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The rationale behind the dramatic increase in the percentage of area under self-cultivation from the first triennium to the second can mainly be traced to the significantly upward trend of profitability consequent to a marked increase in the prices of major commercial and food crops and to technological innovation.

PROFITABILITY OF NAGPUR SANTRA (ORANGES) CULTIVATION

G. S. GUPTA AND P. S. GEORGE*

Indian Institute of Management, Ahmedabad

Fruits and vegetables are an acceptable means of improving the nutritional level of the diet of a large percentage of Indian consumers who are vegetarian. Further, the cultivation of fruits and vegetables is a labour intensive operation; if it is profitable, the production of fruits and vegetables should be encouraged in a labour abounding and capital-scarce country like India.

Oranges, an important citrus fruit are rich in Vitamin C, which is so essential for nutrition. Maharashtra is the leading State in India in orange production; here oranges are grown in 14 districts. However, 47 per cent of the oranges grown in this State are grown in the Nagpur district alone. In 1969-70, Nagpur santras (oranges) occupied about 6,900 hectares from a total area of about 14,800 hectares under orange cultivation in the whole of Maharashtra. The Nagpur santra (orange) has also established its reputation all over the country and abroad for its excellent quality. It is superior to all other mandarine oranges in respect of taste, size, shape, appearance, and keeping quality. The purpose of this paper, therefore, is to evaluate the economic viability of Nagpur santra cultivation.

METHODOLOGY

Several techniques are available for evaluating the economic viability of an investment project. The important ones are (a) Pay-Back Period, (b) Net Present Value (NPV), (c) Internal Rate of Return (IRR), and (d) Benefit-Cost Ratio (BCR). The formal definitions of these four investment criteria are given below :

Pay-Back Period

The pay-back period is the number of years an investment project takes to recover its costs from its returns. Symbolically, the pay-back period

* The authors are faculty members at the Institute. They are grateful to Shri S. N. Chokshi and Smt. T. K. Patel, Research Assistants at the Institute for their help in data collection and computation work.

equals t^* , where t^* is the lowest value of t for which the following inequality holds :

$$\sum_{t=0}^{t^*} C_t < \sum_{t=0}^{t^*} R_t$$

where

$$\begin{aligned} R_t &= \text{Return in period } t. \\ C_t &= \text{Cost in period } t. \end{aligned}$$

Net Present Value

The net present value of an investment is the discounted value of all cash inflows net of all cash outflows of the project during its life time. It can be computed as

$$NPV = \sum_{t=0}^T \frac{R_t - C_t}{(1+i)^t}$$

where, the new notations have the following meanings :

$$\begin{aligned} i &= \text{Discount rate.} \\ T &= \text{Project life.} \end{aligned}$$

Internal Rate of Return

The internal rate of return (r) is that discount rate at which the NPV is zero. The equation for its calculation is

$$\sum_{t=0}^T \frac{R_t - C_t}{(1+r)^t} = 0$$

Benefit-Cost Ratio

The benefit-cost ratio of an investment is the ratio of the discounted value of all cash inflows to the discounted value of all cash outflows during the life of the project. It can be computed as

$$BCR = \frac{\sum_{t=0}^T \frac{R_t}{(1+i)^t}}{\sum_{t=0}^T \frac{C_t}{(1+i)^t}}$$

On the basis of the criterion of pay-back period, a project is worth undertaking if and only if its pay-back period is not greater than the investor's desired maximum pay-back period. If the net present value is positive, the invest-

ment is profitable according to the NPV criterion. If a project guarantees an IRR which is greater than the cost of borrowing the capital, the project is economically viable. Similarly, if the benefit-cost ratio is greater than unity, the investment is profitable by the BCR criterion.

Although because of uncertainty and simplicity, the pay-back period method is quite popular, its use is not recommended, for it ignores the time value of money and the cash flows from the project beyond the pay-back period. The other three techniques are quite reasonable and give consistent results in accept-reject decisions. However, under certain situations, these criteria may give different rankings to alternative investment projects.¹

In this study, all the four criteria are used to evaluate the profitability of Nagpur santra cultivation.

DATA

The data for the study were obtained from the growers of Nagpur santras through a sample survey. Two talukas within the Nagpur district, *viz.*, Katol and Soaner, accounted for about two-thirds of the total area under oranges in the whole district. Therefore, only these two talukas were selected for the survey. Furthermore, to limit the size of the sample, three villages from Katol, *viz.*, Jalal Khoda, Parad Shinya, and Ridhora and three villages from Soaner, *viz.*, Lonkari, Takli and Umari were selected at random from these two talukas. From each selected village a list of farmers was obtained, and from local enquiries an approximate distribution of the area each farmer had under oranges was prepared. Based on this distribution, ten farmers were selected from each village through a stratified sampling procedure. Thus, a sample of 60 orange growers was selected from the Nagpur district for the analysis. The distribution of the selected 60 farmers according to the size of their orange gardens is given in Table I.

TABLE I—DISTRIBUTION OF ORANGE GROWERS ACCORDING TO THE SIZE OF THE GROVE

Size of the orange grove (acres)	Number of growers
Up to 1.00	11
1.01—2.00	13
2.01—3.00	14
3.01—5.00	11
Above 5.00	11
Total	60

1. E. J. Mishan: *Cost-Benefit Analysis*, Praeger, New York, 1967.

The 60 orange growers had a total of 101 groves. Information was collected on the following items for each garden through interviews with gardeners :

1. Area under orange grove.
2. Year of plantation.
3. Yearwise data on plantation and maintenance cost.
4. Yearwise data on production of oranges.

No problem was encountered in collecting information on the first two items. Information on the last two items could be obtained for only the last four to five years. However, since the gardens were planted in different years between 1950 and 1972, the average production and cost data for different plants up to the age of 24 years could be easily compiled from the last four to five years data alone.

Because of the nature of the data, the computation of the measure of investment worth introduces a few conceptual problems in identifying the proper estimates of costs and returns. Though there are different approaches available to overcome this problem, it was considered desirable to utilize the actual data on costs over the last four to five years. In order to obtain comparable revenue figures, it was necessary to obtain revenue data at current prices. For this, production data for different years was converted to revenue figures using prices during the corresponding period.

Since the prices realised differed only marginally from farmer to farmer, the data were compiled according to the bahar (*ambia* and *mrig*) taken and the agency (resident agents, wholesalers, and direct market sale) through which oranges were sold. The realised price did not vary significantly with different bahars or different selling agencies. Therefore, the average price realised was calculated and used in converting production figures from quantities to value terms.

The data on price realised were available for 1972-73 alone. The average price realised in 1972-73 was 8.5 paise per orange. The data on prices realised between 1968-69 and 1971-72 were obtained by interpolation from the time-series of the wholesale price of oranges in Bombay (Table II).

The wholesale price (Bombay) indicates the price paid by the consumers in Bombay, and the price realised by the farmers is the price realised by the farmers net of all marketing expenses. This might explain the gap between the two prices.

TABLE II—PRICE OF ORANGES

Year			Price realised by farmers*	Wholesale price (Bombay)	Price realised by farmers**
1968-69	..	..	—	20.2	(8.5/22.6) (20.2) = 7.3
1969-70	..	..	—	19.4	(8.5/23.6) (19.4) = 7.0
1970-71	..	..	—	18.8	(8.5/23.6) (18.8) = 6.8
1971-72	..	..	—	23.7	(8.5/23.6) (23.7) = 8.5
1972-73	..	..	8.5	23.6	8.5

* Obtained from the survey.

** Obtained from interpolation.

The data on the 60 sample farmers were classified into five groups according to the area under oranges.

These groups were :

- Group I : Up to 1.00 acre
- Group II : 1.01 — 2.00 acres
- Group III : 2.01 — 3.00 acres
- Group IV : 3.01 — 5.00 acres
- Group V : Above 5.00 acres

Groupwise data on cost and revenue per acre of orange trees of all ages are given in Table III. Since the data on these variables were not available for certain ages for some groups from the sample survey, it was obtained by taking a simple average of that variable in that age in other groups.²

ASSUMPTIONS

To compute the net present value, internal rate of return, and benefit-cost ratio, the productive life of orange trees, their salvage value, and all cash inflows and cash outflows in each period of their productive life must be drawn. Cash inflows from orange cultivation are the same as revenues from orange cultivation. Cash outflows include land cost, plantation cost, and annual maintenance cost. Plantation cost includes initial land preparation cost, cost of digging pits, cost of plants, and other miscellaneous charges. The maintenance cost consists of expenses on interculture, manures and fertilizers, insecticides, irrigation, and other miscellaneous charges. The cost data in Table III have a downward bias as the initial investment on land is not taken into account. Thus, to this extent, the profitability indices are over-estimated.

2. Here it should be pointed out that the small number of observations and non-availability of data in certain cases might have influenced the trends in costs and returns in each size-group. This might explain partly the year-to-year erratic fluctuation in costs and revenues reported in Table III.

TABLE III—COSTS AND REVENUES OF NAGPUR SANTRAS BY THE SIZE OF THE AVERAGE GROVE

Number of years since plantation	Size of the orange grove (acres)										Total		
	Upto	1. 00	1. 01—2. 00		2. 01—3. 00		3. 01—5. 00		Above 5. 00				
	C	R	C	R	C	R	C	R	C	R	C	R	
1	..	176	..	273	..	277	..	275	..	263	..	265	..
2	..	255	..	376	..	371	..	377	..	351	..	361	..
3	..	385	..	510	..	539	..	472	..	402	..	438	..
4	..	458	..	481	..	443	..	468	..	426	..	440	..
5	..	518	510	434	757	457	..	500	..	422	..	440	674
6	..	522	438	476	1,529	484	1,804	500	..	426	376	450	937
7	..	655	1,082	616	2,448	603	3,210	521	2,692	545	1,625	561	1,950
8	..	387	1,202	748	4,291	635	2,683	542	2,195	557	1,568	597	2,267
9	..	998	2,378	580	1,960	833	1,453	512	3,141	583	1,750	618	2,155
10	..	1,140	2,080	584	2,868	704	1,426	501	3,069	475	2,390	557	2,508
11	..	983	1,357	779	1,897	887	2,417	427	2,769	475	1,938	565	2,321
12	..	823	1,131	297	2,125	1,250	2,205	329	360	475	2,009	497	1,538
13	..	850	1,998	510	2,380	1,248	2,507	466	1,232	475	2,293	605	2,043
14	..	640	1,230	700	1,284	792	1,983	514	1,592	330	1,247	492	1,537
15	..	705	3,060	700	2,341	800	3,145	542	2,084	320	2,734	495	2,529
16	..	760	850	693	1,980	644	2,537	428	1,537	333	2,642	431	2,164
17	..	725	1,275	714	3,643	352	3,967	457	4,196	383	1,162	434	2,936
18	..	398	2,312	764	2,186	240	5,100	245	1,140	389	1,204	308	1,936
19	..	523	5,475	800	3,400	523	3,183	367	1,586	523	3,183	403	2,271
20	..	522	3,150	800	2,720	522	2,270	365	1,437	522	2,270	401	1,774
21	..	700	4,284	654	2,550	654	2,554	686	1,020	654	2,554	576	2,363
22	..	800	4,845	800	4,845	800	4,845	800	4,845	800	4,845	800	4,845
23	..	800	2,040	800	2,040	800	2,040	800	2,040	800	2,040	800	2,040
24	..	800	2,295	800	2,295	800	2,295	800	2,295	800	2,295	800	2,295

C = Cost per acre in rupees.

R = Revenue per acre in rupees.

The oldest garden in the sample was planted in 1950, and it produced about 24,000 oranges per acre in 1972-73. As against this, the average production of all the 101 gardens of different ages was about 18,000 oranges per acre. From the data it appears that the productive life of an orange tree is more than 23 years. In this study, the profitability indices for a plant life of 24 years and 30 years were worked out.

The data on cost and revenue were available for gardens up to the age of 24 years only. To fill up the data gap, it was assumed that the revenues and costs for trees 25 to 30 years old were the same as those of trees 24 years old. Though at the end of their productive life orange trees provide wood, their scrap value is very small. The salvage value was therefore assumed to be zero.

RESULTS AND INTERPRETATION

The agewise cost and return data of Table III were used to compute the various measures of investment worth. The results are given in Tables IV and V. Since the net present value and the benefit-cost ratio are functions of the discount rate, these measures were obtained separately for discount rates equal to six per cent, 10 per cent, and 12 per cent. Currently in India, the six per cent rate applies to borrowings used for investing in declared backward areas and the 10 to 12 per cent rate applies to borrowings for other purposes.

TABLE IV—MEASURES OF INVESTMENT WORTH PER ACRE OF NAGPUR SANTRA CULTIVATION

(n = 30)

Measures of investment worth	Size of the orange grove (acres)					Total
	Upto 1.00	1.01- 2.00	2.01- 3.00	3.01- 5.00	Above 5.00	
1. Pay-back period (years)	9	7	7	8	8	7
2. Net present value at (Rs.)						
(a) Discount rate = 6%	11,851	17,144	16,710	13,481	13,169	14,855
(b) Discount rate = 10%	5,951	10,094	9,362	7,548	7,037	8,401
(c) Discount rate = 12%	4,260	7,910	7,136	5,736	5,207	6,438
3. Internal rate of return (per cent)	29.3	45.9	39.2	34.4	31.2	39.4
4. Benefit-cost ratio at						
(a) Discount rate = 6%	2.32	2.99	2.81	2.85	2.85	2.98
(b) Discount rate = 10%	2.00	2.76	2.51	2.53	2.49	2.67
(c) Discount rate = 12%	1.85	2.64	2.36	2.37	2.30	2.50

TABLE V—MEASURES OF INVESTMENT WORTH PER ACRE OF NAGPUR SANTRA CULTIVATION

(n = 24)

Measures of investment worth	Size of the orange grove (acres)					Total
	Upto 1.00	1.01- 2.00	2.01- 3.00	3.01- 5.00	Above 5.00	
1. Pay-back period (years)	9	7	7	8	8	7
2. Net present value at (Rs.)						
(a) Discount rate = 6%	9,927	15,219	14,786	11,556	11,245	12,930
(b) Discount rate = 10%	5,224	9,366	8,635	6,820	6,310	7,674
(c) Discount rate = 12%	3,807	7,457	6,683	5,283	4,753	5,985
3. Internal rate of return (per cent)	29.1	45.9	39.1	34.3	31.1	39.3
4. Benefit-cost ratio at						
(a) Discount rate = 6%	2.25	3.00	2.80	2.85	2.85	2.99
(b) Discount rate = 10%	1.94	2.76	2.48	2.51	2.45	2.56
(c) Discount rate = 12%	1.80	2.63	2.33	2.34	2.26	2.48

The results of Tables IV and V can be used to

- (a) analyse the absolute profitability of santra cultivation,
- (b) determine the replacement time of santra trees,
- (c) determine the optimum size of orange groves, and
- (d) throw some light on the profitability of investment in the orange crop in relation to alternative investment opportunities.

Since the results are not substantially different for the two life periods (24 years and 30 years), the results for a plant life of 30 years only are discussed.

Since no information is available on the maximum pay-back period desired by orange growers, not much can be said about the worthwhileness or otherwise of santra cultivation on the basis of the criterion of the pay-back period. On the basis of all other investment criteria, investment in santra cultivation in groves of all sizes is quite profitable. The net present value even at as high a discount rate as 12 per cent varies from Rs. 4,260 per acre to Rs. 7,910 per acre, depending upon the size of the orange grove.³ The internal rate of return is also very high. It varies from a low of 29.3 per cent on gardens occupying up to 1.00 acre of land to a high of 45.9 per cent on those occupying 1 to 2 acres of land. The benefit-cost ratio at a 12 per cent discount rate varies from 1.85 to 2.64 depending on the size of the orange grove. The net present value and the benefit-cost ratios are higher at low discount rates than at high discount rates.

The uniform annual return, which helps in determining the replacement period can be computed by dividing the NPV by the present value of an annuity of Re. 1 over the life of the project. At a discount rate of 12 per cent, the present value of Re. 1 received at the end of each period for 30 periods is Rs. 8.06.⁴ Thus, the uniform annual returns at a 12 per cent discount rate from orange groves of sizes up to 1 acre, 1 to 2 acres, 2 to 3 acres, 3 to 5 acres, and above 5 acres, and of all size-groups are Rs. 529 (4,260/8.06), Rs. 981 (7,910/8.06), Rs. 885 (7,136/8.06), Rs. 713 (5,736/8.06), Rs. 644 (5,207/8.06), and Rs. 799 (6,438/8.06) respectively. This means that so long as net returns (revenue—cost) are greater than Rs. 529 per acre on groves up to 1 acre in size, the groves should not be replanted. Old orange trees in groves 1 to 2 acres in size should not be replaced by new trees until net returns from old trees do not fall below Rs. 981 per acre, and so on. On this basis, no sample grove needs to be replanted as yet.

3. Both the net present value and benefit-cost ratio are negative functions of the discount rate.

4. Ready tables are available which provide these numbers directly. For example, see V. L. Mote, M. Malya, and J. Saha: Tables for Capital Investment Analysis, Indian Institute of Management, Ahmedabad, 1969.

From all the measures of investment worth it is clear that the optimum size of an orange grove is 1 to 2 acres as groves of this size are the most profitable ones (Table IV). The pay-back period for investment in such gardens is seven years, the IRR is 45.9 per cent, the NPV at a 12 per cent discount rate is Rs. 7,910 per acre, and the benefit-cost ratio at a 12 per cent discount rate is 2.64. The least profitable groves are those of size up to 1 acre. These gardens have a pay-back period of nine years, an IRR of 29.3 per cent, a NPV at a 12 per cent discount rate of Rs. 4,260 per acre and a benefit-cost ratio at a 12 per cent discount rate of 1.85. In the descending order of profitability, the different sizes of orange groves rank as follows: 1 to 2, 2 to 3, 3 to 5 and above 5 and up to 1 acre. Thus, the profitability first increases as the size of orange grove increases from up to 1 acre to 1 to 2 acres and declines steadily thereafter.

In the absence of studies on alternative uses of land and other resources, not much can be said about the comparative advantage of orange cultivation. All that can be said is that so long as the alternative uses do not fetch as much NPV, IRR, or/and benefit-cost ratio as promised by orange cultivation, orange cultivation is relatively profitable.

CONCLUSION

The cultivation of Nagpur santra is very desirable from the consumers' point of view and a highly profitable venture from the producers' point of view. Excluding the land cost, investment in this project has a pay-back period of seven to nine years and yields an internal rate of return of 29.3 to 45.9 per cent, depending upon the size of the grove; the net present value and benefit-cost ratio even at as high a discount rate as 12 per cent varies from Rs. 4,260 to Rs. 7,910 per acre and 1.85 to 2.64 respectively again according to the size of the grove. Furthermore, the productive life of an orange tree is more than 24 years and an orange grove need not be replanted until it gives fruits yielding Rs. 529 per acre in a grove of upto 1 acre, Rs. 981 per acre in a grove of 1 to 2 acres, Rs. 885 per acre in a grove of 2 to 3 acres, Rs. 713 per acre in a grove of 3 to 5 acres and Rs. 644 per acre in a grove of more than 5 acres (discount rate = 12 per cent). The optimum size of an orange garden is between 1 and 2 acres. It is needless to point out that all these findings should be interpreted in the light of the limitations of the data used.