Economic Evaluation of Kinnow Cultivation under Different Irrigation Systems in Rajasthan

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ABSTRACT

The present study was conducted in Sri-Ganganagar and Bikaner districts of Rajasthan. Kinnow cultivation under different irrigation system *viz.;* solar, diesel and electric irrigation system was found to be popular in the state. Therefore, study on economic evaluation of kinnow cultivation under different irrigation system in Rajasthan has been conducted to evaluate kinnow orchard orchards under different irrigation system. Total 240 respondents were selected for the study. Standard techniques like NPV, BC ratio, IRR, Break-Even point and Payback period were employed. The investment in kinnow orchard has been seen as profitable business. In the study area, the net present value was work out to be ₹ 842521 per ha under solar irrigation system ₹ 798964 per ha electric irrigation system and ₹ 762808 per ha under diesel irrigation system. Internal rate of return was found to be 38 per cent, 37 per cent and 35 per cent under solar irrigation, electric irrigation and diesel irrigation system. Benefit-Cost Ratio was at 2.36, 2.23 and 2.08 under solar, electric and diesel irrigation system. Break–Even point was 5.82 ton, 4.79 ton and 6 ton under solar, diesel and electric irrigation system. Payback period estimated to be 7.1 years, 7.2 years and 7.3 year under solar, electric and diesel irrigation system. Hence, the kinnow orchard with solar irrigation system has been found to be very economic feasible and it should be realized to the farming community for attraction towards use of renewable energy in fruits production in the state.

Keywords: NPV, IRR, BCR, Kinnow, solar, and Rajasthan

Horticultural sector has been played an important role in providing the livelihood security to the farmers under the changing agriculture scenario. The diversification in agriculture for improving sustainability, profitability and productivity will help in not only increase the farm income but also it provides productive employment. India has the largest producer of fruits (57.73 million tons) after china in the world with its projected value touching 98 MT by the year 2020-2021 (Bhat *et al.* 2017). India's diverse climate ensures accessibility of all varieties of fruits and vegetables. According to National Horticulture Database published by National Horticulture Board, India has been produced around 86.602 million metric tons of fruits and 169.48 million metric tons of vegetables in the year

2014-15 (GoI, 2014). The total area under fruit cultivation stood at 6.11 million hectares while vegetables it was around 9.54 million hectares. Due to second largest producer of fruits and vegetables it has tremendous opportunities for export. The export of fruits and vegetables from India was ₹ 8,391.41 crores in the year 2015-16 which was comprised of fruits worth ₹ 3,524.50 crores and vegetables worth ₹ 4,866.91 crores (APEDA, 2015). Among the fruit crops, kinnow cultivation in Rajasthan is gaining impetus among the fruit growers due to its profitability and good market value. Kinnow originated as a hybrid of king and willow leaf mandarins (Citrus nobilis × C. deliciosa) at Riverside, California (Sharma *et al.* 2007). Kinnow fruits are medium oblate base flattered, deep orange yellow in colour and very juicy (50%), which

having good contents of TSS (15%) and sugar (11%) with good flavor (Gangwar *et al.*, 2005), and have lot of market potential, which can help in increasing the farm income.

In Rajasthan during 2015-16, kinnow occupies 8.74 thousand ha under cultivation, where Sri-Ganganagar and Bikaner district is well known for its area and production. Sri-Ganganagar district occupied 7.38 thousand ha and Bikaner occupied 0.01 thousand ha area under kinnow cultivation in the year 2015-16, which was 84.40 per cent and 0.21 per cent respectively of the total area of Rajasthan and its production has been realized 133.18 thousand MT in Sri-Ganganagar and 0.01 thousand MT in Bikaner which was 20.28 per cent and 0.009 per cent of the total production of state (GoR, 2016). Therefore, the present paper is an effort to evaluate the kinnow orchards in systematically and scientific manner.

MATERIALS AND METHODS

The present study was conducted in eight village taking four villages each of Sri-Ganganagar and Bikaner districts as both the districts having highest area and production as well as highest number of solar units for irrigation in the state of Rajasthan. Total 240 kinnow growers were selected purposively and categorised into three categories *viz.;* solar irrigation system (160 farmers), diesel irrigation system (40 farmers) and electric irrigation system (40 farmers). For analysis of data, economic efficiency measures Net Present Value (NPV), Internal rate of return (IRR), Break-Even point (BEP), Benefit-Cost Ratio (B:CR) and Payback period (PB) were used.

Analytical Tools

Net Present Value (NPV)

Net present value of an investment is the discounted rate of all cash flow and cash inflow of the orchard during its life time. For cash flow analysis 12 per cent rate of interest has been taken in to account. It was computed as:

$$NPV = \sum_{i=1}^{n} \frac{Yn}{(1+r)^n} - C$$

Where,

Y_n = Net cash inflows in the nth year

r = Discount rate

C = Initial cost of investment

n = Economic life of the mandarin orchard.

Internal Rate of Return (IRR)

Internal rate of return is the rate of return at which the net present value of a stream of payments/income is equal to zero. It was calculated as:

$$IRR = \begin{pmatrix} \text{lower discount} \\ \text{rate} \end{pmatrix} \times \begin{pmatrix} \text{difference between} \\ \text{two discount rate} \end{pmatrix} \times \\ \begin{pmatrix} \dfrac{\text{NPV at lower discount rate}}{\text{different between two NPV}} \end{pmatrix}$$

Benefit Cost Ratio (BCR)

The benefit cost ratio (BCR) of an investment is the ratio of the discounted value of all cash inflow to the discounted value of all cash inflows during the life of the project. It was estimated as:

$$BCR = \frac{\text{Gross present value of income}}{\text{Gross present value of costs}}$$

Break – Even Point

Break–Even point is the point at which the two curves, total cost curve and total revenue curve intersect each other which indicates the level of production at which the producer neither loss money nor make a profit. It was calculated by using the following formulae:

$$BEP = \frac{FC}{(P-VC)}$$

Where,

FC = Fixed cost in per hectare of kinnow

P = Price per quintal of kinnow in rupees

VC = Variable cost per quintal of kinnow in rupees

Pay-Back Period (PB)

The pay-back period is defined as the length of time required to recover an initial investment through cash flow generated by the investment. It was estimated as:

$$\text{Pay back period} = \frac{\text{Cost of investment}}{\text{Annual net cash flow}}$$

RESULTS AND DISCUSSION

Economic Viability of Kinnow Orchard

The costs and return estimates were discounted at an annual rate of interest of 12 per cent for the medium term investment for each year and presented category wise from Tables 1 to 3.

Table 1: Cash flow analysis of kinnow orchard under solar irrigation system

Year	Cost	Return	Net returns	Discount factor at 12%	Discounted net cash flow
1	93237	0	-93237	0.89	-83247.6
2	80969	0	-80969	0.80	-64547.8
3	80175	0	-80175	0.71	-57067.1
4	81591	145920	64329	0.64	40882.01
5	83747	153600	69853	0.57	39636.72
6	85749	180480	94731	0.51	47993.61
7	87527	253440	165913	0.45	75050.78
8	87306	307200	219894	0.40	88811.69
9	87830	345600	257770	0.36	92954.27
10	88549	384000	295451	0.32	95127.35
11	89092	445440	356348	0.29	102441.5
12	89935	456960	367025	0.26	94206.19
13	90843	476160	385317	0.23	88304.7
14	91136	480000	388864	0.20	79569.34
15	91647	499200	407553	0.18	74458.46
16	90528	503040	412512	0.16	67289.66
17	90402	506880	416478	0.15	60657.65
Total		5137920	3647658		842521.4

Table 2: Cash flow analysis of kinnow orchard under diesel irrigation system

Year	Cost	Return	Net returns	Discount factor at 12%	Discounted net cash flow
1	108769	0	-108769	0.89	-97114.86
2	85641	0	-85641	0.80	-68272.44
3	85334	0	-85334	0.71	-60739.26
4	90234	153600	63366	0.64	40270.23
5	96037	172800	76763	0.57	43557.22
6	99660	192000	92340	0.51	46782.42
7	103363	245760	142397	0.45	64412.98
8	103809	303360	199551	0.40	80595.12
9	102864	376320	273456	0.36	98610.97
10	104124	384000	279876	0.32	90112.58
11	104182	433920	329738	0.29	94791.72
12	105373	430080	324707	0.26	83344.28
13	106204	464640	358436	0.23	82144.26
14	106485	480000	373515	0.20	76428.63
15	106557	483840	377283	0.18	68928.17
16	106646	491520	384874	0.16	62781.30
17	106592	492288	385695	0.15	56174.31
Total		5104128	3382252		762808

Table 3: Cash flow analysis of kinnow orchard under electric irrigation system

Year	Cost	Return	Net returns	Discount factor at 12%	Discounted net cash flow
1	97113	0	-97113	0.89	-86707.83
2	83703	0	-83703	0.80	-66727.52
3	81982	0	-81982	0.71	-58353.40
4	84410	145920	61510	0.64	39090.65
5	87393	153600	66207	0.57	37567.68
6	89906	180480	90574	0.51	45887.67
7	92539	249600	157061	0.45	71046.59
8	93241	303360	210119	0.40	84863.63
9	94257	368640	274383	0.36	98945.11
10	95149	384000	288851	0.32	93002.34
11	96165	433920	337755	0.29	97096.46
12	96764	437760	340996	0.26	87525.21
13	96879	468480	371601	0.23	85161.43
14	97530	476160	378630	0.20	77475.30
15	97633	483840	386207	0.18	70558.60
16	97570	491520	393950	0.16	64261.77
17	95276.78	495360	400083	0.15	58269.86
Total		5072640	3495130		798964

Following this procedure, the estimates relating to discounted benefits and discounted costs were obtained for each category of growers. With the help of discounted benefits and costs, the Net Present Value (NPV), Benefit-Cost ratio (B-C ratio), Break-Even point and the Payback period were computed. The economic feasibility indicators of kinnow orchard under different irrigation system were presented in Table 4. It revealed from table 4 that the net present value of kinnow orchard was estimated of ₹ 842521 under solar irrigation system, ₹ 798964 electric irrigation system and ₹ 762808 under diesel irrigation system. The net present value was found to be higher in kinnow orchard under solar irrigation system as compared to electric irrigation system and diesel irrigation system. It may be due to better management practice and low cost of irrigation compare to diesel and electric irrigation

system. Internal rate of return ranging from 35 per cent under diesel irrigation system to 38 per cent under solar irrigation system in kinnow orchard indicated that kinnow growing was a profitable enterprise. The B: C ratio was estimated as 1:2.36 under solar irrigation system, 1:2.23 under electric irrigation and 1:2.08 under diesel irrigation. The benefit cost ratio was found to be more under solar irrigation system because increase productivity of kinnow orchard under solar irrigation system. The B-C ratio analysis was found that the investment in kinnow orchard is economically viable. The break-even point of kinnow orchard was reached at 5.82 ton, 6.00 ton and 4.79 ton under solar irrigation system, electric irrigation system and diesel irrigation system. Further the payback of kinnow orchard was estimated at 7.1 years under solar irrigation system, 7.2 years under electric irrigation system and 7.3 years under diesel irrigation system. Therefore, the kinnow cultivation was economical in the study area. Similarly, Kumar *et al.* (2017), Kaur and Singla (2016) and Bhat *et al.* (2011), in which study reported that the kinnow cultivation was economically feasible.

Table 4: Economic feasibility of kinnow orchard under different irrigation system

Category	NPV (₹)	IRR (%)	B:C ratio	Break-Even point (Ton)	Pay-back period (Year)
Solar	842521	38	2.36	5.82	7.1
Electric	798964	37	2.23	6.00	7.2
Diesel	762808	35	2.08	4.79	7.3

CONCLUSION

The study has revealed that investment in kinnow orchards has been found to be an economically profitable, financially viable and socially acceptable business under solar irrigation, diesel irrigation and electric irrigation system in Rajasthan. The net present value was work out to be ₹ 842521 under solar irrigation system, ₹ 798964 electric irrigation system and ₹ 762808 under diesel irrigation system. Internal rate of return was found to be 38, 37 and 35 per cent under solar irrigation, electric irrigation

and diesel irrigation system. Benefit- Cost Ratio was at 2.36, 2.23 and 2.08 under solar irrigation system, electric irrigation system and diesel irrigation system. Break–Even point was 5.82, 6.00 and 4.79 ton under solar irrigation, electric irrigation system and diesel irrigation. Payback period was at 7.1, 7.2 and 7.3 year under solar irrigation, electric irrigation system and diesel irrigation.

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