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Assessment of the Time of Orchard Replacement of Orange Cultivation in Arunachal Pradesh, India

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A B S T R A C T

For perennial cash crops like orange having a long production period and with revenue being realised throughout the life of the plant, the optimum replacement period is the year when the amortized present value of Accumulated Net Revenue (ANR) from the incoming plantation just exceeds the anticipated Net Revenue (NR) from the existing plantation in the year (t+1). So long as the anticipated net revenue in the year (t+1) exceeds the amortized present value of Accumulated Net Revenue in the year 't', it is profitable to continue with the existing plantation assuming that the present orchard will be replaced by new plantation of same crops, not by other perennials or by competing annual crops. The anticipated net revenue in the year 46th year is equal to the net revenue in the 47th year. So, the optimum period to replace the existing orange trees is at the age of 46th year when the condition $P\frac{1-V}{1-V^t} > NR_{t+1}$ is satisfied.

Introduction

Mandarin orange (*Citrus reticulata*) is most common among citrus fruits grown in India. It occupies nearly 40% of the total area under citrus cultivation in India. The production of Citrus constitutes about 33% of the total production of fruits in the state. The production of citrus is 36,000 MT from an area of 34,000 ha having productivity of 1.04 MT/ha. Recently the Govt. of Arunachal Pradesh has taken steps for area expansion under mandarin orange in 8 districts out of 19 districts of the state. Although there are area expansions happening, the most important decision is to know the time of orchard replacement with new plant trees. The decision maker inputs expected yields, annual costs, prices, and harvest cost for the replacement orchard along with the expected current annual income for the existing orchard and a discount rate. The model uses the information for the replacement orchard to calculate the expected net income for each year and the discount rate is used to determine the net present value each year. These annual estimates are accumulated through a particular year to determine total net present value of income up to and including that year. This is done for each year in the expected life of the replacement orchard. Since these are estimates of total income, they cannot be compared to an annual income. To accomplish this, the accumulated net present value estimate for each year is amortized to determine the necessary annual income that will equal the accumulated net present value for that year. The largest amortized value is selected to represent the expected average, or annual, income from the replacement orchard. If this is larger than the income expected from the existing orchard, the decision should be to replace.

The main objective for this study is the assessment of the time of orchard replacement of mandarin orange in Arunachal Pradesh.

Materials and Methods

Determination of replacement year of the orchard

Determination of replacement age of an existing orchard from which stream of revenues being realised throughout the life of perennial crops has been a critical issue since long and a large volume of analytical methods are available in the literature. But the decision criteria on asset replacement proposed by Faris (1960) have been widely used to estimate the replanting of age orchards. The basic principle to follow with respect to the immediate replacement of enterprises can be stated on the optimum time to replace when the marginal net revenue from the present enterprise is equal to the highest amortized present value of net revenue from the following enterprises. The basic principle has been mathematically elucidated by Perrin (1970) by comparing gain from keeping the current asset for another time interval with the opportunity gains could be realised from a replacement assets during the same period e.g. a forest should be left to grow another year if the additional net return are greater than the average annual net return from a new stand. The principle involved with optimum replacement of any durable asset is the maximisation of the present value of the stream of future cost margin, which may, if needed be completed over the infinite time period (Rae, 1977). So any replacement decision therefore compares the presently expected cash balance with the present value of the future stream of cash balances, should asset be replaced immediately (Chisholm and Dillon, 1971). Etherington (1977) has applied Perrin’s exposition on principles to decision making regarding asset replacement, to estimate the decision making of the replanting of rubber trees. According to this principle, for perennial cash crops like orange having a long production period and with revenue being realised throughout the life of the plant, the optimum replacement period is the year when the amortized present value of Accumulated Net Revenue (ANR) from the incoming plantation just exceeds the anticipated Net Revenue (NR) from the existing plantation in the year (t+1). So long as the anticipated net revenue in the year (t+1) exceeds the amortized present value of Accumulated Net Revenue in the year ‘t’, it is profitable to continue with the existing plantation assuming that the present orchard will be replaced by new plantation of same crops, not by other perennials or by competing annual crops. On the other hand, if the anticipated net revenue is less than ANR, long run average net return should be maximised through replacement of existing plantation with a new but same crop. Here it is to be noted that if the farmer thinks of replacing the present plantation with the competing annual crops, then the optimum replacement period is the year when the present value of Net Return is less than the expected net return from the competing annual crop combination. The penalty or opportunity cost of operating the existing plantation beyond its optimum replacement period is the additional potential net revenue from a new one which is forgone due to non-replacement (Olayemi and Onyenkawa, 1999).

Simulation of the model

Accumulated present value of net return for period 'n' is given by the following formula for profit maximisation.

$$P_v = \sum_{t=1}^{n} \frac{NR_n}{(1+r)^{n-1}} \quad \text{.................. (i)}$$

Where

P_v = Present value

NP_n = Annual Net Revenue in year 't'

n = Optimum replacement period to be determined

r = Discount rate

The amortized present value of the net revenue was obtained by a accumulating value of the net revenue. This is represented as follows:

Accumulated present value of NP_n =

$$\sum_{t=0}^{n} \frac{NP_n}{(1+r)^{n}} \quad \text{............. (ii)}$$

Equation (ii) is multiplied by amortized factor

$\frac{1-V}{1-V^t}$, when $V = \frac{1}{(1+r)}$ and t = number of years.

Now, we obtain,

$$ANP_n = [\sum_{t=0}^{n} \frac{NR_n}{(1+r)^n}] \frac{1-V}{[1-V^t]}$$

The existing plantation is to be replaced when $ANR_n \geq NR_{n+1}$

Results and Discussion

Determination of replacement year of the orchard

For perennial cash crops like orange having a long production period and with revenue being realised throughout the life of the plant, the optimum replacement period is the year when the amortized present value of Accumulated Net Revenue (ANR) from the incoming plantation just exceeds the anticipated Net Revenue (NR) from the existing plantation in the year (t+1). So long as the anticipated net revenue in the year (t+1) exceeds the amortized present value of Accumulated Net Revenue in the year 't', it is profitable to continue with the existing plantation assuming that the present orchard will be replaced by new plantation of same crops, not by other perennials or by competing annual crops. On the other hand, if the anticipated net revenue is less than ANR, long run average net return should be maximised through replacement of existing plantation with a new but same crop. Here it is to be noted that if the farmer thinks of replacing the present plantation with the competing annual crops, then the optimum replacement period is the year when the present value of Net Return is less than the expected net return from the competing annual crop combination.

The penalty or opportunity cost of operating the existing plantation beyond its optimum replacement period is the additional potential net revenue from a new one which is forgone due to non-replacement. Here, from Table 1 it is projected that the anticipated net revenue in the year 46^{th} year is equal to the net revenue in the 47^{th} year. So, the optimum period to replace the existing orange trees is at the age of 46^{th} year when the condition $P\frac{1-V}{1-V^t} > NR_{t+1}$ is satisfied.

Table.1 Estimation of replacement year of the orange orchard:

Age of the plantation	Net Return (NR)	Discount factor (v)	Present value of net return (Pn)	Cummulative NPV (∑Pn)	$r(1+r)^{n-1}$	$(1+r^n)^{-1}$	$\frac{1-V}{1-V^n}$	$P_n(\frac{1-V}{1-V^n})$	$NR_{(t-1)}$
1	-43730.00	0.91	-39754.55	-39754.55	0.10	0.10	1.00	-39754.55	-8663.45
2	-8663.45	0.83	-7159.87	-46914.42	0.11	0.21	0.52	-24574.22	-6205.00
3	-6205.00	0.75	-4661.91	-51576.33	0.12	0.33	0.37	-18854.19	-7331.67
4	-7331.67	0.68	-5007.63	-56583.96	0.13	0.46	0.29	-16227.81	-8505.00
5	-8505.00	0.62	-5280.94	-61864.90	0.15	0.61	0.24	-14836.19	-11293.50
6	-11293.50	0.56	-6374.89	-68239.78	0.16	0.77	0.21	-14243.96	31622.22
7	31622.22	0.51	16227.20	-52012.58	0.18	0.95	0.19	-9712.43	35613.33
8	35613.33	0.47	16613.88	-35398.70	0.19	1.14	0.17	-6032.07	38516.67
9	38516.67	0.42	16334.83	-19063.87	0.21	1.36	0.16	-3009.33	36531.25
10	36531.25	0.39	14084.38	-4979.49	0.24	1.59	0.15	-736.72	43100.00
11	43100.00	0.35	15106.29	10126.79	0.26	1.85	0.14	1417.41	41200.00
12	41200.00	0.32	13127.59	23254.38	0.29	2.14	0.13	3102.63	34440.00
13	34440.00	0.29	9976.04	33230.42	0.31	2.45	0.13	4252.85	43966.67
14	43966.67	0.26	11577.80	44808.22	0.35	2.80	0.12	5529.59	40453.85
15	40453.85	0.24	9684.33	54492.55	0.38	3.18	0.12	6513.04	44364.91
16	44364.91	0.22	9655.10	64147.65	0.42	3.59	0.12	7453.76	37825.00
17	37825.00	0.20	7483.47	71631.12	0.46	4.05	0.11	8118.03	50111.11
18	50111.11	0.18	9012.92	80644.05	0.51	4.56	0.11	8939.04	47960.00
19	47960.00	0.16	7841.84	88485.89	0.56	5.12	0.11	9616.56	56247.06
20	56247.06	0.15	8360.77	96846.66	0.61	5.73	0.11	10341.43	48500.00
21	48500.00	0.14	6553.83	103400.49	0.67	6.40	0.11	10868.74	48285.71
22	48285.71	0.12	5931.71	109332.19	0.74	7.14	0.10	11331.29	50762.86
23	50762.86	0.11	5669.10	115001.30	0.81	7.95	0.10	11769.00	53240.00
24	53240.00	0.10	5405.22	120406.52	0.90	8.85	0.10	12182.93	40313.93
25	40313.93	0.09	3720.81	124127.33	0.98	9.83	0.10	12431.70	44792.47
26	44792.47	0.08	3758.33	127885.67	1.08	10.92	0.10	12690.80	39727.41
27	39727.41	0.08	3030.31	130915.98	1.19	12.11	0.10	12884.23	42065.58
28	42065.58	0.07	2916.97	133832.95	1.31	13.42	0.10	13073.17	33622.02
29	33622.02	0.06	2119.51	135952.46	1.44	14.86	0.10	13190.86	35944.96
30	35944.96	0.06	2059.95	138012.42	1.59	16.45	0.10	13309.32	31172.96
31	31172.96	0.05	1624.07	139636.49	1.74	18.19	0.10	13391.93	30314.04
32	30314.04	0.05	1435.75	141072.23	1.92	20.11	0.10	13462.36	26701.08
33	26701.08	0.04	1149.66	142221.89	2.11	22.23	0.09	13511.00	28852.05
34	28852.05	0.04	1129.34	143351.24	2.32	24.55	0.09	13562.81	24034.82

35	24034.82	0.04	855.26	144206.49	2.55	27.10	0.09	13593.39	18262.98
36	18262.98	0.03	590.79	144797.29	2.81	29.91	0.09	13603.45	21262.98
37	21262.98	0.03	625.31	145422.60	3.09	33.00	0.09	13620.80	18993.05
38	18993.05	0.03	507.78	145930.37	3.40	36.40	0.09	13630.82	21484.05
39	21484.05	0.02	522.16	146452.53	3.74	40.14	0.09	13645.51	19893.05
40	19893.05	0.02	439.54	146892.07	4.11	44.26	0.09	13655.54	18967.28
41	18967.28	0.02	380.98	147273.05	4.53	48.79	0.09	13662.90	20681.97
42	20681.97	0.02	377.66	147650.71	4.98	53.76	0.09	13672.45	16701.00
43	16701.00	0.02	277.24	147927.95	5.48	59.24	0.09	13675.00	18341.80
44	18341.80	0.02	276.80	148204.75	6.02	65.26	0.09	13679.60	15822.38
45	15822.38	0.01	217.07	148421.82	6.63	71.89	0.09	13680.58	16950.33
46	**16950.33**	**0.01**	**211.40**	**148633.22**	**7.29**	**79.18**	**0.09**	**13682.76**	**8311.04**
47	8311.04	0.01	94.23	148727.45	8.02	87.20	0.09	13675.74	13132.17
48	13132.17	0.01	135.36	148862.81	8.82	96.02	0.09	13673.93	7447.10
49	7447.10	0.01	69.78	148932.59	9.70	105.72	0.09	13667.40	10158.18
50	10158.18	0.01	86.53	149019.13	10.67	116.39	0.09	13663.59	0.00

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In conclusion, 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. Many factors obviously determine the optimum replacement strategy of orchards. It is therefore rather obvious that no nice, neat prescriptions exist. Technological forecasting should improve. There is also a serious need for more research on technology of production, and for the design of research endeavours 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. The anticipated net revenue in the year 46th year is equal to the net revenue in the 47th year. So, the optimum period to replace the existing orange trees is at the age of 46th year when the condition $P\frac{1-V}{1-V^t} > NR_{t+1}$ is satisfied.

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