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RESETTING AND REPLANTING OPTIONS IN FLORIDA CITRUS GROVES AND THE FINANCIAL CONSEQUENCES

RONALD P. MURARO AND WILLIAM S. CASTLE
University of Florida, IFAS
Citrus Research and Education Center
700 Experiment Station Road
Lake Alfred, FL 33850

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Abstract. **Citrus growers frequently have asked when should trees lost in a citrus grove be replaced, i.e., every year, every three years, etc. or should no trees be replaced until the entire block has become non-productive (or non-profitable). To answer these questions, a discounted cash budget model was developed to compare several tree replacement scenarios which included no tree loss and tree loss with and without tree replacement. These scenarios were compared with a hypothetical zero tree loss situation based on data obtained from a long-term 'Valencia' field trial on Carrizo citrange rootstock planted at 116 trees per acre (25' × 15'). The analyses indicated resetting a citrus grove will result in positive returns over no resetting. If a block in a grove is experiencing a high annual tree loss with a rapid decline in yield and returns, replanting the entire block should be evaluated before resetting a grove.**

The average annual tree loss across the Florida citrus industry is about 3% to 4%. Where these losses occur essentially every year, the causes are usually diseases like citrus tristeza virus, blight, and foot or root rot. However, the extent of tree loss among individual groves can vary markedly from zero, to 10% or more. As a result, tree losses may have substantially different impacts on grove revenues and equity depending on the extent of loss. The costs of tree removal, resetting, and any extra expenses associated with a mixed-age grove add 10% to 13% to the annual expenditures for a bearing grove (Muraro et al., 1996). Therefore, it seems important to evaluate the suitability of regular resetting versus replanting after grove productivity declines to some unprofitable level; and, if resetting, what should be the frequency; and, if replanting, then when is the appropriate time? Answers to these questions can become the basis for resetting and replanting strategies. Our objective was to determine the economic outcomes of various resetting or replanting scenarios using real data from a long-term 'Valencia' rootstock trial.

Materials and Methods

Data from 'Valencia' trees on Carrizo citrange rootstock in a flatwoods field experiment (Castle and Muraro, 1992) were used to calculate the expected yields (Table 1) and economic returns of a hypothetical grove planted at 116 trees per acre (25' × 15'). This tree density was selected to simplify the analyses. We assumed that with 15 ft between trees in the row, a reset would not encounter enough interplant competition to significantly affect its performance. The scion/rootstock combination was chosen as one well representative of tree vigor, productivity, and juice quality in the Florida industry.

Financial outcomes were determined by a cash budget investment analysis with comparisons among reset/replant scenarios based on the internal rate of return (IRR). The IRR is a form of cash flow analysis where the annual cash flows are discounted using an interest rate at which the present value of the cumulative cash flows equal the initial capital investment. The initial capital investment was assumed to equal the total cumulative costs of the first year of the analysis. The IRR represents an average annual rate of return, or yield, on the investment over the time period of the investment. The investment time periods used in this paper were 20 and 30 years.

The capital investment costs used in the analyses included a land cost in the Florida flatwoods of $1,450 per acre (Table 2). Part of the land area must be utilized for roads, ditches, canals, bedding/mounding, etc., thus, only 85% of the land area was assumed planted. Therefore, in this case study, the land acquisition, preparation and irrigation costs on a planted acre basis totaled $4,160 per acre.

Annual cultural costs for a mature processed orange grove (Table 3) were based on 1995-96 summary data (Muraro et al., 1996). Miscellaneous costs (additional hand tools, labor, etc.) and overhead costs (grove manager, office supplies, telephone, etc.) were also included in the total grove care costs. Harvesting costs and soluble solids prices were fixed at $1.95/Florida field box (90 lb) and $1.10 delivered-in price/solids for these analyses. Tree removal and reset costs were in addition to the normal grove care costs and vary with the total number of trees per acre being replaced (Muraro, 1985). Current data shown in Table 4 was used for this study (Muraro, 1996).

Cash budget analyses were calculated for thirteen tree loss and reset/replant scenarios. These scenarios are situations where tree loss is substantial (25%) in the early years as occurs sometimes from freezes, flooding, Phytophthora, poor planting, or a combination of these events and all tree losses are replaced to situations where tree loss is moderate (4% to 5% annually), steady, and beginning later in grove life as appears to commonly occur in the industry from the causes given above, plus lightning, equipment damage, blight, tristeza, etc. It is sometimes unclear in these situa-

Table 1. Yield per tree for 'Valencia' orange/Carrizo rootstock used in the reset/replacement tree investment analysis.

Year	Normal boxes per tree[z]	@ 2/3 normal box yield per tree	Pound solids per box
4	0.3	0.2	4.6
5	0.8	0.5	4.9
6	1.7	1.1	5.5
7	2.2	1.5	5.8
8	3.0	2.0	6.2
9	3.5	2.3	6.7
10	3.9	2.6	6.9
11	4.4	2.9	7.0
12	4.8	3.2	7.1
13	5.3	3.5	7.1
14	5.7	3.8	7.1
15+	6.0	4.0	7.1

[z]Based on actual yield data from 'Valencia' orange/Carrizo citrange field experiment.

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Table 2. Grove assumptions used in reset/replacement tree investment analysis.

	Initial planting		Replanting after year 15
Proportion of land planted	85%		85%
Initial capital investment per planted acre:			
Land[z]	$1,706		—
Land preparation[y]	$1,354		$685
Irrigation[x]	$1,100		$800
Total	$4,160		$1,485
Trees planted per acre:	116		116
Solidset/initial planting:	Age of Trees		
	1	2	3
	- - - - - - - - - - - - Per tree - - - - - - - - - - - -		
Tree planting cost (tree, wrap, stake, etc.)[w]	$4.50	—	—
Annual grove care cost for young trees	$3.42	$3.81	$3.65

[z]Indiantown land cost per acre was $1,450 ÷ .85.
[y]Indiantown "initial" land preparation cost per acre was $1,151 ÷ .85. "Replanting" land preparation cost per acre was $583 ÷ .85.
[x]Irrigation costs are for microsprinkler systems and include well, pump tubing, sprinklers, and controls. Replanting irrigation costs include distribution system, tubing, sprinklers, etc.
[w]Includes: "bareroot tree" = $3.00; plant, stake and water tree = $1.00; and tree wrap = $0.50.

tions as to whether resetting is worthwhile, and, where annual tree loss is "excessive" (8%), but the circumstances are otherwise similar to the moderate loss scenario. Heavy loss will result in all originally planted trees being removed within 20 years. Also, to analyze the concern that a reset tree will not yield as well as the original tree removed, the per tree box yield in two investment scenarios was reduced to two-thirds of the original tree yields.

The costs and yields for each scenario's cash budget analysis was adjusted to reflect the specific reset situation. For example, scenarios 3 and 7 where no tree replacement occurred, the annual grove care cost was reduced during the latter years to reflect the grove care requirements of the remaining trees. Likewise, depending upon the total trees removed/replaced per acre each year, the per tree removal and reset care costs were adjusted as shown in Table 4. Also, the yields for each scenario incorporates yields, by age of tree, of the remaining original planted trees along with the annual cumulative yields of all the reset trees. Note that the cash budget analysis does not incorporate an annual inflation factor.

Table 3. Prices, harvesting, cultural and other costs used in the reset/replacement tree investment analysis.

Delivered-in price per pound solids		$1.10
Harvesting costs per box (pick, roadside and haul fruit)		$1.95
Annual grove care cost for a mature South Florida processed orange grove:		
Cultivation and herbicide		$194.06
Spraying		110.59
Fertilization		143.24
Hedging		47.88
Irrigation/ditch maintenance		170.66
Miscellaneous costs (3%)		19.99
Supervision and overhead (7%)		48.05
Total		$734.47
Estimate annual tree loss:		
@ 4.3+% rate beginning in year 8	5 trees/acre/year	
@ 7.8+% rate beginning in year 8	9 trees/acre/year	

For comparative purposes, the scenarios were divided into the following four groups:

Group A — 20-year analysis:
- #1 – zero annual tree loss
- #2 – 25% tree loss in first 5 years with annual resets; zero tree loss from year 6 through 20

Group B — 20-year analysis:
- #3 – 4.3+% annual tree loss from year 8 with no resets
- #4 – 4.3+% annual tree loss from year 8 with annual resets
- #5 – 4.3+% annual tree loss from year 8 with resets replaced every 3 years
- #6 – 4.3+% annual tree loss from year 8 with annual resets with reset yields at two-thirds of normal yields

Group C — 20-year analysis:
- #7 – 7.8+% annual tree loss from year 8 with no resets
- #8 – 7.8+% annual tree loss from year 8 with annual resets
- #9 – 7.8+% annual tree loss from year 8 with annual resets with reset yields at two-thirds of normal yields

Group D — 30-year analysis:
- #10 – 4.3+% annual tree loss from year 8 with annual resets
- #11 – 4.3+% annual tree loss from year 8 with no resets and replanting entire grove/block in year 16
- #12 – 7.8+% annual tree loss from year 8 with annual resets
- #13 – 7.8+% annual tree loss from year 8 with no resets and replanting entire grove/block in year 16

Results and Discussion

The return on investment as measured by the internal rate of return (IRR) was used to compare the analyses of the thirteen scenarios along with the cumulative annual net cash flow. The IRRs calculated represent rates of returns above inflation.

Group A—No tree loss versus 25% tree loss during years 1-5: Scenario 1 with zero tree loss had the largest cumulative annual net cash flow ($27,052) and the highest IRR (14.6%) of all the scenarios (Table 5). Scenario 2, where a 25% tree loss occurred during the first 5 years and then zero tree loss for years 6 through 20, showed that with tree replacement the cumulative annual net cash flow ($24,392) and IRR (13.5%) of citrus a grove can compare very favorably with a citrus grove having no tree loss. The reduced production as a result of the 25% tree loss during the early years of the citrus grove was quickly overcome by resetting. Annual production for scenario 2 was only moderately less than scenario 1 through year 17 at which time the annual yields averaged 696 boxes per acre.

Group B—4.3+% annual tree loss with normal and reduced reset yields and resetting every year versus every 3 years: Favorable IRRs, with and without resets, were calculated at a moderate annual tree loss of 4.3+% beginning in year 8 (Table 5). Where trees were reset every year with normal yields, scenario 4 had an IRR of 11.4%. The IRR when resetting every three years, scenario 5, was 11.3% and was not significantly different than resetting every year. Reducing the reset yields to two-thirds of normal yields (scenario 6), resulted in an IRR of 10.9%. This indicates that in a moderate tree loss situation, even with reduced reset yields because of competition from remaining original trees or the reset planting site is less suitable for tree growth and development, there was a financial benefit to resetting a citrus grove.

Table 4. Reset costs used in the reset/replacement tree investment analysis.

	Number of resets/replacement trees per acre				
Reset/replacement trees:	1-2	3-5	6-10	11-25	26+
Tree removal	$5.21	$4.53	$3.62	$2.93	$2.34
Planting cost (site preparation, tree, wrap, stake, etc.)[z]	$11.49	$10.49	$9.24	$8.84	$7.74
Annual grove care cost for reset trees:					
Year #1	$3.71	$3.44	$3.25	$3.10	$2.92
Year #2	$3.25	$2.94	$2.54	$2.23	$2.03
Year #3	$2.61	$2.33	$1.99	$1.71	$1.44
Total 3-year cumulative costs	$26.27	$23.73	$20.64	$18.81	$16.47

[z]Site preparation for bedded citrus grove—cost of root removal, rotovating/leveling tree planting site. Fumigate planting site would cost approximately $2.50 per tree.

For comparison purposes, scenario 3 shows the effect of no resetting under a moderate tree loss situation. Although the 10.3% IRR indicates a favorable return on investment, the per acre cumulative annual net cash flow was approximately $2,000 less than either scenario 4 ($15,377) or scenario 5 ($14,952) and about $1,000 less than scenario 6 ($14,395). Comparing yields in year 20 under a moderate 4.3+% tree loss rate, the total yield per acre for scenario 3 was 330 boxes or about two-thirds of the 485 boxes of scenario 4. Scenario 5, where resetting occurred every three years, average fruit yield was 460 boxes per acre. With reduced reset yields, the average yield was 436 boxes per acre or approximately a 10% yield reduction versus a normal yield situation.

Group C—7.8+% annual tree loss with normal and reduced reset yields: The IRR was calculated using a high annual tree loss rate of 7.8+% (Table 5). The IRR for scenario 8 (resets with normal yields) was 7.1% or over 40% less than at the comparable 4.3% IRR rate (scenario 4). Scenario 7 (no reset trees) and scenario 9 (resets with reduced yields) had similar IRRs of 5.0% and 5.4%, respectively, which were approximately 50% lower than the comparable IRRs at the moderate tree loss rate (scenarios 3 and 6). The cumulative annual net cash flow for scenario 8 was $6,428 or 60% less than the comparable moderate tree loss rate (scenario 4). The cumulative annual net cash flows for scenario 7 ($3,502) and scenario 9 ($4,659), were almost 75% and 70% lower, respectively, than the comparable scenarios at the 4.3+% annual tree loss. From year 15, annual net cash flow declined rapidly for scenarios 7, 8 and 9. The no reset scenario 7 actually had negative returns the last two years of the analysis. By year 20, the per acre yields had declined to 48 boxes, 317 boxes and 277 boxes for scenarios 7, 8 and 9, respectively. Although at the high annual tree loss rate resetting provided some financial benefit, the results suggest that a grove experiencing an 8+% annual tree loss replanting an entire block should be evaluated to change to a more profitable scion/rootstock combination and/or planting density.

Group D—Resetting every year versus replanting entire grove: The cash budget analysis was extended to 30 years for both annual tree loss rates to evaluate whether replanting an entire grove would be more economical than resetting. For the two replant scenarios (#11 and #13), it was assumed that tree loss would begin in year 8 and no resets would be planted. In year 16, the entire block would be pushed and replanted. The additional costs of citrus tree

Table 5. Cumulative cash flow and internal rate of return (IRR) for 'Valencia' orange grove reset investment analysis.

	Cumulative annual net cash flow ($)	IRR[z] (%)		Cumulative annual net cash flow ($)	IRR[z] (%)
20-year analysis			20-year analysis		
#1: No tree loss	27,052	14.6	#6: 4.3+% tree loss from year 8 with resets @ 2/3 normal yields	14,395	10.9
#2: 25% tree loss in first 5 years with annual resets	24,392	13.5			
#3: 4.3+% tree loss from year 8 with no resets	13,236	10.3	#7: 7.8+% tree loss from year 8 with no resets	3,502	5.0
#4: 4.3+% tree loss from year 8 with annual resets	15,377	11.4	#8: 7.8+% tree loss from year 8 with annual resets	6,428	7.1
#5: 4.3+% tree loss from year 8 with resetting every 3 years	14,952	11.3	#9: 7.8+% tree loss from year 8 with resets @ 2/3 normal yields	4,659	5.4
30-year analysis			30-year analysis		
#10: 4.3+% tree loss from year 8 with annual resets	33,014	11.6	#12: 7.8+% tree loss from year 8 with annual resets	13,028	7.7

[z]Internal rate of return (IRR) calculation includes an ending grove value which was added to the final year's net annual income (year 20 or year 30).

Table 5. Cumulative cash flow and internal rate of return (IRR) for 'Valencia' orange grove reset investment analysis.

	Cumulative annual net cash flow ($)	IRR[z] (%)		Cumulative annual net cash flow ($)	IRR[z] (%)
#11: 4.3+% tree loss from year 8 with no resets and replant in year 16 with no resets	14,665	8.4	#13: 7.8+% tree loss from year 8 with no resets and replant in year 16 with no resets	8,013	5.9

[z]Internal rate of return (IRR) calculation includes an ending grove value which was added to the final year's net annual income (year 20 or year 30).

removal, rebedding and replacement of the irrigation system was included in the total costs in year 16. For the remaining 17 through 30 year period, the analysis assumed that the tree loss and annual yield would be the same as the original planting.

The IRRs and cumulative annual net cash flows for the four 30-year scenarios are shown in Table 5. Scenario 10 (4.3+% tree loss) and scenario 12 (7.8+% tree loss) showed the effect of annual resetting over a 30-year period. The cumulative annual net cash flow for both scenario 10 ($33,014) and scenario 11 ($13,028) were more than double of their respective 20-year scenario analyses of 4 ($15,377) and 8 ($6,428). This indicates that under a 20-year investment time period, the benefits of resetting is not fully achieved. The IRRs of scenario 10 (11.6%) and scenario 12 (7.7%) were higher than all the comparable 20-year tree loss rate analyses.

Comparing the investment analysis results of the 30-year reset and replant scenarios, further demonstrates the benefit of resetting. The cumulative annual net cash flow of the scenario 11 (4.3+% tree loss/replant in year 16) was almost 55% less than scenario 10 (4.3+% tree loss with resets). The cumulative annual net cash flow of scenario 13 (7.8+% tree loss/replant in year 16) was $8,013 or about 40% less than scenario 12 (7.8+% tree loss with resets). With a moderate annual tree loss, the IRR of scenario 10 with resets was 11.6% whereas without resets and replanting in year 16 the IRR was 8.4%.

Likewise, the IRRs of the high tree loss rate were 7.7% for scenario 12 with resets and 5.9% for scenario 13 without resets and replanting. Note that the IRR of the 30-year moderate tree loss/replant (scenario 11) was higher than any of the 20 or 30 year high tree loss scenarios. This further suggests that grove situations where annual tree loss rates have reached 8+%, the grower should evaluate replanting the entire block.

With resetting, at the moderate loss rate (scenario 10), the average per acre yield leveled off at 484 boxes per acre. This yield is over 50% greater than the 317 boxes per acre at which the high tree loss rate (scenario 12) average yield leveled off. Total cumulative box yield for scenarios 10, 11, 12 and 13 were 11,506, 8,186, 8,538 and 7,016 boxes, respectively. Thus, the benefits of resetting were again shown by the cumulative yields and net returns; particularly under a moderate tree loss occurs (scenario 10).

Summary

Resetting a citrus grove will result in positive returns over no resetting and over replanting of an entire grove. Under a high tree loss rate, the benefits of resetting may be less desirable. Therefore, the grove manager should make an evaluation of the grove site, soil type, scion/rootstock combination along with the market outlook for the citrus variety in questions before beginning an aggressive resetting/replanting program.

A citrus grove is a highly capitalized, long-term investment. Evaluating the economic feasibility of tree replacement is an integral part of management decisions. The intent of this paper was to provide guidelines to assist grove managers with their tree replacement analysis. The grove situation analyzed assumed a tree density of 116 trees per acre (25' × 15'). Citrus plantings with higher tree densities with in-row planting distance of less than 15 feet, will likely have different reset strategies than discussed in this paper. Therefore, future analysis should consider that in high density citrus groves with trees planted on vigorous rootstocks, every tree lost possibly should not be replanted in order to maintain an efficient productive and profitable citrus investment.

NOTE: For information on the annual per acre yields and costs and returns, contact the authors of this paper.

References

Castle, W. S. and J. C. Baldwin. 1995. "Tree survival in long-term citrus rootstock field trials." Proc. Fla. State Hort. Soc. 108:73-77.

Castle, William S. and Ronald P. Muraro. Notebook Entitled: "Financial analyses of 15 years horticultural data obtained from a Valencia orange cooperative field trial involving 12 rootstocks located at Indiantown, Florida." December 1992, 85 pp. (controlled distribution to date).

Muraro, Ronald P., Fritz M. Roka, Robert E. Rouse and Robert M. Turley. "Budgeting Costs and Returns for Southwest Florida Citrus Production, 1995-96." Economic Information Report 96-3. August 1996. Food and Resource Economics Department, University of Florida, IFAS. 37 pp.

Muraro, Ronald P. "Estimated Cost of Planting and Maintaining a Reset Citrus Tree through 4 Years of Age." August 1985. (Mimeo Handout).

Muraro, Ronald P. "Estimated Cost of Planting and Maintaining a Reset Citrus Tree through 3 Years of Age." November 1996. (Mimeo Handout).