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ECONOMIC ANALYSIS OF ALMOND ORCHARD REPLACEMENT

by

Kent Olson

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Economic Analysis of Almond Orchard Replacement

by

Kent D. Olson, Economist
Cooperative Extension, University of California

Deciding when to replace your almond orchard is one of the hardest and most important decisions facing growers. The answer depends upon the age and condition of the trees, disease problems, economic conditions, perceptions of the future, new varieties, new pollinizing arrangements, and many other factors.

There are obvious times to replace an orchard. Disease may have caused enough damage to warrant replacement. The yield may have decreased to the level that gross income does not pay operating expenses. Changes in consumer tastes and preferences and(or) changes in export demand may cause expected receipts to drop below the future cost of production.

If we further consider the replacement decision, we can envision a set of circumstances where replacement is not an obvious choice, but it may be the right choice. Consider the orchard which is 30 years old. Since this orchard was planted, new management techniques; new perhaps better, pollinizing arrangements; and more efficient irrigation systems have been developed. All these improvements should result in an orchard which has a higher, longer lasting mature yield. Should the present orchard be replaced?

This replacement question is harder to answer for several reasons. The present orchard is making a positive income. The grower would have to endure several years of costs but no income with the new orchard. Interest rates are higher now than when the present orchard was planted. The income for the new orchard is all in the future; the present orchard produces income now. All of these conditions confound the replacement decision.

How do we compare the potential of a new orchard to the reality of the present orchard? We could estimate the average annual income over the life of the new orchard and compare it to the income from the present orchard. This approach ignores two facts. First, this average is for several years in the future and is not the dame as income this year. Second, the average ignores the early years of large development costs and no or little income. Thus, the average income approach will not provide a satisfactory answer.

Another method would be to estimate the total income produced during the remaining life of the present orchard and during the entire life of the new orchard. This approach is not satisfactory either. It ignores the differences in value of income in different years. There is no adjustment for the difference in life span. It does not evaluate adequately the impact of the development costs in the early days.

These two approaches are too simplistic. They fail to recognize the time value of money. The main part of the replacement decision is converting future income into a value which we can compare to the present orchard's income.

Economic Considerations

The decision to replace an asset which produces income over time involves the analysis of the time value of money. Faris (1960a) formulated this decision rule: "the optimum time to replace is when the marginal net revenue from the present enterprise is equal to the highest amortized present value of anticipated net revenue from the following enterprise" (p.766). Winder and Trant (1961) argue that Faris forgot the time value of the income from the present orchard. Faris (1961) replies that their basic point is valid but, argues that it is a special case of his general rule. (Faris doesn't accept anything they say.)

Faris (1960b) and Reed (1962) explain the procedures involved in replacement analysis and give several examples for cling peaches in California. However, they do not treat adequately the present value of next year's expected income from the present orchard.

For orchard replacement, the rule becomes: *the optimum time to replace is when the present value of next year's expected income from the present orchard is equal to or less than the discount and amoritized value of the future income from the new orchard.* That is, we compare next year's net income from the present orchard to the net income in future years from the new orchard by adjusting for differences in when the income occurs over time. This adjustment is for the time value of money.

In a replacement decision, the net return should be gross income adjusted for operating costs, development costs, other variable costs, and income tax deductions. In a replacement case, many resources, such as land, machinery, and some other investments, would not change; thus, they do not have to be included in the analysis for either the new orchard or the present orchard. Exceptions to this are machinery replacements needed for the new orchard but not for the present orchard. Many of these costs don't need to be included because they are fixed over time. The goal of management is to maximize the return to these fixed items whether they are land, management, capital, etc. and whether they are actual or opportunity costs.

The net return is adjusted by using the allowed depreciation for orchard development and the investment tax credit. Assuming the grower is making enough income to pay taxes, the increased depreciation and tax credit will decrease his/her after-tax costs. The decrease in his/her tax bill is the annual, allowed depreciation multiplied by the marginal tax rate plus the investment tax credit, if any.

By converting income in different years to an equivalent value (i.e., an annuity) in the current year, we can compare income from both the present and new orchards on an equal basis. This conversion involves adjusting for interest and inflation effects. By evaluating each year separately, we account for the early years which involve development costs and for income variation during the life of the new orchard.

An annuity is an amount of money received each period for a specified number of periods. In this study, the annuity is an annual amount received for a specified number of years. The annuity represents the annual value which is equivalent to receiving the expected net returns from the new orchard for a specified number of years; hence, we use the term "equivalent annuity".

The equivalent annuity can be expressed in mathematical form:

$$A_T = \frac{\sum_{t=o}^{T} [NR_t/(1 + i)^t]}{[1-[1/(1 + i)^T]/i}$$

where A_T = the equivalent annuity in year T,

NR_t = the net after-tax return in the year t,

i = the discount rate, and

T = the expected life of the new orchard for this specific equivalent annuity.

The net return, adjusted for each year, is given by the following formula:

$$NR_t = (P*Y_t)-NHC_t-(HC*Y_t)+(X*D_t)+ITC_t$$

where NI_t = the net income in the tth year,

P = expected meat price per pound,

Y_t = expected meat yield in year t,

NHC_t = non-harvest costs in year t,

HC = harvest costs per pound,

X = marginal tax rate (in decimal form),

D_t = tax allowed depreciation of the orchard development costs in year t, and

ITC_t = investment tax credit, if any, in year t.

The maximum equivalent annuity over the life of the new orchard is compared to the return from the present orchard. Often, the replacement decision is made in one year and the present orchard is pulled that fall and the new orchard planted the next spring. In this case the maximum equivalent annuity is compared to the present value of the next year's return from the present orchard. When price and yield are somewhat variable, a three to five year average may be more appropriate to use than the current expectations for the present orchard.

If the equivalent annuity is greater than the present value of next year's income from the present orchard, the analysis supports the decision to replace the orchard. If the equivalent annuity is less, the analysis does not support replacement.

At this point, it is wise to analyze the sensitivity of the replacement decision. What are the effects of changes in the price? What if the yield of the new orchard increases at a slower rate and to a lower mature level? What effect does a different discount rate have? Are the price and yield of the present orchard stable or unstable? Failure to evaluate these variations may cause a wrong decision involving a large amount of money.

The actual decision to replace or not to replace depends on other factors also. The cash flow situation is an important consideration. If you don't have the money and you can't get enough credit, don't pull profitable trees no matter what the equivalent annuity analysis shows. The need for capital for replacement may cause the scheduling of replacement over several years rather than replacing a large block in one year. Anticipation of improved technology may delay replacement. Anticipation of several years of low prices may encourage replacement because the expected income potential of the present orchard is lower. The age of the owner and his/her goals may affect the decision. The higher profitability of other crops may cause replacement with another crop.

The Analysis Procedure

The equivalent annuity is superior to simple averages or totals; but, the analysis is more complicated. However, the value of the better information usually outweighs the "costs" of the more complicated work. The steps involved in this analysis are specified below.

Step 1. Determing Projected Returns and Costs of New Orchard

The first step is to estimate the expected net return from the new orchard for each year of its life. To do this, estimates must be made of the expected life, costs, and gross incomes of the new orchard. Since they are the same whether the orchard is replaced or not, fixed costs (such as interest payments for land, taxes, some depreciation, etc.) can be excluded from this analysis.

As an example, the projected net returns for a new almond orchard are listed in Table 1. The yields and the nonharvest costs for the first fifty years are listed. The yields are considered typical. Many factors affect the production pattern over time; another example uses a more productive orchard. The cost in year zero is the cost of tree removal and land preparation minus the value of the firewood. The establishment and production costs are adapted from budgets by Asai (1981a and 1981b). The development costs are depreciated starting when the income starts; the ACRS method for 15 years is used assuming the orchard is in service for 12 months in the first year. The tax rate is 32 percent. The after-tax expected net return is calculated using an expected price of $0.80 per lb. and a harvest cost of $0.10 per lb. of almond meat. The net return is expected to be positive in year four until year 35 (Table 1).

<u>Step 2</u>. Calculate Present Value of Future Returns from New Orchard

Next, it is necessary to calculate the present value of the expected returns. This is necessary in order to compare net returns in different years. Discounting is done by multiplying the estimated net return by the appropriate present value factor found in interest tables. The discount rate and the year determine the appropriate present value factor. The discount rate chosen is usually the interest rate that would be incurred on a new loan for orchard replacement.

A discount rate of 12 percent is used to estimate the present value of the net returns in the example (Table 1). The present value of the net return in year 10 ($591.79) is $190.54. This is calculated by multiplying the net return by the present value factor for 10 years and 12 percent, that is, 0.3220.

Step 3. Calculate Accumulated Discounted Net Returns for the New Orchard Over its Productive Life

This step involves accumulating the discounted net returns over time. The sum of the present values of the expected net returns for years zero through 10 is the accumulated present value in year 10 ($426.41; Table 1). The accumulated, discounted net income indicates the profitability--in discounted dollars--of the new orchard through a specific year--taking the discount rate into account.

Economically, this step calculates some important numbers. At the selected discount rate and considering only monetary terms, a grower is indifferent between receiving the accumulated discounted net returns now as a lump payment and having the expected net returns from the new orchard from year zero through the specified year. However, this indifference is only in monetary terms; there is no allowance for psychic value, risk preferences, or other factors.

Step 4. Determine the Equivalent Annuity of the Accumulated Discounted Net Returns for the New Orchard

In the years where it is positive, the accumulated, discounted net returns needs to be adjusted to allow for comparison on an annual basis. Thus, we calculate the ordinary annuity which is equivalent to the accumulated, discounted net returns for a specific year. A grower should be indifferent between this annuity and the expected net income from the new orchard. (Remember, this indifference does not account for other, nonmonetary factors.) The equivalent annuity makes it easy to compare the profitability of keeping the orchard to different ages.

In year 10, the accumulated present value is $279.33 (Table 1). This is converted to an annuity by dividing by the appropriate annuity factor. For 10 years and a 12 percent discount rate, the annuity factor is 5.6502; the equivalent annuity is thus $49.44 ($279.33 ÷ 5.6502).

Step 5. Compare the Maximum Equivalent Annuity of the New Orchard with the Expected Return from the Old Orchard

The maximum equivalent annuity calculated in the previous step is compared to the present value of next year's expected net return from the present orchard. If the present value of next year's net return from the present orchard is less than the maximum equivalent annuity of the new orchard, it is time to replace; if it is not less, the present orchard is profitable to keep for at least one more year.

An Example Analysis

As an example of analyzing the replacement decision, let's consider a thirty year old orchard. The orchard has received good care from planting to the present. Although his net income is still positive, the grower has noticed the yield starting to decrease slowly.

Following the steps outlined above, we first estimate the net returns from a new almond orchard. Since this is a long term decision, we use long term prices and costs when applicable. For instance, we can use the next year's estimate of nursery trees, but we should use a long term estimate of the meat price because this year's or next year's prices probably are not good indicators of the price in teh, twenty, or thirty years.

Two new orchards are evaluated. The first is a typical orchard which increases to a maximum yield of 1800 lbs. of meat (Table 1.0 The second is a higher, more productive orhcard which increases rapidly to a maximum of 2200 lbs. of meat (Table 2). The maximum equivalent annuities for these two orchards are estimated with four meat prices, three discount rates, and two tax rates (Table 2).

The increasing price has the expected effect of increasing both the equivalent annuity and the optimal age. The increasing interest rate decreases the equivalent annuity but increases the optimal replacement age. The change in the tax rate has little effect upon the equivalent annuity or the optimal age.

To complete the analysis of the replacement decision, the annuities must be compared to the expected return from the present orchard. The grower expects a yield of 1400 lbs. or almond meats. Even though this is an estimate of next year's return, we should use a longer term estimate of the almond meat price, say $0.75 per pound. With expected costs of $830 per acre and a discount rate of 12 percent, the present value of next year's returns from the present orchard is $196 per acre.

The information in Table 3 shows what we expect. At lower prices and lower interest rates, the choice is not to replace the orchard. The tax rate has little effect on the choice.

If the long term meat price is expected to be above $0.60 per pound, this analysis shows that the owner should seriously consider replacing the present orchard--especially with the high yielding orchard. As stated earlier, other factors may also affect the replacement decision.

Conclusion

From the example analysis it appears that expected price and desired rate of return are the most important variables to evaluate. However, the year in which the equivalent annuity is maximized is fairly stable even with variation in price and interest rate. The tax rate has a small effect.

This type of replacement decision analysis should be done for those orchards which have decreasing or below normal yields. Economically, it may be more profitable to replace an orchard with a positive income. However, there are other considerations which enter into the final decision besides the equivalent annuity.

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Table 1.

Year	Yield	Nonharvest Cost	Expected Net Return	Present Value of Expected Net Return	Accumulated Present Value	Equivalent Annuity
0	0.00	$150.00	-$150.00	-$150.00	-$150.00	$0.00
1	0.00	$520.00	-$520.00	-$464.29	-$614.29	$0.00
2	0.00	$205.00	-$205.00	-$163.42	-$777.71	$0.00
3	0.00	$260.00	-$260.00	-$185.06	-$962.77	$0.00
4	400.00	$310.00	$127.08	$80.76	-$882.01	$0.00
5	800.00	$400.00	$196.32	$111.40	-$770.61	$0.00
6	1200.00	$500.00	$372.69	$188.82	-$581.80	$0.00
7	1500.00	$600.00	$479.06	$216.70	-$365.10	$0.00
8	1800.00	$690.00	$595.42	$240.48	-$124.61	$0.00
9	1800.00	$690.00	$591.79	$213.41	$88.79	$16.66
10	1800.00	$690.00	$591.79	$190.54	$279.33	$49.44
11	1800.00	$690.00	$591.79	$170.13	$449.46	$75.70
12	1800.00	$690.00	$591.79	$151.90	$601.36	$97.08
13	1800.00	$690.00	$588.16	$134.79	$736.15	$114.60
14	1800.00	$690.00	$588.16	$120.35	$856.50	$129.22
15	1800.00	$690.00	$588.16	$107.45	$963.95	$141.53
16	1800.00	$690.00	$588.16	$95.94	$1,059.90	$151.98
17	1800.00	$690.00	$588.16	$85.66	$1,145.56	$160.90
18	1800.00	$690.00	$588.16	$76.48	$1,222.04	$168.57
19	1800.00	$690.00	$570.00	$66.18	$1,288.22	$174.89
20	1800.00	$690.00	$570.00	$59.09	$1,347.31	$180.38
21	1800.00	$690.00	$570.00	$52.76	$1,400.07	$185.15
22	1800.00	$690.00	$570.00	$47.11	$1,447.18	$189.31
23	1800.00	$690.00	$570.00	$42.06	$1,489.24	$192.95
24	1800.00	$690.00	$570.00	$37.55	$1,526.79	$196.14
25	1800.00	$690.00	$570.00	$33.53	$1,560.32	$198.94
26	1750.00	$690.00	$535.00	$28.10	$1,588.42	$201.18
27	1700.00	$690.00	$500.00	$23.45	$1,611.87	$202.94
28	1650.00	$690.00	$465.00	$19.47	$1,631.34	$204.31
29	1600.00	$690.00	$430.00	$16.07	$1,647.41	$205.37
30	1500.00	$690.00	$360.00	$12.02	$1,659.43	$206.01
31	1400.00	$690.00	$290.00	$8.64	$1,668.07	$206.32
32	1300.00	$690.00	$220.00	$5.85	$1,673.92	$206.36
33	1200.00	$690.00	$150.00	$3.56	$1,677.49	$206.20
34	1100.00	$690.00	$80.00	$1.70	$1,679.18	$205.87
35	1000.00	$750.00	-$50.00	-$0.95	$1,678.24	$205.28
36	950.00	$750.00	-$85.00	-$1.44	$1,676.80	$204.66
37	900.00	$750.00	-$120.00	-$1.81	$1,674.99	$204.08
38	850.00	$750.00	-$155.00	-$2.09	$1,672.90	$203.49
39	800.00	$750.00	-$190.00	-$2.29	$1,670.61	$202.92
40	750.00	$800.00	-$275.00	-$2.96	$1,667.66	$202.29
41	700.00	$800.00	-$310.00	-$2.97	$1,664.68	$201.70
42	650.00	$800.00	-$345.00	-$2.96	$1,661.73	$201.13
43	600.00	$800.00	-$380.00	-$2.91	$1,658.82	$200.59
44	550.00	$800.00	-$415.00	-$2.83	$1,655.98	$200.08
45	500.00	$700.00	-$350.00	-$2.13	$1,653.85	$199.68
46	450.00	$700.00	-$385.00	-$2.10	$1,651.75	$199.30
47	400.00	$600.00	-$320.00	-$1.56	$1,650.20	$198.99
48	350.00	$600.00	-$355.00	-$1.54	$1,648.66	$198.70
49	300.00	$500.00	-$290.00	-$1.12	$1,647.53	$198.47
50	250.00	$400.00	-$225.00	-$0.78	$1,646.75	$198.30

Table 2.

Year	Yield	Nonharvest Cost	Expected Net Return	Present Value of Expected Net Return	Accumulated Present Value	Equivalent Annuity
0	0.00	$150.00	-$150.00	-$150.00	-$150.00	$0.00
1	0.00	$520.00	-$520.00	-$464.29	-$614.29	$0.00
2	0.00	$205.00	-$205.00	-$163.42	-$777.71	$0.00
3	500.00	$260.00	$311.10	$221.43	-$556.28	$0.00
4	900.00	$350.00	$488.00	$310.13	-$246.14	$0.00
5	1500.00	$500.00	$875.20	$496.61	$250.47	$69.48
6	2000.00	$650.00	$1,172.40	$593.97	$844.44	$205.39
7	2100.00	$750.00	$1,159.60	$524.54	$1,368.99	$299.97
8	2200.00	$750.00	$1,246.80	$503.56	$1,872.55	$376.95
9	2200.00	$750.00	$1,246.80	$449.61	$2,322.16	$435.82
10	2200.00	$750.00	$1,246.80	$401.44	$2,723.60	$482.03
11	2200.00	$750.00	$1,246.80	$358.43	$3,082.02	$519.06
12	2200.00	$750.00	$1,244.00	$319.30	$3,401.33	$549.10
13	2200.00	$750.00	$1,244.00	$285.09	$3,686.42	$573.89
14	2200.00	$750.00	$1,244.00	$254.55	$3,940.97	$594.58
15	2200.00	$750.00	$1,244.00	$227.27	$4,168.24	$612.00
16	2200.00	$750.00	$1,244.00	$202.92	$4,371.16	$626.78
17	2200.00	$750.00	$1,244.00	$181.18	$4,552.35	$639.41
18	2200.00	$750.00	$1,230.00	$159.95	$4,712.30	$650.00
19	2200.00	$750.00	$1,230.00	$142.81	$4,855.11	$659.14
20	2200.00	$750.00	$1,230.00	$127.51	$4,982.62	$667.07
21	2100.00	$750.00	$1,140.00	$105.57	$5,088.14	$672.86
22	2100.00	$750.00	$1,140.00	$94.21	$5,182.35	$677.91
23	2100.00	$750.00	$1,140.00	$84.12	$5,266.47	$682.32
24	2100.00	$750.00	$1,140.00	$75.11	$5,341.57	$686.20
25	2100.00	$750.00	$1,140.00	$67.06	$5,408.63	$689.60
26	2100.00	$750.00	$1,140.00	$59.87	$5,468.51	$692.60
27	2100.00	$750.00	$1,140.00	$53.46	$5,521.96	$695.24
28	2000.00	$750.00	$1,050.00	$43.96	$5,565.93	$697.10
29	2000.00	$750.00	$1,050.00	$39.25	$5,605.18	$698.74
30	2000.00	$750.00	$1,050.00	$35.05	$5,640.23	$700.20
31	1950.00	$750.00	$1,005.00	$29.95	$5,670.18	$701.32
32	1900.00	$750.00	$960.00	$25.54	$5,695.72	$702.17
33	1850.00	$750.00	$915.00	$21.74	$5,717.46	$702.79
34	1800.00	$750.00	$870.00	$18.45	$5,735.91	$703.23
35	1700.00	$800.00	$730.00	$13.83	$5,749.74	$703.29
36	1600.00	$800.00	$640.00	$10.82	$5,760.56	$703.16
37	1500.00	$800.00	$550.00	$8.30	$5,768.87	$702.88
38	1400.00	$800.00	$460.00	$6.20	$5,775.07	$702.48
39	1300.00	$800.00	$370.00	$4.45	$5,779.52	$701.99
40	1200.00	$850.00	$230.00	$2.47	$5,781.99	$701.38
41	1100.00	$850.00	$140.00	$1.34	$5,783.34	$700.72
42	1000.00	$850.00	$50.00	$0.43	$5,783.77	$700.05
43	950.00	$850.00	$5.00	$0.04	$5,783.80	$699.41
44	900.00	$850.00	-$40.00	-$0.27	$5,783.53	$698.80
45	950.00	$700.00	$155.00	$0.95	$5,784.48	$698.40
46	800.00	$700.00	$20.00	$0.11	$5,784.58	$697.95
47	750.00	$600.00	$75.00	$0.36	$5,784.95	$697.59
48	700.00	$600.00	$30.00	$0.13	$5,785.08	$697.24
49	650.00	$500.00	$85.00	$0.33	$5,785.41	$696.95
50	600.00	$400.00	$140.00	$0.48	$5,785.89	$696.72

Table 3. Estimated Maximum Equivalent Annuities and the Corresponding Age of the Almond Orchard for Both Yield Levels and for Variations in Expected Prices, Interest Rates, and Tax Rates

Expected Almond Meat Price ($/lb.)	Marginal Tax Rate 32%, Interest Rate 8% Eq.Ann.[a]	Age	32%, 12% Eq.Ann.	Age	32%, 15% Eq.Ann.	Age	50%, 8% Eq.Ann.	Age	50%, 12% Eq.Ann.	Age	50%, 15% Eq.Ann.	Age
Typical yielding orchard[b]:												
.60	$ 49	30yrs.	$ 1	31yrs.	__[c]	__[c]	$ 58	30yrs.	$ 11	30yrs.	__[c]	__[c]
.80	284	31	206	32	151	32	293	30	216	32	160	32
1.00	521	31	412	32	334	33	530	31	421	32	344	33
1.20	757	31	617	33	518	34	766	31	626	33	528	33
High yielding orchard[d]:												
.60	185	32	137	34	101	34	192	32	145	34	109	34
.80	501	34	420	34	361	35	508	34	428	34	369	35
1.00	817	34	703	35	621	36	824	34	711	35	629	36
1.20	1,133	34	986	35	880	36	1,140	34	994	35	889	36

[a] Eq. Ann. = equivalent annuity.

[b] An example for the typical yielding orchard is in Table 1.

[c] In certain cases, the accumulated present value did not become positive; thus, an equivalent annuity was not calculated.

[d] An example for the high yielding orchard is in Table 2.