Evaluating economic efficiency of APS for citrus

Scientists and growers try to determine if advanced production systems can offset high production costs.

By Fritz Roka and Ron Muraro

The costs of citrus production in Florida have increased by nearly $1,000 per acre in the past five years. Higher prices for petroleum and the presence of two diseases (canker and greening) have accounted for more than two-thirds of the cost increase. Advanced production systems (APS) are being evaluated by university scientists and growers to see whether these horticultural strategies can offset some of the higher production costs.

APS are characterized by two things: 1) high-density planting and 2) intensive management of nutrients and water (irrigation). An important goal of APS is to accelerate and increase early fruit production.

The purpose of this article is to outline how growers should evaluate changes in economic efficiency from adopting an APS design. While cost and yield data used in this article are from published sources, the analysis should be regarded as hypothetical. The ultimate analysis of economic efficiency will depend on actual production budgets and realized fruit yields, both of which will vary by grower and growing conditions.

Any new technology must improve production efficiency, which is measured as the ratio of inputs to outputs. If 200 pounds of nitrogen from a "standard" fertilizer yields 500 boxes of oranges, the nutrient use efficiency is 0.4 pounds-N/box (200 lbs./500 boxes). If by using a controlled release fertilizer (CRF), total applied nitrogen decreases to 150 pounds per acre with no change in fruit yield, nutrient use efficiency improves to 0.3 lbs.-N/box, or a 25 percent improvement. While higher production efficiency is a necessary condition for the adoption of a new technology, improved economic efficiency is the sufficient condition before a new technology can be commercially viable.

As economic efficiency improves, "unit costs" decrease. Unit costs are the ratio of dollars spent (costs) to output produced (units). Returning to our fertilizer example, if nitrogen from a "standard" fertilizer costs 50 cents per pound, then economic efficiency is $.20/box ($0.50/lb. times 200 lb./500 box). In order for CRF to improve economic efficiency, the cost of nitrogen from CRF must be less than $.66/lb. ($.20/lb. times 500 box/150 lb.). If the price of nitrogen from CRF was $.60/lb., total fertilizer costs would decrease to $90 per acre ($.60 times 150 pounds), and unit

Table 1. Cost assumptions to establish an APS or OHS system of 360 trees per acre (TPA) as compared to a standard planting of 150 TPA

		150 TPA	360 TPA	Difference
New trees	$9.00/tree	$1,350	$3,240	$1,890
Planting costs	$3.50/tree	$ 525	$1,260	$ 735
Irrigation/bed preparation		$1,000	$1,300	$ 300
YR(0) Totals		***$2,875***	***$5,800***	
Young tree management (yrs. 1-3)		$2,320	$4,875	$2,555
Added Costs by YR3				***$5,480***
Mature grove care	$1,400/ac			
Harvest and haul	$2.10/box			

costs with respect to nitrogen would decrease from 20 cents to 18 cents per box of oranges.

COST AND PRODUCTION ASSUMPTIONS

The added costs to establish a high-density planting, a key feature of APS, are nearly $5,500 per acre if a block is planted with 360 trees per acre (TPA), rather than a more typical density of 150 TPA (Table 1). APS may require some additional investment into the existing irrigation infrastructure and beds may have to be reshaped to accommodate the higher tree density. More trees per acre also translate to higher costs to grow young trees over the first three years of a new block.

In order to improve economic efficiency from adopting APS, fruit production over the life of the grove must increase to more than offset the higher initial costs to establish APS. Consider Figure 1, which presents two scenarios of fruit production by tree age and planting density — 150 TPA (blue) and 360 TPA (red). It is assumed that up until age 5, tree canopies for either planting density do not overlap. Since

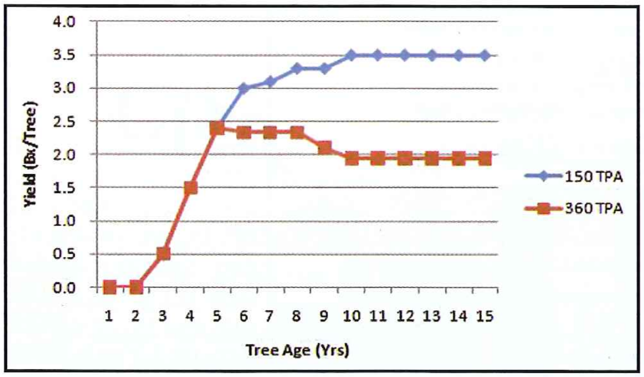

***Figure 1.** A hypothetical example of citrus yields per tree by tree age, two tree density plantings — 150 and 360 trees per acre (TPA).*

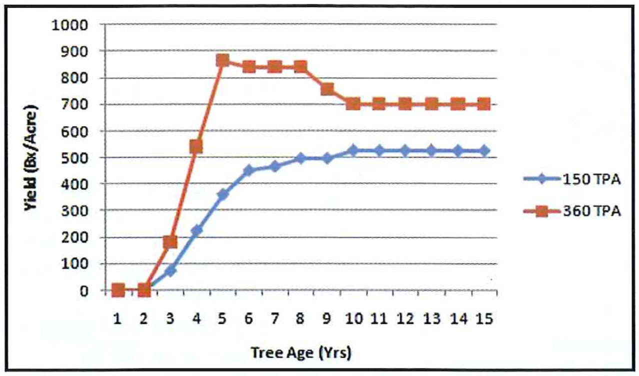

***Figure 2.** Production per acre by tree age, two tree densities, and enhanced early fruit production using tree yields presented in Figure 1.*

all trees are managed identically, yields per tree are expected to be the same. After the fifth year, trees planted at 360 TPA begin to hedge together and yield per tree levels off. In fact, yield per tree may even decrease over time as individual tree canopies become more intertwined. Production per tree when planted at 150 TPA continues to increase until trees establish a hedge row, presumed to be after year 10.

More trees per acre translate to more boxes per acre, at least during the initial years of young tree production. Between the third and fifth year of tree age, production from a 360 TPA planting is more than double the production from a 150 TPA planting (Figure 2). Even after accounting for decreasing tree yields after the fifth year, per acre production from 360 TPA should remain higher than a 150 TPA planting.

NET PRESENT VALUE ANALYSIS

Given the upfront costs presented in Table 1 and yield scenarios presented in Figures 1 and 2, a grower must determine whether it is in his or her financial advantage to invest in a high-density APS. Net present value (NPV) analysis provides a way to compare the cumulative stream of annual net returns between the two tree densities. Table 2 presents annual net returns for 15 years by tree density. The initial year (Year 0) includes grove setup and new tree planting costs. Subsequent years include grove-care costs of young and mature trees, overhead, harvest and fruit-hauling costs. Starting in the third year for both TPA scenarios, revenues from fruit sales are calculated by assuming each box produces 6.2 pound-solids. Fruit prices are held constant at \$1.20/p.s.

Over a 15-year horizon and a constant delivered-in price of \$1.20/p.s., the cumulative NPVs for our example are a positive \$3,217/ac for 360 TPA and a negative (\$337)/ac for 150 TPA (Table 2, page 16). In this example, the higher annual yields for the 360 TPA more than offset the higher costs to establish an APS. The higher returns from 360 TPA affords a grower a greater cushion against low market prices than from 150 TPA. At prices below \$1.25, returns from a 150 TPA planting are negative. Negative returns from 360 TPA do not occur until prices fall below \$1.05.

SUMMARY

The added costs associated with citrus diseases and a general inflation of input prices are forcing citrus growers in Florida to re-examine the way they grow citrus and look for new

Table 2. Summary and comparison of net present value calculations of Standard- and High-density plantings over 15 years and at a delivered-in price of $1.20 per pound-solids.

		Standard Density (150 trees per acre)	High Density (360 trees per acre)
	Discount factor	NPV	NPV
Year	10%	$/ac	$/ac
0	1.0000	($2,875)	($5,800)
1	0.9091	($1,089)	($1,976)
2	0.8264	($971)	($1,752)
3	0.7513	($413)	($465)
4	0.6830	($136)	$1,013
5	0.6209	$324	$1,995
6	0.5645	$566	$1,742
7	0.5132	$556	$1,583
8	0.4665	$580	$1,439
9	0.4241	$527	$1,118
10	0.3855	$541	$901
11	0.3505	$492	$819
12	0.3186	$447	$745
13	0.2897	$407	$677
14	0.2633	$370	$616
15	0.2394	$336	$560
Total 15 year NPV ($/ac)		*($337)*	*$3,217*

production strategies that will help enhance their overall economic efficiencies. Advanced production systems are receiving attention among growers and researchers. These systems require a higher initial investment that probably will amount to several thousand dollars per acre. Almost by definition, higher tree densities should produce more boxes of fruit per acre.

The economic question becomes: What minimum increase in production is necessary to cover initial investment costs under a reasonable range of expected fruit price? Not only is cumulative production important, but also increasing production from young trees. Enhancing production from young trees carries two benefits:

- 1) more total boxes of production over time, and
- 2) increasing net returns earlier in the cash-flow stream when discount rates are relatively higher.

A final conclusion of an NPV analysis is that any investment in APS requires adequate market prices for fruit to be sustained well into the future.

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