>
<td>13</td>
<td>5.1</td>
<td>6.2</td>
<td>8.0</td>
<td>8.0</td>
</tr>
<tr>
<td>14</td>
<td>5.3</td>
<td>6.4</td>
<td>8.2</td>
<td>8.2</td>
</tr>
<tr>
<td>15</td>
<td>6.3</td>
<td>7.4</td>
<td>9.2</td>
<td>9.2</td>
</tr>
</tbody>
</table>

\textsuperscript{1}Based on records from D. C. Ferree, Wooster, Ohio. 15 to 18 sprays on bearing trees and two herbicide applications (1 hr/A). Mowing averaged 2.2 hours (not included) at 5 to 9 mowings per A per year. Hydra ladder use in year 8 thru 15 for 141 trees/A only (not included).
\textsuperscript{2}726 T/A had same number of rows/A as 605 trees/A, but trees planted closer.
Table 7. Equipment Cost per Hour for Different Farm Sizes, 1990.

<table>
<thead>
<tr>
<th>Item1</th>
<th>Initial Cost</th>
<th>Salvage Value</th>
<th>40A</th>
<th>80A</th>
<th>160A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor 85D2 w/cab</td>
<td>$39,000</td>
<td>$9,750</td>
<td>---</td>
<td>---</td>
<td>$15.24</td>
</tr>
<tr>
<td>Tractor 65D2 w/cab</td>
<td>31,308</td>
<td>7,827</td>
<td>---</td>
<td>14.03</td>
<td>12.02</td>
</tr>
<tr>
<td>Tractor 55D2 w/cab</td>
<td>28,322</td>
<td>7,080</td>
<td>16.17</td>
<td>11.41</td>
<td>---</td>
</tr>
<tr>
<td>Tractor 55D2</td>
<td>20,490</td>
<td>5,122</td>
<td>---</td>
<td>17.08</td>
<td>12.49</td>
</tr>
<tr>
<td>Tractor 45D2 w/cab</td>
<td>25,640</td>
<td>6,410</td>
<td>17.08</td>
<td>12.02</td>
<td>---</td>
</tr>
<tr>
<td>Tractor 45D4</td>
<td>23,640</td>
<td>5,910</td>
<td>24.58</td>
<td>17.58</td>
<td>16.41</td>
</tr>
<tr>
<td>Tractor 45D2</td>
<td>17,640</td>
<td>4,410</td>
<td>14.26</td>
<td>10.20</td>
<td>9.56</td>
</tr>
<tr>
<td>Tractor 28D4</td>
<td>13,472</td>
<td>3,368</td>
<td>14.26</td>
<td>10.20</td>
<td>9.56</td>
</tr>
<tr>
<td>Sprayer 500PTO</td>
<td>14,775</td>
<td>3,694</td>
<td>---</td>
<td>7.10</td>
<td>4.32</td>
</tr>
<tr>
<td>Sprayer 400PTO</td>
<td>11,352</td>
<td>2,838</td>
<td>---</td>
<td>7.10</td>
<td>4.32</td>
</tr>
<tr>
<td>Sprayer 300PTO</td>
<td>9,143</td>
<td>2,286</td>
<td>9.97</td>
<td>5.63</td>
<td>---</td>
</tr>
<tr>
<td>Sprayer 100PTO</td>
<td>6,076</td>
<td>1,519</td>
<td>6.72</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Sprayer Herbicide 100</td>
<td>2,285</td>
<td>571</td>
<td>9.15</td>
<td>5.19</td>
<td>3.00</td>
</tr>
<tr>
<td>Mower 9ft</td>
<td>5,100</td>
<td>510</td>
<td>7.19</td>
<td>5.06</td>
<td>3.90</td>
</tr>
<tr>
<td>Mower 6ft</td>
<td>3,587</td>
<td>359</td>
<td>6.00</td>
<td>3.88</td>
<td>2.82</td>
</tr>
<tr>
<td>Hydraladder</td>
<td>7,000</td>
<td>1,750</td>
<td>---</td>
<td>---</td>
<td>5.36</td>
</tr>
<tr>
<td>Front &amp; Rear Forklifts</td>
<td>4,225</td>
<td>423</td>
<td>4.33</td>
<td>2.88</td>
<td>1.81</td>
</tr>
<tr>
<td>Fertilizer Spreader</td>
<td>1,050</td>
<td>105</td>
<td>12.20</td>
<td>6.20</td>
<td>3.20</td>
</tr>
<tr>
<td>Well, Pump, Tanks3</td>
<td>9,000</td>
<td>900</td>
<td>26.69</td>
<td>13.42</td>
<td>6.78</td>
</tr>
</tbody>
</table>

1Describes a tractor having 85, 65, 55, 45 or 28 horsepower, diesel, 2 or 4 wheel drive with cab or without cab.
2Includes straight line depreciation, interest at 11%, shelter and insurance, fuel at $1.20/gal with 30% added for oil, filters and lubricant, and repair. A 40, 80 or 160 A farm has 15, 12, or 10 year life, respectively and different hours of use per year. See Table 5.
3Cost per acre per year.

Table 8. Equipment Rental Rates Used on All Farm Sizes, 1990.

<table>
<thead>
<tr>
<th>Item1</th>
<th>Initial Cost</th>
<th>Salvage Value</th>
<th>Total Cost/Hr2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree Planter</td>
<td>$2050</td>
<td>$205</td>
<td>$14.75</td>
</tr>
<tr>
<td>Plow-316</td>
<td>2610</td>
<td>261</td>
<td>19.91</td>
</tr>
<tr>
<td>Disk-8FT</td>
<td>4200</td>
<td>420</td>
<td>30.26</td>
</tr>
<tr>
<td>Post Driver3</td>
<td>850</td>
<td>51</td>
<td>4.68</td>
</tr>
</tbody>
</table>

1All have a 15 year life, straight line depreciation, with 20 hours per year except for post driver which has 30 hours per year.
2Costs include depreciation, interest at 11%, shelter, insurance and repair.
3Post driver is used to establish posts for support systems.
Table 9. Estimated Hours\(^1\) per Acre of Pruning and Training for Different Cultivars, 141 Trees/Acre, Freestanding.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Pruning and Training (Hours/Acre)</th>
<th>York Imperial</th>
<th>Spur Delicious</th>
<th>Golden Delicious</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.8</td>
<td>1.7</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>6.5</td>
<td>4.2</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>19.4</td>
<td>8.1</td>
<td>19.3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>12.4</td>
<td>11.5</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>30.4</td>
<td>23.1</td>
<td>31.7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>24.6</td>
<td>15.4</td>
<td>20.3</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>38.6</td>
<td>23.2</td>
<td>36.8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>27.9</td>
<td>19.1</td>
<td>29.6</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>30.1</td>
<td>24.4</td>
<td>38.9</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>26.4</td>
<td>11.8</td>
<td>32.1</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>38.2</td>
<td>26.1</td>
<td>27.4</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>29.2</td>
<td>12.4</td>
<td>38.5</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>26.8</td>
<td>23.6</td>
<td>26.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>324.5</td>
<td>196.8</td>
<td>324.3</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)Includes summer and winter pruning and training. 36.8 hrs/A=15.6 min./tree. Based on records from D. C. Ferree, Wooster.

Table 10. Estimated Hours\(^1\) per Acre of Pruning and Training for Different Cultivars, 340 Trees/Acre, Trained to Slender Spindle.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Pruning and Training (Hours/Acre)</th>
<th>York Imperial</th>
<th>Spur Delicious</th>
<th>Golden Delicious</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.8</td>
<td>2.8</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
<td>0.6</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.0</td>
<td>0.6</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>6.7</td>
<td>4.2</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>8.8</td>
<td>4.7</td>
<td>9.4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>13.8</td>
<td>9.5</td>
<td>13.4</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>23.6</td>
<td>18.7</td>
<td>22.8</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>24.2</td>
<td>19.1</td>
<td>23.6</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>22.8</td>
<td>21.0</td>
<td>29.8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>25.0</td>
<td>18.6</td>
<td>24.0</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>35.0</td>
<td>18.5</td>
<td>34.7</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>29.2</td>
<td>20.7</td>
<td>28.2</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>31.2</td>
<td>19.4</td>
<td>33.0</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>36.4</td>
<td>19.1</td>
<td>36.1</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>30.2</td>
<td>11.2</td>
<td>31.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>291.1</td>
<td>198.7</td>
<td>298.1</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)Includes summer and winter pruning and training. 34.7 hrs/A=8.6 min./tree. Based on records from D. C. Ferree, Wooster.
### Table 11. Estimated Hours\(^1\) per Acre of Pruning and Training for Different Cultivars, 605 Trees/Acre, Trellised.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>York Imperial</th>
<th>Spur Delicious</th>
<th>Golden Delicious</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td>2</td>
<td>6.7</td>
<td>5.6</td>
<td>6.9</td>
</tr>
<tr>
<td>3</td>
<td>11.4</td>
<td>5.8</td>
<td>12.9</td>
</tr>
<tr>
<td>4</td>
<td>21.8</td>
<td>12.0</td>
<td>24.1</td>
</tr>
<tr>
<td>5</td>
<td>31.2</td>
<td>21.4</td>
<td>32.0</td>
</tr>
<tr>
<td>6</td>
<td>34.8</td>
<td>27.4</td>
<td>36.8</td>
</tr>
<tr>
<td>7</td>
<td>35.8</td>
<td>20.7</td>
<td>38.6</td>
</tr>
<tr>
<td>8</td>
<td>44.5</td>
<td>18.1</td>
<td>44.5</td>
</tr>
<tr>
<td>9</td>
<td>34.5</td>
<td>22.1</td>
<td>33.6</td>
</tr>
<tr>
<td>10</td>
<td>30.2</td>
<td>11.3</td>
<td>34.5</td>
</tr>
<tr>
<td>11</td>
<td>31.8</td>
<td>19.2</td>
<td>30.2</td>
</tr>
<tr>
<td>12</td>
<td>34.2</td>
<td>24.1</td>
<td>35.2</td>
</tr>
<tr>
<td>13</td>
<td>33.1</td>
<td>23.6</td>
<td>32.4</td>
</tr>
<tr>
<td>14</td>
<td>32.5</td>
<td>20.4</td>
<td>36.4</td>
</tr>
<tr>
<td>15</td>
<td>32.4</td>
<td>21.3</td>
<td>30.5</td>
</tr>
<tr>
<td>Total</td>
<td>417.2</td>
<td>255.3</td>
<td>430.9</td>
</tr>
</tbody>
</table>

\(^1\)Includes summer and winter pruning and training. 38.6 hrs/A = 3.8 min./tree. Based on records from D. C. Ferree, Wooster.

### Table 12. Estimated Hours\(^1\) per Acre of Pruning and Training for Different Cultivars, 605 Trees/Acre, Trained to Slender Spindle.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>York Imperial</th>
<th>Spur Delicious</th>
<th>Golden Delicious</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.3</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td>2</td>
<td>1.6</td>
<td>1.2</td>
<td>1.6</td>
</tr>
<tr>
<td>3</td>
<td>3.4</td>
<td>2.5</td>
<td>3.6</td>
</tr>
<tr>
<td>4</td>
<td>5.1</td>
<td>4.8</td>
<td>4.6</td>
</tr>
<tr>
<td>5</td>
<td>5.6</td>
<td>5.9</td>
<td>5.8</td>
</tr>
<tr>
<td>6</td>
<td>12.9</td>
<td>7.0</td>
<td>12.6</td>
</tr>
<tr>
<td>7</td>
<td>22.9</td>
<td>17.9</td>
<td>24.2</td>
</tr>
<tr>
<td>8</td>
<td>33.9</td>
<td>20.3</td>
<td>38.7</td>
</tr>
<tr>
<td>9</td>
<td>38.9</td>
<td>22.4</td>
<td>40.3</td>
</tr>
<tr>
<td>10</td>
<td>42.2</td>
<td>24.2</td>
<td>45.2</td>
</tr>
<tr>
<td>11</td>
<td>43.0</td>
<td>26.7</td>
<td>43.0</td>
</tr>
<tr>
<td>12</td>
<td>49.4</td>
<td>32.6</td>
<td>45.9</td>
</tr>
<tr>
<td>13</td>
<td>45.9</td>
<td>29.4</td>
<td>49.1</td>
</tr>
<tr>
<td>14</td>
<td>42.2</td>
<td>29.0</td>
<td>43.0</td>
</tr>
<tr>
<td>15</td>
<td>46.0</td>
<td>32.4</td>
<td>39.1</td>
</tr>
<tr>
<td>Total</td>
<td>398.5</td>
<td>261.6</td>
<td>402.0</td>
</tr>
</tbody>
</table>

\(^1\)Includes summer and winter pruning and training. 38.7 hrs/A = 3.8 min./tree. Based on records from D.C. Ferree, Wooster.
Table 13. Estimated Hours\(^1\) per Acre of Pruning and Training for Different Cultivars, 726 Trees/Acre, Trellised.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Pruning and Training (Hours/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>York Imperial</td>
</tr>
<tr>
<td>1</td>
<td>2.8</td>
</tr>
<tr>
<td>2</td>
<td>8.0</td>
</tr>
<tr>
<td>3</td>
<td>13.7</td>
</tr>
<tr>
<td>4</td>
<td>26.2</td>
</tr>
<tr>
<td>5</td>
<td>37.4</td>
</tr>
<tr>
<td>6</td>
<td>41.8</td>
</tr>
<tr>
<td>7</td>
<td>44.2</td>
</tr>
<tr>
<td>8</td>
<td>43.4</td>
</tr>
<tr>
<td>9</td>
<td>33.7</td>
</tr>
<tr>
<td>10</td>
<td>32.2</td>
</tr>
<tr>
<td>11</td>
<td>34.2</td>
</tr>
<tr>
<td>12</td>
<td>43.0</td>
</tr>
<tr>
<td>13</td>
<td>35.7</td>
</tr>
<tr>
<td>14</td>
<td>35.0</td>
</tr>
<tr>
<td>15</td>
<td>40.9</td>
</tr>
<tr>
<td>Total</td>
<td>470.2</td>
</tr>
</tbody>
</table>

\(^1\)Includes summer and winter pruning and training. 49.0 hrs/A = 4.0 min./tree. Based on records from D.C. Ferree, Wooster.

Table 14. Estimated Hours\(^1\) per Acre of Pruning and Training for Different Cultivars, 726 Trees/Acre, Trained to Slender Spindle.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Pruning and Training (Hours/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>York Imperial</td>
</tr>
<tr>
<td>1</td>
<td>6.6</td>
</tr>
<tr>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>4</td>
<td>6.4</td>
</tr>
<tr>
<td>5</td>
<td>7.0</td>
</tr>
<tr>
<td>6</td>
<td>16.1</td>
</tr>
<tr>
<td>7</td>
<td>28.6</td>
</tr>
<tr>
<td>8</td>
<td>37.4</td>
</tr>
<tr>
<td>9</td>
<td>43.6</td>
</tr>
<tr>
<td>10</td>
<td>50.7</td>
</tr>
<tr>
<td>11</td>
<td>50.1</td>
</tr>
<tr>
<td>12</td>
<td>49.2</td>
</tr>
<tr>
<td>13</td>
<td>48.6</td>
</tr>
<tr>
<td>14</td>
<td>47.8</td>
</tr>
<tr>
<td>15</td>
<td>46.2</td>
</tr>
<tr>
<td>Total</td>
<td>445.1</td>
</tr>
</tbody>
</table>

\(^1\)Includes summer and winter pruning and training. 48.2 hrs/A = 4.0 min./tree. Based on records from D.C. Ferree, Wooster.
### Table 15. Total Cost Per Bushel For Harvesting Apples, 1990.

<table>
<thead>
<tr>
<th>Market</th>
<th>Piece Rate¹</th>
<th>Housing</th>
<th>Social Security²</th>
<th>Bin³</th>
<th>Labor⁴</th>
<th>Transport⁵</th>
<th>Supervision⁶</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processed</td>
<td>$.50</td>
<td>$.05</td>
<td>$.04</td>
<td>$.09</td>
<td>$.05</td>
<td>$.12</td>
<td>$.06</td>
<td>$.91</td>
</tr>
<tr>
<td>Fresh</td>
<td>$.56</td>
<td>$.05</td>
<td>$.04</td>
<td>$.09</td>
<td>$.05</td>
<td>$.12</td>
<td>$.06</td>
<td>$.97</td>
</tr>
</tbody>
</table>

¹For 25 bushel bin, piece rate is $12.50 for processed and $14.00 for fresh fruit.
²Social Security is $.0765/$1.00.
³Original cost is $35.00, repair is 25% original value and life is 10 yr. Used twice per season.
⁴Assumes labor to move bins in and out of orchard at 40 bins/8 hours.
⁵Assumes all apples are transported to processor or packinghouse or to storage and returned to packinghouse by truck.
⁶Assumes one person for 12 people/day. Does not refer to crew leader.

### Table 16. Cost Per Packed, Stored and Unstored Box, Fresh Marketed Apples, 1990.

<table>
<thead>
<tr>
<th>Type Box</th>
<th>Cost/Box</th>
<th>Package</th>
<th>Labor</th>
<th>Commission/</th>
<th>Unstored</th>
<th>Storage³</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Equipment¹</td>
<td>Handling</td>
<td>Promotion</td>
<td>Total</td>
<td>Reg.</td>
<td>CA</td>
</tr>
<tr>
<td>12/3 Bags (36 Lb)</td>
<td>$1.25</td>
<td>$1.00</td>
<td>$.30</td>
<td>$.55</td>
<td>$3.10</td>
<td>$.70</td>
<td>$1.15</td>
</tr>
<tr>
<td>Trays (42 lb.)</td>
<td>$1.95</td>
<td>$1.00</td>
<td>$.30</td>
<td>$.55</td>
<td>$3.80</td>
<td>$.70</td>
<td>$1.15</td>
</tr>
</tbody>
</table>

¹Labor at $5.06/hr for grading and $6.90/hr stacking and moving, and $9.52/hr for supervision. Equipment includes grader, waxer, and forklift, moving an average of 150 boxes or more per hour.
²Handling is moving bins/boxes to and from grader to short term storage (10 to 14 days) and onto truck.
³Rental cost per box for 2 to 4 months of regular (Reg.) or 4 to 6 months controlled atmosphere (CA) storage.

### Table 17. Average Price (Sept.—May) Received Per lb. for Fresh Marketed Golden Delicious Apples, 1985-1989.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bags¹:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>$0.185</td>
<td>$0.257</td>
<td>$0.187</td>
<td>$0.213</td>
<td>$0.229</td>
<td>$0.211</td>
<td>$.185-.257</td>
</tr>
<tr>
<td>Controlled Atmosphere</td>
<td>$0.222</td>
<td>$0.278</td>
<td>$0.215</td>
<td>$0.239</td>
<td>$0.243</td>
<td>$0.239</td>
<td>$.222-.278</td>
</tr>
<tr>
<td>Trays²:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>$0.286</td>
<td>$0.300</td>
<td>$0.214</td>
<td>$0.300</td>
<td>$0.245</td>
<td>$0.270</td>
<td>$.214-.300</td>
</tr>
<tr>
<td>Controlled Atmosphere</td>
<td>$0.262</td>
<td>$0.268</td>
<td>$0.226</td>
<td>$0.274</td>
<td>$0.274</td>
<td>$0.261</td>
<td>$.226-.274</td>
</tr>
</tbody>
</table>

¹12-3 lb film bags, U.S. Fancy or better, 21/4 inch minimum, FOB.
²42 lb box, U.S. Combination Extra Fancy & Fancy, mostly 72 to 125 size (3 3/8 inch - 2 13/16 inch), FOB.
³Average range of prices received 1985-1989.
Source: Marketing Appalachian District Apples, Federal/State Market News Service.
### Table 18. Average Price (Sept.—May) Received Per lb. for Fresh Marketed Red Delicious Apples, 1985-1989.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bags1:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>$0.199</td>
<td>$0.270</td>
<td>$0.199</td>
<td>$0.241</td>
<td>$0.214</td>
<td>$0.225</td>
<td>$.199—.270</td>
</tr>
<tr>
<td>Controlled Atmosphere</td>
<td>$0.236</td>
<td>$0.306</td>
<td>$0.227</td>
<td>$0.222</td>
<td>$0.212</td>
<td>$0.241</td>
<td>$.222—.306</td>
</tr>
<tr>
<td>Trays2:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>$0.251</td>
<td>$0.319</td>
<td>$0.224</td>
<td>$0.292</td>
<td>$0.245</td>
<td>$0.266</td>
<td>$.222—.319</td>
</tr>
<tr>
<td>Controlled Atmosphere</td>
<td>$0.286</td>
<td>$0.285</td>
<td>$0.196</td>
<td>$0.256</td>
<td>$0.223</td>
<td>$0.249</td>
<td>$.196—.286</td>
</tr>
</tbody>
</table>

12-3 lb film bags, U.S. Fancy or better, 2¼ inch minimum, FOB.  
242 lb box, U.S. Combination Extra Fancy & Fancy, mostly 72 to 125 size (3 3/8 inch — 2 13/16 inch), FOB.  
3Average range of prices received 1985-1989.  
Source: Marketing Appalachian District Apples, Federal/State Market News Service.

### Table 19. Net Price1 Received Per Box For Fresh Marketed Red and Golden Delicious Apples, 2¼ Inch, Extra Fancy/Fancy Grade, 1990.

<table>
<thead>
<tr>
<th>Cultivar/Box</th>
<th>Packing/Storage</th>
<th>Cost/lb</th>
<th>Packing</th>
<th>Avg</th>
<th>Return</th>
<th>Net Return Stored</th>
<th>Net Return Not Stored</th>
<th>Avg Net Return2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reg</td>
<td>CA</td>
<td>Avg</td>
<td>Only</td>
<td>Return</td>
<td>Stored</td>
<td>Not Stored</td>
<td>All Apples</td>
</tr>
<tr>
<td>Red Delicious</td>
<td>$0.106</td>
<td>$.118</td>
<td>$0.112</td>
<td>$.086</td>
<td>$.233</td>
<td>$.121</td>
<td>$.147</td>
<td>$.134</td>
</tr>
<tr>
<td>12/3 lb</td>
<td>$.107</td>
<td>$.118</td>
<td>$0.112</td>
<td>$.090</td>
<td>$.257</td>
<td>$.145</td>
<td>$.167</td>
<td>$.156</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>$0.106</td>
<td>$.118</td>
<td>$0.112</td>
<td>$.086</td>
<td>$.225</td>
<td>$.113</td>
<td>$.139</td>
<td>$.126</td>
</tr>
<tr>
<td>12/3 lb</td>
<td>$.107</td>
<td>$.118</td>
<td>$0.112</td>
<td>$.090</td>
<td>$.266</td>
<td>$.154</td>
<td>$.176</td>
<td>$.165</td>
</tr>
</tbody>
</table>

1In this study, 25% of all apples are stored in regular storage, 25% are stored in CA storage, and 50% are sold without long term storage (packing only).  
2Based on average price received for 12/3s and trays, 1985-1989. See Tables 17 and 18. Avg net return for all apples, 2¼ inch, 12/3 lb box for both Red and Golden Delicious was $.104 and for juice was $.0447.

### Table 20. Prices Paid for York Imperial and Golden Delicious for Processing, 1985-1989.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2¼ inch and up</td>
<td>$0.0838</td>
<td>$0.0788</td>
<td>$0.0875</td>
<td>$0.0925</td>
<td>$0.1000</td>
<td>$0.0885</td>
</tr>
<tr>
<td>2½ inch— 2¾ inch</td>
<td>$0.0638</td>
<td>$0.0712</td>
<td>$0.0875</td>
<td>$0.0850</td>
<td>$0.0950</td>
<td>$0.0772</td>
</tr>
<tr>
<td>Other</td>
<td>$0.0325</td>
<td>$0.0550</td>
<td>$0.0362</td>
<td>$0.0450</td>
<td>$0.0550</td>
<td>$0.0447</td>
</tr>
<tr>
<td>Juice</td>
<td>$0.0350</td>
<td>$0.0425</td>
<td>$0.0462</td>
<td>$0.0500</td>
<td>$0.0500</td>
<td>$0.0447</td>
</tr>
</tbody>
</table>

Source: Marketing Appalachian District Apples, Federal/State Market News Service.
<table>
<thead>
<tr>
<th>Farm Size</th>
<th>Housing Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>40A:</td>
<td>No Housing Provided but Transportation Provided.</td>
</tr>
<tr>
<td>80A:</td>
<td>8 People for July 1 to November 1. 2 Trailers (used) 12 ft x 60 ft, $5,000 Each Plus $8000 Sewage. Total Value=$20,000. Depreciation 12 years; $5000 Salvage Value. Depreciation = $1,250.00/yr. Repair = 321.50/yr. Tax, Insurance = 240.00/yr. Interest (10%) = 525.00/yr. Utilities = 600.00/yr. Total = $2,927.50/yr. $365.94/person/year or $.046/bushel¹</td>
</tr>
<tr>
<td>160A:</td>
<td>35 People for July 1 to November 1. 1 Block Building, $80,000 plus $10,000 Sewage. Depreciation 20 years; $22,500 Salvage Value. Depreciation = $3,375.00/yr. Repair = 1,125.00/yr. Tax, Insurance = 1,600.00/yr. Utilities = 5,625.00/yr. Interest (10%) = 2,100.00/yr. Total = $13,825.00/yr. $395.00/person/year or $.049/bushel²</td>
</tr>
</tbody>
</table>

¹12 months/yr., 40 days labor=4000 bu./person/season. $182.97 divided by 4000 bushels harvested=$.046/bushel. ²$197.59 divided by 4000 bushels harvested=$.049/bushel. Source: Ron Slonaker, Personal Communications, 1990.
Appendix B

Estimated Yield, Fruit Size, and Culls
Table 1. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for York Imperial, 141 Trees/Acre.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Actual Bu/Acre¹</th>
<th>5 Yr. Moving Avg. Bu/Acre</th>
<th>2 3/4&quot;—3 1/4&quot; &amp; up</th>
<th>2 1/4&quot;—2 3/4&quot;</th>
<th>Juice³</th>
<th>Cull Shrink⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>4</td>
<td>36.9</td>
<td>35.4</td>
<td>0.85</td>
<td>0.09</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>5</td>
<td>87.2</td>
<td>84.8</td>
<td>0.84</td>
<td>0.10</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>6</td>
<td>225.3</td>
<td>263.0</td>
<td>0.80</td>
<td>0.12</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>7</td>
<td>426.7</td>
<td>404.7</td>
<td>0.75</td>
<td>0.15</td>
<td>0.07</td>
<td>0.03</td>
</tr>
<tr>
<td>8</td>
<td>539.0</td>
<td>561.6</td>
<td>0.73</td>
<td>0.16</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td>9</td>
<td>745.4</td>
<td>726.5</td>
<td>0.61</td>
<td>0.26</td>
<td>0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>10</td>
<td>871.4</td>
<td>830.4</td>
<td>0.65</td>
<td>0.21</td>
<td>0.09</td>
<td>0.05</td>
</tr>
<tr>
<td>11</td>
<td>1050.1</td>
<td>942.9</td>
<td>0.45</td>
<td>0.35</td>
<td>0.14</td>
<td>0.06</td>
</tr>
<tr>
<td>12</td>
<td>946.2</td>
<td>955.4</td>
<td>0.42</td>
<td>0.38</td>
<td>0.14</td>
<td>0.06</td>
</tr>
<tr>
<td>13</td>
<td>1101.4</td>
<td>965.8</td>
<td>0.55</td>
<td>0.27</td>
<td>0.12</td>
<td>0.06</td>
</tr>
<tr>
<td>14</td>
<td>807.8</td>
<td>1026.3</td>
<td>0.48</td>
<td>0.34</td>
<td>0.11</td>
<td>0.07</td>
</tr>
<tr>
<td>15</td>
<td>1102.1</td>
<td>954.9</td>
<td>0.56</td>
<td>0.29</td>
<td>0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>Total</td>
<td>7939.5</td>
<td>7751.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Based on records from S. S. Miller, USDA, Kearneysville, WV.
²Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).
³Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
⁴Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.

Table 2. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for Golden Delicious, 141 Trees/Acre.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Actual Bu/Acre¹</th>
<th>5 Yr. Moving Avg. Bu/Acre</th>
<th>2 3/4&quot;—3 1/4&quot; &amp; up</th>
<th>2 1/4&quot;—2 3/4&quot;</th>
<th>Juice³</th>
<th>Cull Shrink⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>12.6</td>
<td>10.4</td>
<td>0.75</td>
<td>0.18</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>4</td>
<td>35.8</td>
<td>39.1</td>
<td>0.74</td>
<td>0.19</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>5</td>
<td>186.9</td>
<td>156.4</td>
<td>0.70</td>
<td>0.23</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>6</td>
<td>167.3</td>
<td>303.7</td>
<td>0.65</td>
<td>0.25</td>
<td>0.08</td>
<td>0.02</td>
</tr>
<tr>
<td>7</td>
<td>378.1</td>
<td>439.1</td>
<td>0.63</td>
<td>0.26</td>
<td>0.08</td>
<td>0.03</td>
</tr>
<tr>
<td>8</td>
<td>749.1</td>
<td>604.1</td>
<td>0.51</td>
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<td>0.04</td>
</tr>
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<td>9</td>
<td>713.8</td>
<td>834.5</td>
<td>0.55</td>
<td>0.31</td>
<td>0.10</td>
<td>0.04</td>
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<tr>
<td>10</td>
<td>1011.8</td>
<td>898.9</td>
<td>0.35</td>
<td>0.45</td>
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<td>0.06</td>
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<td>1319.6</td>
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<td>0.08</td>
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<tr>
<td>12</td>
<td>700.2</td>
<td>1053.8</td>
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<td>0.46</td>
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<td>0.08</td>
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<tr>
<td>14</td>
<td>1161.1</td>
<td>909.6</td>
<td>0.32</td>
<td>0.48</td>
<td>0.12</td>
<td>0.08</td>
</tr>
<tr>
<td>15</td>
<td>658.2</td>
<td>752.6</td>
<td>0.44</td>
<td>0.39</td>
<td>0.11</td>
<td>0.06</td>
</tr>
<tr>
<td>Total</td>
<td>8172.1</td>
<td>7931.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Based on records from D. C. Elfving, Simcoe, Ontario, and D.C. Ferree, Wooster, Ohio.
²Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).
³Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
⁴Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.
### Table 3. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for Spur Red Delicious, 141 Trees/Acre.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Actual Bu/Acre</th>
<th>5 Yr. Moving Avg. Bu/Acre</th>
<th>Size/Grade %</th>
<th>Cull &amp; Shrink</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 3/4”—3 1/4” &amp; up</td>
<td>1 1/4”—2 3/4”</td>
</tr>
<tr>
<td>1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>4</td>
<td>44.2</td>
<td>30.4</td>
<td>0.90</td>
<td>0.06</td>
</tr>
<tr>
<td>5</td>
<td>101.2</td>
<td>94.9</td>
<td>0.90</td>
<td>0.06</td>
</tr>
<tr>
<td>6</td>
<td>286.0</td>
<td>292.0</td>
<td>0.82</td>
<td>0.11</td>
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<td>7</td>
<td>479.9</td>
<td>479.1</td>
<td>0.79</td>
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<td>8</td>
<td>548.5</td>
<td>660.1</td>
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<td>9</td>
<td>980.1</td>
<td>805.1</td>
<td>0.69</td>
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<td>1008.2</td>
<td>885.1</td>
<td>0.57</td>
<td>0.26</td>
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<td>1010.9</td>
<td>894.4</td>
<td>0.52</td>
<td>0.28</td>
</tr>
<tr>
<td>12</td>
<td>883.0</td>
<td>972.0</td>
<td>0.46</td>
<td>0.36</td>
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<tr>
<td>13</td>
<td>1023.2</td>
<td>920.8</td>
<td>0.49</td>
<td>0.34</td>
</tr>
<tr>
<td>14</td>
<td>936.8</td>
<td>903.6</td>
<td>0.44</td>
<td>0.37</td>
</tr>
<tr>
<td>15</td>
<td>750.3</td>
<td>825.4</td>
<td>0.56</td>
<td>0.31</td>
</tr>
<tr>
<td>Total</td>
<td>8050.3</td>
<td>7763.2</td>
<td>(-3.6%)</td>
<td></td>
</tr>
</tbody>
</table>

¹Based on records from D.C. Elfving, Simcoe, Ontario and L.D. Tukey, Penn State.
²Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).
³Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
⁴Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.

### Table 4. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for York Imperial, 340 Trees/Acre.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Actual Bu/Acre</th>
<th>5 Yr. Moving Avg. Bu/Acre</th>
<th>Size/Grade %</th>
<th>Cull &amp; Shrink</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 3/4”—3 1/4” &amp; up</td>
<td>1 1/4”—2 3/4”</td>
</tr>
<tr>
<td>1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
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<td>4</td>
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<td>85.6</td>
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<td>200.6</td>
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<td>408.0</td>
<td>455.1</td>
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<td>7</td>
<td>612.0</td>
<td>536.7</td>
<td>0.75</td>
<td>0.13</td>
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<td>8501.4</td>
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¹Based on records from S.S. Miller, USDA, Kearneysville, WV.
²Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).
³Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
⁴Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.
Table 5. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for Golden Delicious, 340 Trees/Acre.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Actual Bu/Acre</th>
<th>5 Yr. Moving Avg. Bu/Acre</th>
<th>2 3/4&quot;—3 1/4&quot; &amp; up</th>
<th>2 1/4&quot;—2 3/4&quot; &amp; up</th>
<th>Juice</th>
<th>Cull Shrink</th>
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<td>8922.2</td>
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1Based on records from D. C. Ferree, Wooster, Ohio.
2Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film bag).
3Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
4Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.

Table 6. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for Spur Red Delicious, 340 Trees/Acre.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Actual Bu/Acre</th>
<th>5 Yr. Moving Avg. Bu/Acre</th>
<th>2 3/4&quot;—3 1/4&quot; &amp; up</th>
<th>2 1/4&quot;—2 3/4&quot; &amp; up</th>
<th>Juice</th>
<th>Cull Shrink</th>
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</thead>
<tbody>
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<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
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<tr>
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<tr>
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<tr>
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<td>8569.8</td>
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</table>

1Based on records from L.D. Tukey, Penn State and D.C. Elfving, Simcoe, Ontario.
2Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film bag).
3Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
4Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.
Table 7. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for York Imperial, 605 Trees/Acre.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Actual Bu/Acre</th>
<th>5 Yr. Moving Avg. Bu/Acre</th>
<th>2 3/4”—3 1/4” &amp; up</th>
<th>2 1/4”—2 3/4”</th>
<th>Juice</th>
<th>Cull Shrink</th>
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1 Based on records from L.D. Tukey, Penn State.
2 Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).
3 Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
4 Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.

Table 8. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for Golden Delicious, 605 Trees/Acre.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Actual Bu/Acre</th>
<th>5 Yr. Moving Avg. Bu/Acre</th>
<th>2 3/4”—3 1/4” &amp; up</th>
<th>2 1/4”—2 3/4”</th>
<th>Juice</th>
<th>Cull Shrink</th>
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<tr>
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<td>9348.4</td>
<td>(−2.1%)</td>
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</table>

Based on records from L. D. Tukey, Penn State and D. C. Ferree, Ohio State, Wooster.
2 Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).
3 Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
4 Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.
Table 9. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for Spur Red Delicious, 605 Trees/Acre.

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Actual Bu/Acre1</th>
<th>5 Yr. Moving Avg. Bu/Acre</th>
<th>2 3/4&quot;—3 1/4&quot; &amp; up</th>
<th>2 1/4&quot;—2 3/4&quot;</th>
<th>Juice3</th>
<th>Cull</th>
<th>Shrink4</th>
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<td>0.00</td>
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Based on records from L. D. Tukey, Penn State and D. C. Elfving, Simcoe, Ontario.

2Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).

3Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.

4Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.

Table 10. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for York Imperial, 726 Trees/Acre.

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<th>Tree Age</th>
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<th>5 Yr. Moving Avg. Bu/Acre</th>
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<th>2 1/4&quot;—2 3/4&quot;</th>
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<th>Cull</th>
<th>Shrink⁴</th>
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¹Based on records from L. D. Tukey, Penn State.

²Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).

³Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.

⁴Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.
### Table 11. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for Golden Delicious, 726 Trees/Acre.

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<th>Size/Grade %²</th>
<th>Cull &amp; Shrink¹²³⁴</th>
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<td>2 1/4&quot;—2 3/4&quot;</td>
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¹Based on records from L.D. Tukey, Penn State.
²Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).
³Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
⁴Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.

### Table 12. Estimated Yield, Five Year Moving Average, Fruit Size and Grade for Spur Red Delicious, 726 Trees/Acre.

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<th>Size/Grade %²</th>
<th>Cull &amp; Shrink¹²³⁴</th>
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¹Based on records from L. D. Tukey, Penn State.
²Fruit size was modified from research data to reflect field and storage conditions. Fifty percent of 2 3/4 to 3 1/4 inch or larger are US Extra Fancy/Fancy (tray pack) and fifty percent US Fancy (film bags). The 2 1/4 to 2 3/4 inch apples were US Fancy (film Bag).
³Juice apples include fruit less than 2 1/4 inch in diameter, drops, and fruit with defects in excess of amounts permitted in utility grade.
⁴Culls and shrink include unharvested fruit, storage water loss, and diseased or rotted fruit having no value.
Appendix C

Annual Costs, Returns and Internal Rates of Return
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2. IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
3. IRR using a 10% increase in annual returns over 15 yrs.
<table>
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<th>York Imperial</th>
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<td>-33.0%</td>
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<tr>
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<tr>
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<td>IRR² 15 Yr</td>
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<td>IRR² 10% Increase 15 Yr</td>
<td>+5.5</td>
<td>+6.7</td>
<td>+5.5</td>
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2. IRR = Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
3. IRR using a 10% increase in annual returns over 15 yrs.
Table 3. Total Cost and Total Return per Year, 160 A Farm, Free Standing or Trained to Modified Slender Spindle, for Golden Delicious and York Imperial Apples for Processing, 1990.

<table>
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<tr>
<th>Year</th>
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<td>Cost</td>
<td>Return</td>
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<td>$ 363</td>
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<td>15</td>
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<td>$25510</td>
<td>$28452</td>
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<td>-31.1%</td>
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<td>10 Yr</td>
<td>-5.0</td>
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<td>15 Yr</td>
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<td>+2.7</td>
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<tr>
<td>IRR 3</td>
<td>10% Increase</td>
<td>15 Yr</td>
<td>+5.4</td>
<td>+6.8</td>
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</table>

1Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
2IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
3IRR using a 10% increase in annual returns over 15 yrs.
Table 4. Total Cost and Total Return per Year, 40 A Farm, Free Standing or Trained to Modified Slender Spindle, for Golden and Red Delicious Apples for Fresh Market, 1990.

<table>
<thead>
<tr>
<th>Year</th>
<th>141 T/A Golden Delicious</th>
<th>340 T/A Golden Delicious</th>
<th>141 T/A Red Delicious</th>
<th>340 T/A Red Delicious</th>
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<tbody>
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<td>Return</td>
<td>Cost</td>
<td>Return</td>
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<td>0</td>
<td>$477</td>
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<th>-32.9%</th>
<th>-23.4%</th>
<th>-35.8%</th>
<th>-27.9%</th>
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</thead>
<tbody>
<tr>
<td>10 Yr</td>
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<td>+4.4</td>
<td>+7.7</td>
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<tr>
<td>15 Yr</td>
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<td>+13.6</td>
<td>+11.6</td>
<td>+13.2</td>
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</tr>
</tbody>
</table>

IRR³ 10% increase 15 Yr +12.5 +16.3 +13.9 +15.6

¹Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
²IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
³IRR using a 10% increase in annual returns over 15 yrs.
Table 5. Total Cost and Total Return per Year, 80 A Farm, Free Standing or Trained to Modified Slender Spindle, for Golden and Red Delicious Apples for Fresh Market, 1990.

<table>
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<th>Year</th>
<th>Golden Delicious1</th>
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<td></td>
<td></td>
<td>$31543</td>
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IRR2

|      | 5 Yr  | -26.8% | -19.1% | -34.1% | -23.3% |
|      | 10 Yr | +4.9   | +11.5  | +6.1   | +10.1  |
|      | 15 Yr | +12.2  | +15.7  | +13.1  | +15.3  |

IRR3

|      | 10% Increase | 15 Yr | +14.6  | +18.3  | +15.4  | +17.6  |

1Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
2IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
3IRR using a 10% increase in annual returns over 15 yrs.
<table>
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<th>Year</th>
<th>Golden Delicious¹</th>
<th>Red Delicious¹</th>
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<th>Cost</th>
<th>Return</th>
<th>Cost</th>
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**IRR²**
- 5 Yr: -25.3% -18.3% -27.5% -22.4%
- 10 Yr: +5.4 +11.6 +7.4 +10.2
- 15 Yr: +12.5 +15.7 +13.9 +15.3

**IRR³**
- 10% Increase 5 Yr: +14.9 +18.3 +15.6 +17.7

¹Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
²IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
³IRR using a 10% increase in annual returns over 15 yrs.
Table 7. Total Cost and Total Return per Year, 40 A Farm, Trained to Palmette Trellis, for Golden Delicious and York Imperial Apples for Processing, 1990.

<table>
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<th>Year</th>
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<td>15 Yr</td>
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<tr>
<td></td>
<td>10% Increase</td>
<td>15 Yr</td>
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</table>

¹Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
²IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
³IRR using a 10% increase in annual returns over 15 yrs.
Table 8. Total Cost and Total Return per Year, 80 A Farm, Trained to Palmette Trellis, for Golden Delicious and York Imperial Apples for Processing, 1990.

<table>
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IRR\(^2\)  
5 Yr  -26.9%  -26.6%  -36.6%  -36.7% 
10 Yr -3.5  -4.8  -6.6  -6.2 
15 Yr +2.6  +2.3  +1.6  +2.5 

IRR\(^3\)  
10% Increase 15 Yr +5.2  +4.8  +3.9  +4.7 

\(^1\)Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.  
\(^2\)IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.  
\(^3\)IRR using a 10% increase in annual returns over 15 yrs.
### Table 9. Total Cost and Total Return per Year, 160 A Farm, Trained to Palmette Trellis, for Golden Delicious and York Imperial Apples for Processing, 1990.

<table>
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<th>Year</th>
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<td>605 T/A</td>
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**IRR**

- **5 Yr**: -26.3%, -26.8%, -35.3%, -35.9%
- **10 Yr**: -3.8, -5.2, -6.5, -6.3
- **15 Yr**: +2.2, +1.8, +1.4, +2.1

**IRR with a 10% increase in annual returns over 15 yrs.**

- **10% Increase 15 Yr**: +4.9, +4.4, +3.8, +4.4

---

2. IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
3. IRR using a 10% increase in annual returns over 15 yrs.
Table 10. Total Cost and Total Return per Year, 40 A Farm, Trained to Palmette Trellis, for Fresh Market Golden Delicious and Red Delicious Apples, 1990.

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<th>Year</th>
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<th>726 T/A Gold.</th>
<th>726 T/A Red.</th>
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<td>$47415</td>
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IRR<sup>2</sup>
- 5 Yr: -18.6% -18.6% -23.7% -23.5%
- 10 Yr: +6.2 +5.3 +5.9 +3.8
- 15 Yr: +11.5 +11.2 +10.9 +10.4

IRR<sup>3</sup>
- 10% Increase: 15 Yr: +14.0 +13.7 +13.2 +12.7

<sup>1</sup>Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
<sup>2</sup>IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
<sup>3</sup>IRR using a 10% increase in annual returns over 15 yrs.
Table 11. Total Cost and Total Return per Year, 80 A Farm, Trained to Palmette Trellis, for Fresh Market Golden Delicious and Red Delicious Apples, 1990.

<table>
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<th>Year</th>
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<th>Golden Delicious 726 T/A</th>
<th>Red Delicious 605 T/A</th>
<th>Red Delicious 726 T/A</th>
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<td>Cost</td>
<td>Return</td>
<td>Year</td>
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<td>5 Yr</td>
<td>-15.9%</td>
<td>-15.4%</td>
<td>10 Yr</td>
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<tr>
<td>IRR³</td>
<td>10%Increase 15 Yr</td>
<td>+15.8</td>
<td>+15.5</td>
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</table>

1Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
2IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
3IRR using a 10% increase in annual returns over 15 yrs.
Table 12. Total Cost and Total Return per Year, 160 A Farm, Trained to Palmette Trellis, for Fresh Market Golden Delicious and Red Delicious Apples, 1990.

<table>
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<tr>
<th>Year</th>
<th>Golden Delicious¹</th>
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</table>

| IRR² | 5 Yr | -15.3% | -15.2% | -19.7% | -20.01% |
|      | 10 Yr | +8.5 | +7.5 | +8.2 | +6.0 |
|      | 15 Yr | +13.3 | +12.9 | +12.8 | +12.1 |

| IRR³ | 10%Increase | 15 Yr | +15.8 | +15.4 | +15.1 | +14.1 |

¹Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
²IRR = Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
³IRR using a 10% increase in annual returns over 15 yrs.
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<td>$29274</td>
<td>$29040</td>
</tr>
</tbody>
</table>

|      | 5 Yr  | 10 Yr | 15 Yr |
| IRR\(^2\) |      |       |       |
| $29492 | $30115 | $30575 | $30752 |
| $29274 | $29040 | $30620 | $31670 |
| 5 Yr  | -27.6% | -28.2% | -37.4% |
| 10 Yr | -5.1  | -7.0  | -8.3  |
| 15 Yr | +0.6  | +0.2  | -0.2  |

| IRR\(^3\) | 10% Increase |
|           | 15 Yr       |
| $29492   | $30115       |
| $29274   | $29040       |
| $30575   | $30752       |
| $30620   | $31670       |
| 5 Yr  | +3.0         |
| 10 Yr | +2.9         |
| 15 Yr | +2.3         |

\(^1\)Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
\(^2\)IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
\(^3\)IRR using a 10% increase in annual returns over 15 yrs.
Table 14. Total Cost and Total Return per Year, 80 A Farm, Trained to Modified Slender Spindle, for Golden Delicious and York Imperial Apples for Processing, 1990.

<table>
<thead>
<tr>
<th>Year</th>
<th>Golden Delicious 605 T/A</th>
<th>726 T/A</th>
<th>York Imperial 605 T/A</th>
<th>726 T/A</th>
</tr>
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<tbody>
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<td>Cost</td>
<td>Return</td>
<td>Cost</td>
<td>Return</td>
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<td>$26732</td>
<td>$30115</td>
<td>$28155</td>
<td>$30752</td>
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<tbody>
<tr>
<td>5 Yr</td>
<td>-23.4%</td>
<td>-24.3%</td>
<td>-33.6%</td>
<td>-33.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Yr</td>
<td>-1.8</td>
<td>-3.9</td>
<td>-5.4</td>
<td>-5.2</td>
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</tr>
<tr>
<td>15 Yr</td>
<td>+3.5</td>
<td>+2.5</td>
<td>+2.2</td>
<td>+2.9</td>
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<tbody>
<tr>
<td>10% Increase</td>
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<td>+5.1</td>
<td>+4.5</td>
<td>+5.2</td>
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</tbody>
</table>

¹Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
²IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
³IRR using a 10% increase in annual returns over 15 yrs.
Table 15. Total Cost and Total Return per Year, 160 A Farm, Trained to Modified Slender Spindle, for Golden Delicious and York Imperial Apples for Processing, 1990.

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<th>605 T/A</th>
<th>726 T/A</th>
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<td>Cost</td>
<td>Return</td>
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<td>1016</td>
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<td>1330</td>
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<td>1331</td>
<td>2032</td>
<td>1327</td>
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<td>$30115</td>
<td>$28961</td>
<td>$30752</td>
</tr>
</tbody>
</table>

| IRR² | 5 Yr | -23.8% | -24.2% | -32.5% | -33.0% |
| 10 Yr| -4.7 | -4.5   | -5.4   | -5.4   |
| 15 Yr| +1.8 | +1.8   | +1.9   | +2.5   |

| IRR³ | 10% Increase | 15 Yr | +4.6 | +4.6 | +4.3 | +4.8 |

¹Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
²IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
³IRR using a 10% increase in annual returns over 15 yrs.
Table 16. Total Cost and Total Return per Year, 40 A Farm, Trained to Modified Slender Spindle, for Fresh Market Golden Delicious and Red Delicious Apples, 1990.

<table>
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<tr>
<th>Year</th>
<th>Golden Delicious</th>
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<th>Red Delicious</th>
</tr>
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<td>938</td>
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<td>2042</td>
<td>4037</td>
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<table>
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<th>Year</th>
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<th>Total Return</th>
<th>Total Cost</th>
<th>Total Return</th>
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<tr>
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<td>$28788</td>
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<td>$30005</td>
<td>$45804</td>
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</tbody>
</table>

IRR<sup>2</sup>  
5 Yr  -16.4%  -16.5%  -22.1%  -22.1%  
10 Yr  +7.5%  +6.1%  +6.8%  +4.6%  
15 Yr  +12.4% +11.7% +11.5% +10.9%  

IRR<sup>3</sup>  
10% Increase  15 Yr  +14.9%  +14.2%  +13.9%  +13.1%  

<sup>1</sup>Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.  
<sup>2</sup>IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.  
<sup>3</sup>IRR using a 10% increase in annual returns over 15 yrs.
Table 17. Total Cost and Total Return per Year, 80 A Farm, Trained to Modified Slender Spindle, for Fresh Market Golden Delicious and Red Delicious Apples, 1990.

<table>
<thead>
<tr>
<th>Year</th>
<th>605 T/A</th>
<th>726 T/A</th>
<th>605 T/A</th>
<th>726 T/A</th>
</tr>
</thead>
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<td>Cost</td>
<td>Return</td>
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<table>
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</tr>
</thead>
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<td>15 Yr</td>
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</table>

IRR\(^2\) = Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.

IRR\(^3\) using a 10% increase in annual returns over 15 yrs.

1Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
2IRR=Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
3IRR using a 10% increase in annual returns over 15 yrs.
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<tr>
<td></td>
<td>5 Yr</td>
<td>-13.1%</td>
<td>-18.2%</td>
<td>-18.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 Yr</td>
<td>+9.7</td>
<td>+8.4</td>
<td>+9.0</td>
<td>+6.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 Yr</td>
<td>+14.2</td>
<td>+13.5</td>
<td>+13.4</td>
<td>+12.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10% Increase 15 Yr</td>
<td>+16.7</td>
<td>+16.0</td>
<td>+15.7</td>
<td>+14.6</td>
<td></td>
</tr>
</tbody>
</table>

^1 Annual costs and returns based on 1990 input prices and 1986-1990 average product prices.
^2 IRR = Internal rate of return analysis using a land cost of $2,000 and $2,000 salvage value.
^3 IRR using a 10% increase in annual returns over 15 yrs.