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ECONOMIC ASPECTS OF AVOCADO PRODUCTION: ORCHARD REPLACEMENT

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OPSOMMING

Die optimale vervangingsouderdom van 'n boordkan bepaal worddeur verwagte toekomstige marges van 'n nuweboordte verdiskonteeren te amortiseer en dit te vergelyk met huidige verwagte marges op 'n bestaande boord. Nuwe tegnologie kan marges op nuwe boorde verhoog en sodoende vroeer vervanging winsgewend maak. Prysveranderings het 'n beperkte uitwerking. Inflasie asook die individuele boer se likwiditeit en solvabiliteit kan aansienlike veranderings meebring. Boordvervanging behoort 'n intégrale deel van 'n totale bestuursstrategie te vorm.

SUMMARY

The optimal replacement age of an orchard can be obtained by discounting and amortising expected future margins of a new orchard, and comparing this to present expected margins of the existing orchard. New technology can improve margins on new orchards, and thus render earlier replacement profitable. Price changes have a limited effect. Inflation and the individual farmer's liquidity and solvency can bring about substantial changes. Orchard replacement should form an integral part of a total management strategy.

INTRODUCTION

Intensive agriculture, be it the growing of perennial, or annual crops, or a mixture thereof, has multi-facetted fields of economic problematic. There are facets such as combinations of perennial and annual crops, choice and combinations of cultivars, technology selection, input selection as part of a wider package of financial and asset management, market identification, forecasting, selection and development and a host of other factors. In a system involving or including perennial crops — such as avocados — the timing of orchard or tree replacement is narrowly intertwined with the majority of other decisions. Its rol e can be cause or effect. It can have profound influence on the profitability of farming. It is for this reason that we decided to concentrate this paper on orchard replacement. The *modus operandi* will be to have a brief look at methodology used in calculating the optimal replacement stage, to illustrate this by means of an example, and to point at factors influencing optimal replacement strategies.

PROCEDURE AND METHODOLOGY

The principle involved with optimal replacement of any durable asset is the maximization of the present value of the stream of future cash margins, which may, if needed, be computed over an infinite time period. (Rae, 1977: 315 - 324). This could be done by comparing gains from a series of different possible strategies. This would be an inefficient procedure, and thus, recourse is taken to marginal criterion which involves comparing gains from holding the asset for one more period with the opportunity gains that could be realized by replacing the asset immediately. In other words: Will it pay better to keep an orchard one more year, or should it be replaced immediately?

Any replacement decision therefore compares the presently expected cash balance with the present value of the future stream of cash balances, should an asset be replaced immediately (Chisholm & Dillon, 1971).

Perhaps the most practical partial procedure for employing this method. Is the one adopted by Paris and Reed (1 962) in their study on cling peach tree replacement. They broke the procedure up into five consecutive steps:

1). Compute a table of earnings of present trees.

2). Compute a table of earnings one would expect from the replacement trees.

3). Calculate the present value of future earnings on the replacement trees. This is done because the present value of R100 which will be received in the future is less than R100; everyone would prefer receiving R100 today to receiving R100 one year hence. Future earnings are therefore discounted, using the formula

$$PV = \frac{FV}{(1+i)^n}$$

where PV = present value
FV = future value
i = discounting factor (decimal)
n = number of time periods.

These values can also be obtained for tables published in many publications (eg. Chisholm & Dillon, 1971; Brigham & Crum, 1983; Paris & Reed, 1961)

4).Amortize the present value of future incomes from replacement trees. This is done by summing up the discounted values of future earnings from replacement trees and converting the sum to a single annual value. This value determines which constant stream of cash revenue would, if accumulated regularly over the period and allowed to grow at the discount factor, yield an eventual cash lump sum equal to this sum of discounted cash yields. Thus, for each possible replacement year, the following formula is employed:

$$A = PV\,[i(1+i)^n] \;/\; [(1+i)^n - 1]$$

where A = Annuity
PV = Present value
i = Discount factor
n = Number of time periods.

These values can be obtained from tables in the same sources that contain discounting tables.

5). Compare the expected cash margin of an orchard at any age with the amortized value; if the amortized value is lower, then the orchard should not yet be replaced. If it is higher, replacement should be done.

APPLICATION: A PRACTICAL EXAMPLE

The data used pertain to an orchard of avocados in the vicinity of Burgershall. Actual yields and marketed quantities were used, and revenues were calculated according to present market prices, after adjusting export prices to the 1980 foreign exchange level of the Rand. The foreign exchange data were obtained from Bulletins of Statistics published by the Central Statistics Services and from Reserve Bank Quarterlies.

Running costs were also converted to present price levels. The following cost items were included: Destumping and orchard preparation; liming; trees (these costs during establishment); packaging; marketing; pest control; weed control; labor; mechanization; irrigation; sundries. The relevant information appears in Table 1, columns 1 to 6. It was assumed at this stage that replacement would be by an orchard yielding the same margins. In column (vii), the future margins were discounted back to a present value at planting time. A discount rate, roughly equivalent to the present rate of inflation (13%) was used. These values were accumulated in column (ix), therefore showing the equivalent present value of an orchard to be planted now.

It appears in Table 1 that in the 17th year the present margin still exceeds the amortized value and hence, this orchard should not be replaced before the 17th year. It should however, be replaced before the 18th year, since the expected revenue in year 18th is exceeded by the amortized value of expected earnings by a new orchard. Figure 1 illustrates this point

TABLE 1 Yields, revenues, costs and replacement data of an avocado orchard. Discount rate = 13%

Year (Age) (i)	Yield (kg) per tree (ii)	Yield (kg) per ha (iii)	Revenue (iv)	Running cost (v)	Margin (vi)	Present value (vii)	Accumulated PV (viii)	Annuity Amortised (ix)
			Rand per hectare					
1	0	0	0	3 547	(3 547)	(3 547)	(3 547)	(3 547)
2	0	0	0	1 036	(1 036)	(917)	(4 464)	(5 044)
3	3	540	668	1 574	(906)	(709)	(5 173)	(3 101)
4	12	2 420	3 001	3 325	(324)	(225)	(5 398)	(2 286)
5	20	4 180	5 121	4 277	844	518	(4 880)	(1 641)
6	37	7 450	8 965	5 084	3 881	2 107	(2 773)	(788)
7	50	10 260	11 971	6 363	5 608	2 694	(79)	(20)
8	64	13 040	14 737	7 507	7 230	3 073	2 994	877
9	77	15 610	17 057	8 435	8 622	3 244	6 238	1 300
10	87	17 800	19 204	9 328	9 876	3 288	9 526	1 857
11	96	19 440	20 831	10 002	10 829	3 190	12 716	2 344
12	98	20 350	21 806	10 404	11 402	2 973	15 689	2 758
13	100	20 370	21 679	10 329	11 350	2 618	18 307	3 094
14	95	19 320	20 420	9 774	10 646	2 174	20 481	3 345
15	84	17 020	17 865	8 675	9 190	1 661	22 142	3 514
16	65	13 320	13 883	6 978	6 905	1 104	23 246	3 596
17	39	8 030	8 369	4 653	3 716	526	23 772	3 599
18	32	6 504	6 779	3 957	2 822	353	24 125	3 585

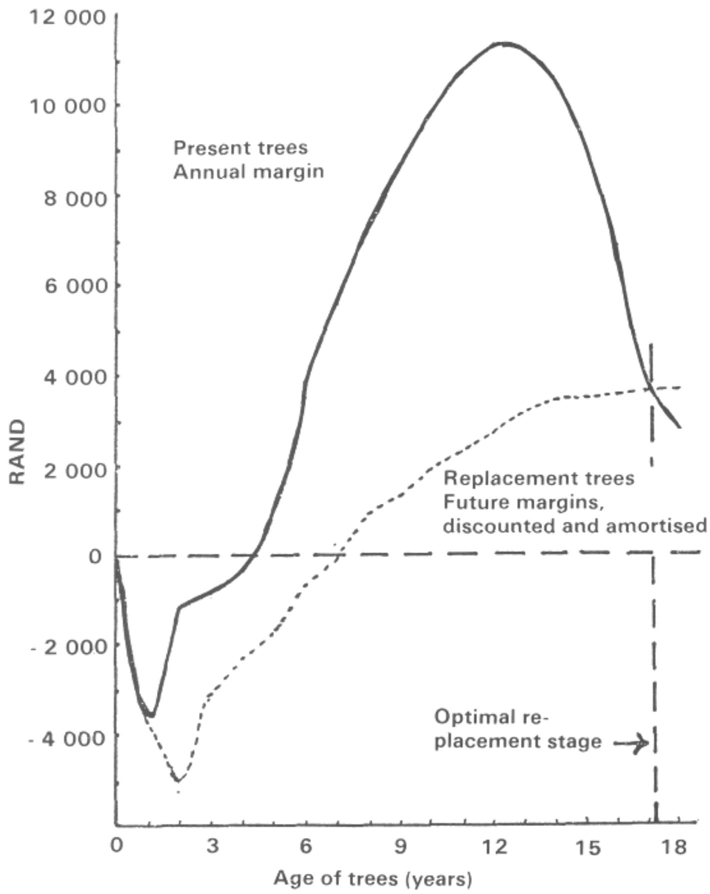

FIG. 1. Margin on present trees compared to future margins on replacement trees.

THE EFFECT OF TECHNOLOGY

Improved technology can be one or more of a large number of improvements, each one of which should have the effect of increasing profit margins per hectare. This can be obtained through higher revenues, sustenance of peak revenues over a longer time and/or net reductions in cost. Various types of technological improvements can potentially yield such results: improved orchard layout and preparation, improved plant material, improved plant nutrition, better disease and pest control, higher yielding cultivars, improved fruit quality, cultivars obtaining higher prices by reaching markets at peak times, better irrigation, cheaper harvesting and transport, etc.

In order to illustrate the potential effects of such technological advancement, a hypothetical orchard with cash margins exceeding that of the orchard used for purpose of Table 1 was visualized. Data pertaining to this orchard as well as the original orchard are presented in Table 2.

OTHER FACTORS AFFECTING OPTIMUM REPLACEMENT STRATEGY

Various other factors can have or are sometimes thought to exercise material effects on optimum replacement strategies.

1. Price changes

Prices of products as well as inputs change over time. Increases in product prices relative to prices of inputs have the effect of shifting upwards both the curve for annual net income from present trees and the curve for amortized discounted future income of replacement trees. If prices of inputs rise relative to those of products, both curves shift downwards. The effect on optimal replacement age is rather slight (Paris & Reed, 1962).

2. Discount rates

Higher discount rates have the effect of decreasing present value of future incomes but increasing annuities from an income stream. The effect on present values is the larger of the two, with the result that a net decrease in amortized value of future earnings is associated with an increase in the discount rate. Thus, the line showing amortized future discount earnings shifts downwards relative to the line depicting net income from an existing orchard. The result is a later optimal replacement or, otherwise stated, a longer economic life for an orchard.

Appropriate discount rates are influenced by the following considerations:

2.1. Inflation

The higher the rate of inflation, the higher should be the discount rate used, and the lower will be amortized present values of future earnings. Consequently, orchard replacement should normally be postponed during times of accelerating inflation. They may be speeded up as inflation rates decline.

2.2 The grower's financial situation

The optimal replacement pattern can vary considerably according to the solvency and liquidity positions of growers. A farmer with a low level of liquid assets may ha veto borrow money to finance replacement. He will in any case, have to borrow more than a person in a more liquid position. In this case, the loan rate, rather than the inflation rate, will be the appropriate discount factor.* the result will be replacement at a later orchard age.

* It will presently be in excess of 20% compared to an inflation rate of approximately 13%.

If, in addition, the farmer has a high degree of indebtedness, he may be in a situation of having to pay a higher rate of interest on borrowed funds. This will once again, lead to a higher optimum replacement age.

3. Income tax rates

If income tax rates are expected to increase over time, future earnings of replacement trees will decline relative to present earnings of existing trees. Therefore, if income tax rates are expected to increase over time, orchard replacement should be postponed. Earlier replacement will be appropriate should tax rates be expected to decline over the long run.

4. Rotational effects

Cash flow effects of population rotations in orchard agriculture should always be borne in mind. There is an obvious danger in replacing too many orchards at once; this may lead to too limited positive cash flow, or even negative cash flow for the business as a whole. The result will be suboptimal stringency in input use, low profit margins and possible aggravated financial problems.

Orchard replacement should therefore be tuned into a long term management strategy. This may involve replacing some groves earlier than the age as indicated by the partial static analysis as used in this paper, and retaining some others over a longer period.

CONCLUSION

Many factors obviously determine the optimum replacement strategy of orchards. It is therefore rather obvious that no nice, neat prescriptions exist orean exist. It is rather the job of management or its advisers to apply the fairly simple tools as presented by the model in this paper to the vexing problem of orchard replacement. Any "rule of thumb" procedure is likely to be very costly; farms vary too much in terms of yield potentials, costs, financial position, asset structure, orchard composition, managerial ability, etc.

Farmers will have to keep accurate records of the right nature for this and also for other management purposes. Technological forecasting should improve.

There is also a serious need for more research on technology of production, and for the design of research endeavors to enable people to interpret research results financially. Better research on market development and price forecasting is also needed. In the last instance, there should also be more research on total farm systems, involving not only orchard replacement, but also the place of orchard management in a total system involving orchard agriculture (of various fruits), other agricultural enterprises and financial management. The operational research tools, computer hardware and software are already available, or can be readily developed.

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TABLE 2. Data pertaining to original orchard and new orchard with better technology. Discount rate = 13%

Year	Annual margin old orchard	New orchard			
		Margin	Present value	Accumulated PV	Annuity amortised
	Rand per hectare				
1	(3 547)	(3 650)	(3 650)	(3 650)	(3 650)
2	(1 036)	(1 103)	(976)	(4 626)	(5 227)
3	(906)	(900)	(705)	(5 331)	(3 196)
4	(324)	369	256	(5 075)	(2 149)
5	844	943	578	(4 497)	(1 512)
6	3 881	4 463	2 422	(2 075)	(590)
7	5 608	6 505	3 124	1 049	262
8	7 230	8 459	3 596	4 645	1 050
9	8 622	10 088	3 795	8 440	1 759
10	9 876	11 654	3 880	12 320	2 401
11	10 829	12 995	3 828	16 148	2 976
12	11 402	13 796	3 597	19 745	3 471
13	11 350	13 734	3 168	22 913	3 872
14	10 646	13 720	2 802	25 715	4 199
15	9 190	12 904	2 332	28 047	4 451
16	6 905	12 584	2 012	30 059	4 650
17	3 716	12 264	1 735	31 794	4 814
18	2 822	11 944	1 495	33 289	4 947
19	2 300	9 555	1 059	34 348	5 022
20		7 644	750	35 098	5 058
21		6 512	565	35 663	5 075
22		5 703	438	36 101	5 083
23		4 999	340	36 441	5 084
24		4 268	257	36 698	5 075