COCOS (1998-99), 13, 40 – 53
Printed in Sri Lanka

IRRIGATION IN SMALL HOLDER COCONUT CULTIVATION IN KERALA, INDIA – A FINANCIAL ANALYSIS

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ABSTRACT

Financial analysis of irrigation investments in existing as well as new plantations of coconut was conducted. The annualized capital costs and variable costs were included in the cost of irrigation. The Levelised Annual Cost Approach was used to compute the pumping cost. The study was conducted in a mixed cropping system. The effective area under each crop was computed and the allocation of irrigation costs was done accordingly. In all the land types the investments in irrigation was found to be highly feasible financially. The financial ratios were found to be higher in midland categories indicating that compared to the other regions, the midland region had higher potential for investment in irrigation.

INTRODUCTION

The importance of irrigation in crop production is highlighted in many studies. This is also true in the case of coconut.

Beneficial effects of summer irrigation of coconut had been recorded by different authors (Marar, 1963; Nelliat, 1968; Mathew, 1972; Padmanabhan, 1973; Shanmugham, 1973; Venkitesan, 1973; and Nelliat *et al.*, 1976). In another experiment conducted for a period of 11 years at Nileswar in Kerala the irrigation had found to record a 74 per cent increase in yield over that of control (Bhaskaran and Leela, 1978). Rao (1991) found that the soil moisture during summer months is the critical factor that influenced the nut yield.

The overall objective of the project was to study the general performance of irrigation investments in small holdings of Kerala. One of the specific objectives was to evaluate the financial feasibility of irrigation investments in coconut cultivation.

MATERIALS AND METHODS

The northern part of this state is facing a long dry spell of six months and abundant monsoon rains amounting to 3000 mm. This situation necessitates adoption of irrigation during summer months for maintaining productivity. Hence, the study was conducted in northern most district of the state, viz., Kasaragod.

A multistage random sampling method was adopted for the study. A sample of 127 holdings was distributed among different land types; lowlands (altitude less than 7.5 m above MSL), midlands (lying between 7.5m and 75m above MSL) and highlands (more than 75m above MSL) and also among different irrigation sources (two major sources in each zone) and un-irrigated holdings for comparison.

The different sample categories are denoted as follows;

S1 - lowland well	S4 - midland rivulets
S2 - lowland river	S5 - highland tanks
S3 - midland well	S6 - highland rivulets

The data collected pertained to the year 1992-93. The data were collected by conducting field surveys using pre-tested schedules.

Concepts Used

Investment in Irrigation

In this study investment in irrigation refers to the expenditure on digging wells or tanks, motor plus pumps unit, electric accessories, pump houses and other associated costs.

Cost of Irrigation

In this study the annualized capital cost and variable cost were used for calculating the cost of irrigation. The total capital investment cost, expected life of the system and the bank rates were used for the computation of annualized cost. The variable costs like repair and maintenance costs, fuel cost and languor charges were also included in working out the variable cost of irrigation.

Costs and Returns per Hectare

The garden land agriculture in Kerala shows a peculiar pattern of multiple cropping with bearing and non-bearing palms along with annuals. Hence, projection of total returns and total costs on per farm basis will not reflect the realistic figures. Hence, costs and returns were worked out on bearing palm basis and multiplied by the density of palms on pure plantation to give comparable values.

In the case of coconut, a stand of 200 palms (KAU, 1992) was taken for computations.

Cost of Irrigation and Pumping

The Levelised Annual Cost (LAC) approach which is equivalent to the Net Present Value (NPV) approach in which each of the cash flows is determined and discounted to a present value, is used to compute the pumping cost. The LAC is defined as,

$$\text{LAC} = \frac{\text{Annualized Cost}}{\text{Annual Energy Out put}}$$

where,

Annualized Cost = Capital Investment x CRF + annual operation, maintenance and repair costs + annual fuel costs

The annual energy output for the pumping systems is in proportion to the amount of water pumped in m^3 $year^{-1}$ for a given system. Hence, the annual water output is considered.

The Capital Recovery Factor (CRF) converts the initial investment into a series of equal annual charges which have the same NPV. CRF is a function of the discount rate and the system life time, and could be obtained from the equation.

$$\text{CRF} = r/1 - (1 + r)^{-OL}$$

where, r is the annual discount rate and OL is the operating life of the system.

In this study the annual discount rate was taken as 15 per cent, being the lending rate of the banks (or the rate at which the farmer is able to borrow money) and the operating life of the system as 25 years.

The annualized cost is given by,

$$AC = I \times CRF + OMR + FC$$

where, AC is the annualized cost, I is the capital investment, OMR is the annual operation, maintenance and repair cost, FC is the fuel cost (either electricity charges or Diesel/Kerosene/Petrol charges depending upon number of hours of operation in an year).

The water output will depend, besides other parameters upon number of the capacity of the system (HP) and the operating hours (N), and could be written as,

$$W = K \times HP \times N$$

where, K is a proportionality constant depending on total head, friction losses etc.

In this study the value of K was computed for each irrigation structure using the details of pumping structure, performance charts from the manufacturers (if available) and also based on the discussions with agricultural engineering experts.

The following formula was used.

$$K = \frac{75 \times E}{T}$$

where, E is the efficiency which ranged from 0.5 to 0.7 and T the total Head.

The LAC is given by,

$$LAC = AC/W$$

$$= \frac{(I \times CRF \times OMR + FC)}{K.HP.N}$$

Since this study involved perennial crop, the sample included only those farmers who were irrigating their crops at least for the past three years.

Allocation of Effective Area Under Each Crop in a Mixed Cropping System

Coconut is cultivated as pure crop as well as mixed crop in the region. Wherever it was cultivated as mixed crop it was necessary to find out the effective area under each crop in order to allocate they irrigation costs.

This was done by using the method proposed by Kaseko (1976). Suppose A and B in mixed stands. Let A and B be densities of the same crops in a pure cropping system.

d' A and d' B be densities of the same crops when they are mixed. and T_B be areas effectively occupied by these crops and T be the total area.

Let $a_A = d'A / d_A$ and $a_B = d'B/d_B$

It is accepted that area occupied by A and B are proportionate to a_A and a_B respectively. It is also accepted that,

$$T_A/a_A = T_B/a_B \text{ and } T_A + T_B = T$$

Thus,

$$T_A = T\,[(a_A/(a_A + a_B)] \text{ and } T_B = T\,[(a_B/ a_A + a_B)]$$

This can be generalized to include 'n' crops in mixed crops stands as follows.

$$T = \sum_{i=1}^{n} C_i \quad \text{where, } C_i = a_i / \sum_{i=1}^{n} a_i$$

The coefficient C_i is that part of the cultivated area effectively occupied by crop i.

Allocation of Irrigation Costs to Individual Crops

Based on the total cost and total water output (discussed above), irrigation cost per unit of water (m^3) was computed out. For individual crops the cost allocation was done as follows. Based on the methodology explained above the effective area for each crop in the farm was found out. Then the area was allocated for bearing as well as non-bearing palms. Since the irrigation water used for non-bearing palms was about one- third of the bearing palms (based on the information from preliminary investigations) the area was adjusted accordingly. In the case of irrigation through shallow earthen channels leading to the basins of palms, a conveyance loss of 20 per cent was deducted from the total water pumped to the lead channels. Similarly, in few cases where the farmers adopted both basin flooding and whole plot wetting, a 10 per cent reduction was considered. Thus, the total water was allocated based on the above procedure, on a weekly basis, then on per palm basis and the cost was distributed accordingly.

The total cost was found out by using the annualized cost and the water output. Based on the water received in the effective area of each individual crop the total cost was allocated.

Other Cost Components

Other cost components were worked out as follows.

(i) Labour cost for opening basins, transportation and application of manure, fertilizers and transportation of harvested nuts. Since crown clearing operations and harvesting were done on contract basic, their labour charges were accounted separately.

(ii) Input costs like cost of organic manure and fertilizers and pesticides.

(iii) Irrigation costs comprising fuel costs, maintenance costs of pumping units and pump sheds and labor charges.

Coconut cultivation in this part of Kerals is comparatively free from severe diseases or pests incidence. Hence, the plant protection expenses were negligible in the respondent farms and hence excluded from the analysis.

The investment cost in coconut included expenses on land preparation, digging pits, planting, shading, fertilization, irrigation and manuring up to the seventh year. The maintenance costs comprised of expenses on labour, irrigation, fertilizers, manure and harvesting costs.

Financial analysis was done in this study with an objective to assess the financial effects of the irrigation investments in coconut crop on farmers, public and private firms, and government operating agencies and any others who may be participating in it. It was undertaken to determine the attractiveness of irrigation investments in arecanut crop. It projected the effects of this particular investment on farm income and estimated the return to the capital engaged.

Discounted cash flow measures like Net Present Worth, Benefit-Cost Ratio, Net Benefit-Investment Ratio (N/K) were used for the analysis (Gittinger, 1982). Besides these present value summation methods, the annual amortization method was also used to find out the benefit-cost ratio. The amortization formula used was,

$$P = B \frac{i}{1 - (1 + i)^{-n}}$$

where,

P - represents the amount of annual payment
B - initial amount
n - number of years (life period of plantation)
i - interest rate

Using the amortized establishment cost (establishment cost comprising the total investment cost viz., 7 years expenditure and compound interest thereon) the absolute profit that can be expected in an year from the plantation can be worked out by deducting this cost along with maintenance cost from gross return. The benefit-cost ratio can be derived as follows.

$$BCR = \frac{GR}{(AEC + MC)}$$

where,

GR - Gross Returns/ha/year
AEC - Amortized Establishment cost/ha
MC - Maintenance Cost per hectare

This method was used only in the case of irrigation investments in new plantation.

Financial analysis was attempted with a view to assess the financial effects of irrigation investments or the profitability of irrigation in arecanut.

Using the 'with and without' approach the financial analysis was done over the useful life of the crop. The useful life period was taken as 60 years. The analysis was done using average prices of the year 1992-93. The discount rate of this financial analysis was taken as 15 per cent, the revised rate at which banks are lending loans to the entrepreneurs.

Due to certain characteristic features of coconut, the estimation of the costs and returns needed special attention which differed in many respects from that of seasonal and annual crops. The characteristic features included the special nature of investment which was spread over many years. This crop has gestation period before bearing and involves large investments. Flow of returns continues for a considerable long period. The total period of 60 years can be distinguished as investment phase of 7 years and productive phase from 8th year to 60th year. The structure of costs and rate of return also differed for each period.

Incremental costs flow were used for working out the different measures of project worth like Net Present Worth, N/K ratio and IRR (Gittinger, 1982).

Incremental benefit flows were worked out by deducting the benefits without irrigation investments from the benefits with irrigation investments, year-wise. Similarly investment cost flows were worked out by deducting the cost without irrigation investments from the cost with irrigation investments, year-wise. The B/C ratio was worked out as the ratio of the present worth of the benefit flows to the present worth of the cost flows.

The net benefit flows were worked out for with irrigation situation and without irrigation and without irrigation situation. The incremental net benefit stream was worked by deducting the incremental net benefits with irrigation situation from incremental net benefits without irrigation. The NPW, N/K ratio and IRR were worked out from the present worth of the incremental net benefit flows.

Two alternative investment scenarios were considered, viz., investment made in a new plantation (at the planting stage itself) and investments in full bearing plantation. Feasible scenarios alone were included in the financial analysis. The possibilities for either expansion of cultivation or introduction in existing gardens were practically nil in the lowland region due to unavailability of suitable lands and higher density of cropping. Hence, these scenarios were also excluded.

RESULTS AND DISCUSSION

The final results are presented as Table 1. The computational procedure followed for the study is illustrated with an example (for the S_3 category, new plantation, new investment) in Tables 2.a. to Table 2.f.

All the included financial measures such as Benefit Cost (B/C) ratio, Net Benefits/Investment (N/K) ratio, Net Present Worth (NPW) and Internal Rate of Return (IRR) of existing plantations were comparatively low in the lowland wells region, ie., 1.59, 3.61, Rs. 38,228.15 and 38.42 per cent respectively. The probable reason could be that even the rainfed plantations were found to give higher yield in the region compared to the other zones in the region, due to more congenial soil and climatic conditions and proximity to the sea.

The incremental returns were not found to be proportionately high resulting in low ratios. The phenomenon is in conformity with the finding of Bhaskaran and Leela (1978) who had conducted an irrigation experiment for 11 years at Agricultural Research Station, Nileswar, Kerala. They observed that the average increase over eleven years from the commencement of irrigation was maximum in the low yield group (20 to 60 nuts) followed by medium yield group (40 to 60 nuts).

Table 1: Financial measures of irrigation investments in coconut cultivation – Kasaragod, Kerala

Land Category	Production Scenarios	B/C ratio		N/K ratio	NPW (Rs.)	IRR (%)
		Cash flow method	Annual amortization method			
S_1	Existing	1.59	-	3.61	38,228.15	38.42
	New	-	3.59	-	-	-
S_2	Existing	-	-	-	-	-
	New	-	-	-	-	-
S_3	Existing	3.24	-	7.44	79,102.54	>50
	New	2.03	2.55	2.29	25,126.00	21.79
S_4	Existing	3.75	-	11.48	99,479.48	>50
	New	2.38	2.93	3.50	37,164.65	27.27
S_5	Existing	2.38	-	5.63	63,168.66	>50
	New	1.50	2.48	1.85	17,191.90	19.68
S_6	Existing	3.07	-	8.36	70,892.00	>50
	New	1.94	2.80	2.58	24,072.92	23.65

Existing = Irrigation investments in full bearing plantations

New = Irrigation investments in new plantations

Table 2: Computational procedure used in the study
(Example: S_3 - New plantation, New investment)

Table 2.a: Cost components of coconut cultivation and irrigation investments (without irrigation)

Cost Items	1	2	3	4-7	8	9	10	11-60
Labour								
1. Plant prottn.	1680	-	-	-	-	-	-	-
2. Planting	210	-	-	-	-	-	-	-
3. Shading	175	-	-	-	-	-	-	-
4. Basin opening	-	170	170	340	500	500	675	675
5. Irrigation	-	-	-	-	-	-	-	-
6. Harvesting	-	-	-	-	390	585	1165	1165
Materials								
1. Seed	3000	600	120	-	-	-	-	-
2. Fertilizer	-	30	30	50	50	50	100	100
3. Manure	-	975	975	1900	1900	1900	2900	2900
4. Irrigation	-	-	-	-	-	-	-	-
5. V.C. of irrigation	-	-	-	-	-	-	-	-
Total investments	5065	1775	1295	2290	2840	3035	4840	4840
Yield (Number)	-	-	-	-	2870	3550	7100	7100
Income (Rs.)	-	-	-	-	5688	8520	17040	17040

Table 2.b: Cost components of coconut cultivation and irrigation investments (with irrigation)

Cost Items	1	2	3	4-7	8	9	10	11-60
Labour								
1. Plant prottn.	1680	-	-	-	-	-	-	-
2. Planting	210	-	-	-	-	-	-	-
3. Shading	175	-	-	-	-	-	-	-
4. Basin opening	-	285	285	570	855	855	1140	1140
5. Irrigation	175	175	175	175	350	350	525	525
6. Harvesting	-	-	-	-	490	740	1475	1475
Materials								
1. Seed	3000	600	120	-	-	-	-	-
2. Fertilizer	-	210	210	425	425	425	640	640
3. Manure	-	850	850	1700	1700	1700	2540	2540
4. Irrigation	12000	1800	1800	1800	1800	1800	1800	1800
5. V.C. of irrigation	320	320	320	320	640	640	950	950
Total investments	17560	4240	3760	4990	6260	6510	9070	9070
Yield (Number)	-	-	-	-	5670	8510	17020	17020
Income (Rs.)	-	-	-	-	13600	20424	40848	40848

Table 2.c: Computation of financial ratios (NPV, N/K ratio and B/C ratio)

a. Incremental costs

Year	Cost flow with	Cost flow without	Incremental costs	D.F.	Present worth
1	17560	5025	12495	0.870	10870.65
2	4240	1775	2465	0.756	1963.54
3	3760	.1295	2465	0.658	1621.97
4-7	4990	2290	2700	1.877	5067.90
8	6260	2840	3420	0.327	1118.34
9	6510	3035	3475	0.284	986.90
10	9070	4840	4230	0.247	1044.81
11-24	9070	4840	4230	1.415	5985.45
25	21070	4840	16230	0.030	486.90
26-50	9070	4840	4230	0.400	1692.00
51	21070	4840	16230	0.001	16.23
52-60	9070	4840	4230	0.005	21.15
					30775.84

Table 2.d: Computation of financial ratios (NPV, N/K ratio and B/C ratio)

a. Incremental benefits

Year	Benefit flow with irrigation	Benefit flow without irrigation	Incremental benifits	D.F.	Present worth
1	-	-	-	-	-
2	-	-	-	-	-
3	-	-	-	-	-
4-7	-	-	-	-	-
8	13600	5680	7920	0.327	2589.84
9	20425	8525	11900	0.284	3379.60
10	40850	17050	23800	0.247	5878.60
11-24	40850	17050	23800	1.415	33677.00
25	40850	17050	23800	0.030	7140.00
26-50	40850	17050	23800	0.400	9520.00
51	40850	17050	23800	0.001	23.80
52-60	40850	17050	23800	0.005	119.00
					62327.84

Table 2.e: Computation of financial ratios (NPV, N/K ratio and B/C ratio)

a. Incremental net benefit flows

Year	Net benefit with irrigation	Net benefit without irrigation	Incremental N.B.	D.F.	Present worth
1	-17560	-5065	-12495	0.875	-10870.65
2	-4240	-1775	-2465	0.756	-1868.54
3	-3760	-1295	-2465	0.658	1621.97
4-7	-4990	-2290	-2700	1.877	-5067.90
K					19424.06
8	7340	2840	4500	0.327	1471.50
9	13915	5490	8425	0.284	2392.70
10	31780	12210	19570	0.247	4833.79
11-24	31780	12210	19570	1.415	27691.55
25	19780	12210	7570	0.030	227.10
26-50	31780	12210	19570	0.400	7828.00
51	19780	12210	19570	0.001	7.57
52-60	31780	12210	19570	0.005	97.85
N					44550.06
NPV					25126.00

Table 2.f: Computation of Internal Rate of Return (IRR)

Year	Incremental net benefit flow	DF at 25%	DF at 20%	DF at 20%
1	-12495	0.800	0.833	0.820
2	-2465	0.640	0.694	0.672
3	-2465	0.512	0.579	0.551
4-7	-2700	1.210	1.498	1.587
8	4500	0.168	0.223	0.204
9	8425	0.134	0.194	0.167
10	19570	0.107	0.162	0.137
11-24	19570	0.411	0.745	0.584
25	7570	0.004	0.010	0.007
26-50	19570	0.010	0.052	0.030
51	7570	-	-	-
52-60	19570	-	-	-
- ve flow	-	-16102.68	-17590.86	-17545.50
+ ve flow	-	+12248.19	+21526.28	+17075.03

Computation of B/C ratio: $\frac{\text{PV of benefits}}{\text{PV of costs}} = \frac{62327.84}{30775.84} = 2.03$

$$\text{Computation of N/K ratio: } \frac{44550.06}{19424.06} = 2.29$$

Computation of NPV : Rs. 25126.00

$$\text{Computation of IRR: } 20 + \frac{2\,(-3935.4)}{4405.87} = 21.786$$

With regard to irrigation investments in existing plantations, the midland categories showed higher profits than the highland categories. The benefit cost ratios were 3.24 and 3.75 for the midland well and midland rivulets categories and the corresponding ratios for the highlands were 2.38 and 3.07. The N/K ratio and Net Present Worth also showed a similar pattern (the N/K ratios were 7.44 and 11.48 for midland wells and midland rivulets and 5.63 and 8.36 for the corresponding highland categories). The Net Present Worth was found to be higher in the case of rivulets both in midland and highland regions compared to the corresponding wells or tank irrigated categories. This was because of the increased investments in irrigation in the later categories as a result of wells/tank construction in the recent years. All the midland and highland categories showed very high internal rate of return (more than 50%) when irrigation investments were made in full bearing plantations.

With regard to the irrigation investments in new plantations a similar trend was noticed as that of existing plantations. Financial ratios were found to be higher in midland categories than that of the highland categories. They were also found to be comparatively high in rivulets categories than that of tanks/ponds categories. The B/C ratios worked out by Annual Amortization method showed higher ratios than the B/C ratios worked out by discounting method, but the results were similar. The foregoing analysis had suggested that existing plantations in the midland regions could be ranked as the most ideal enterprise wherein irrigation investments could be profitably made followed by the existing plantations in the highland regions. The other promising enterprises were irrigation investments in new plantations in midland regions and new plantations in highland regions. While planning for the development of irrigation these regions may be given more attention for enhancing production.

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