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Establishment and Maintenance of Arecanut Plantations under Different Water Management Regimes

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Abstract

The study undertaken to investigate into economics of establishment and maintenance of arecanut plantations under different water management protocols was based on primary data obtained from 150 arecanut growers; 75 each adopting drip method of irrigation (DMI) and flood method of irrigation (FMI). It was observed that arecanut gardens with drip irrigation required higher investment (Rs 530,839/ha) than gardens without drip irrigation (Rs 419,046/ha). The establishment cost of arecanut could be further reduced by growing intercrops by 42.27 and 44.18%. Maintenance of gardens under drip irrigation was found to be less expensive than gardens under flood irrigation due to substantial savings in labor cost. As regards productivity, gardens under drip irrigation facility registered an increase of 25% as compared to gardens with flood irrigation. The benefit cost ratio suggested that gardens under drip irrigation generated higher gross and net returns for every investment (1 : 3.87). Results of break-even analysis revealed that break-even output for drip irrigation and flood irrigation was in the order of 4.69 q and 3.69 q respectively. By adopting, improved irrigation technology, the arecanut growers were able to cross break even point. Perfect equity with respect to income distribution among the beneficiaries and non-beneficiaries prevailed indicating that the drip irrigation did not have significant impact on equity. The discounted cash flow analysis revealed that the investment on arecanut with drip irrigation is economically feasible even without government subsidies. The government subsidies is required to promote large scale adoption of drip irrigation technology and should be continued to better water management.

Key words : Drip irrigation, Flood irrigation, Establishment, Maintenance, Intercropping.

Arecanut is an important plantation crop of India. It is popularly known as betelnut. Arecanut (*Areca catechu*) belongs to family Myrtacae. It is called betelnut because it is chewed along with betel leaves by masses all over the country in tender, dried and processed forms. India is the largest producer of arecanut in the world. The major arecanut growing states are Karnataka, Kerala and Assam which will account for over 85% of the total area and production. It is grown to a small extent in West Bengal, Tamil Nadu and Meghalaya. In Karnataka, arecanut is grown in malnad region, coastal region and central maidan pradesh. Arecanut is grown in dry tracts of Karnataka under borewell irrigation. The ground water is fast depleting in the region due to scanty rainfall. Farmers have been following flood method of irrigation (FMI) and drip method of irrigation (DMI). The conventional method of irrigation (FMI) has many drawbacks. Wastage of water, percolation losses, soil erosion are some of the drawbacks to mention. Despite these, arecanut growers continue to adopt flood method of irrigation while some have adopted drip method of irrigation (DMI) to cope with ground water sacarcity. On one hand, the precious water resource has been shrinking in its supply and on the other hand the productivity is declining causing deep concern to those engaged in the arecanut industry. The state and central governments have taken steps to introduce improved irrigation technologies by providing incentives to lure the farmers to adopt such technologies to save this precious resource. Against the backdrop, the present study was attempted to investigate into establishment of arecanut plantations under drip irrigation and flood irrigation methods, comparative economics of arecanut under DMI and FMI, equity issues of DMI, and economic viability of arecanut plantations under DMI and FMI. The study of this kind would convince the growers regarding advantages of gardens established with and without drip irrigation. The study would of the help to financial institutions to formulate lending policies to finance areca gardens

Table 1. Establishment cost (Rs/ha) of arecanut plantations with and without drip irrigation.

Particulars	Drip irrigation	Flood irrigation
I. Investment		
1 Land rent	35,000	35,000
2 Drilling of borewell	12,620	11,250
3 Casing	8,000	6,000
4 Pumpset	22,000	18,553
5 Pumphouse	2,000	1,200
6 Panel Board	1,800	1,800
7 Security deposit	5,000	5,000
8 Drip irrigation system	50,394	–
9 Fencing	23,847	23,452
10 Land preparation	4,335	4,390
11 Planting	15,150	15,080
12 Miscellaneous	625	5225
13 Sprayer	4350	4350
	1,85,121	1,31,300
II. Maintenance Cost During Establishment Period (yr)		
1	50275	56273
2	40489	21281
3	44430	39568
4	40749	43494
5	67746	45838
6	57741	46507
7	56074	46182
Total of II	357504	299143
III Total Estimated Cost (I+II)	5,42,625	4,30,443
IV. A. Income from intercrops and main crop during establishment period	2,29,342	1,90,189
B. Net establishment cost (III–IV)	313283	240254
% reduction in establishment cost due to income from intercrops and main crop during establishment period inclusive of investment cost	42.27	44.18
% reduction in establishment cost excluding investment cost	64.15	63.58

with improved technologies.

Methods

The study was based on primary data with an overall objective of examining the economics of establishment and maintenance of arecanut gardens under DMI and FMI. The sampling procedure adopted for final selection of arecanut growers is outlined below. Southern Transitional Zone of Karnataka comprises of 14 taluks spread over in five districts. Among these three taluks namely Channagiri, Honnali and Tarikere taliuks are known to produce arecanut under drip irrigation and flood method of irrigation accounted for major area under drip irrigation. Hence, these taluks were purposively selected for the study. From these three selected taluks all the villages growing arecanut under drip irrigation were listed with the help of horticulture departments. From the list, five villages in each taluk were selected to provide proper representation to all the three taluks. Further, from each village five arecanut growers who have adopted drip irrigation were selected at random thus making a sample size of 75 (3 taluks × 5 villages × 5 growers). An equal number of non-adopters were chosen on the same logic for the purpose of comparison. Thus, the overall sample size comprised of 150 arecanut growers. The primary data required for the study were collected with the help of well-designed and pre-tested interview schedule by survey method. The data were analyzed using budgetary analysis to workout costs and returns separately for establishment and maintenance.

Results and Discussion

Establishment Period

The establishment cost is the sum total of initial investment and maintenance cost during subsequent years of establishment period. The establishment period of arecanut is seven years. The initial investment cost included the costs on borewell, pipes, pumpset, pumphouse, energy supply to pumpset, planting material, layout, installation of drip irrigation system and fencing. The maintenance cost during subsequent years of establishment comprised labor expenses on irrigation, manuring, weeding, watch and ward, plant protection, harvesting and replanting; material expenses on manures, tank silt, plant protection chemicals, cakes, lime planting material for gap filling; fixed expenses like land revenue, land rent, depreciation and interest on fixed assets. The details pertaining to investment cost and maintenance costs during establishment period are presented in the Table 1. The investment costs were considered in the initial period and the cost of maintenance during establishment was considered for 7 years which is gestation period. The total per hectare establishment cost was

Table 2. Maintenance cost during establishment period (Rs/ha). D=Drip irrigation, S=Surface irrigation.

Particulars	I		II		III		IV	
	D	F	D	F	D	F	D	F
A Labor								
1. Irrigation	1625	2375	500	600	–	1178	–	3300
2. Interculture	1650	4500	1125	2400	1200	2775	1850	3150
3. Manuring	1740	1948	–	918	2275	2415	1905	2155
4. Weeding	2600	2950	1250	2100	1360	2240	1500	3100
5. Watch	–	5965	–	1400	–	1400	–	1750
6. Plant protection	275	550	225	400	138	345	225	325
7. Filling gaps	–	–	225	150	113	238	–	–
8. Harvesting	–	–	–	–	–	–	–	–
Sub-Total	7890	18288	3325	7968	5086	10591	5480	13780
B Material								
1. FYM	12892	18400	10415	2338	15725	14025	12183	17000
2. Tank silt	11375	5500	6250	450	3225	2775	3125	1575
3. Chemicals	675	1013	619	563	338	788	113	788
4. Lime	–	–	–	–	270	63	263	138
5. Neem cake	–	2250	2438	–	2050	780	2625	–
6. Planting material for gap filling	–	–	494	806	400	520	–	–
7. Interest on working capital	1672	2273	1177	607	1365	1477	1189	1664
Sub-Total	26614	29436	21393	4764	23573	20428	19498	21165
C. Fixed Cost								
1. Land revenue	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
2. Land Rent	5000	5000	5000	5000	5000	5000	5000	5000
3. Depreciation	7323	4190	7323	4190	7323	4190	7323	4190
4. Interest on fixed assets	8446	4357	8446	4357	8446	4357	8446	4357
Sub-total	20771	13549	20771	13549	20771	13549	20771	13549
Grand Total (A+B+C)	55275	61273	45489	26281	49430	44568	45749	48494

Table 2. Continued.

Particulars	V		VI		VII		Total	
	D	F	D	F	D	F	D	F
A Labor								
1. Irrigation	–	4105	–	3700	–	4075	2125	19333
2. Interculture	1500	2550	1575	2550	1500	2400	10400	20325
3. Manuring	3660	3345	2660	2705	2370	3325	14610	16811
4. Weeding	1700	3000	4700	2200	1660	3410	14770	19000
5. Watch	–	1950	–	2650	–	3550	–	18665
6. Plant protection	315	325	338	425	291	600	1807	2970
7. Filling gaps	–	–	–	–	–	–	338	338
8. Harvesting	–	–	–	–	931	820	931	820
Sub-Total	7175	15275	9273	14230	6752	18180	44981	98312
B Material								
1. FYM	34000	15725	21250	12750	23375	12750	129840	92988
2. Tank silt	5925	3150	4125	2775	4875	3525	38900	19750
3. Chemicals	450	1238	473	1125	394	1181	3062	6696
4. Lime	300	125	350	200	363	205	1546	731
5. Neem cake	1650	–	4500	5070	2625	–	16088	1800
6. Planting material for gap filling	–	–	–	–	–	–	894	1326

Table 2. Continued.

Particulars	V		VI		VII		Total	
	D	F	D	F	D	F	D	F
7. Interest on working capital	2475	1776	1999	1808	1919	1792	11796	11397
Sub-Total	44800	22014	32697	23728	33551	19453	202126	140988
C. Fixed Cost								
1. Land revenue	2.00	2.00	2.00	2.00	2.00	2.00	14	14
2. Land Rent	5000	5000	5000	5000	5000	5000	35000	35000
3. Depreciation	7323	4190	7323	4190	7323	4190	51261	29330
4. Interest on fixed assets	8446	4357	8446	4357	8446	4357	59122	30499
Sub-Total	20771	13549	20771	13549	20771	13549	145397	94843
Grand total (A+B+C)	72746	50838	62741	51507	61074	51182	392504	334143

found to be highest in drip irrigated gardens along with non-drip irrigated gardens. To establish arecanut garden, the prospective arecanut grower should have irrigation facility. This investment has to be made even before planting of arecanut seedlings. The total cost of creating irrigation infrastructure was estimated to be Rs 50,420. Of this, digging borewell and purchase of pumpset warranted an expenditure of over Rs 42,000. The cost of energization of pumpset came to Rs 8,800. Fencing of proposed arecanut garden with barbed wire and stone pillars required an expenditure of Rs 23,847. Fencing was an essential item to prevent stray animals from entering the garden site. Fencing was completed before planting seedlings to provide protection against stray cattle and humans. Land preparation was another item of expenditure which was included as an investment cost (Rs 4335). The cost of planting material was estimated to be Rs 15,150 almost at par with non-drip irrigated gardens. The planting material was procured from reputed nurseries located at distant places which added to the transportation cost. The cost of installing drip irrigation was estimated to cost Rs 50,394.

Arecanut from the plantations require 7 years to come to bearing. Economic yields are obtained from eighth year onwards. The maintenance cost of establishing arecanut garden included mostly expenditure on labor, material and fixed costs. The breakup of maintenance cost is shown in Table 2. The maintenance costs per hectare came to Rs 392,504 and Rs 334,143 for DMI and FMI. The fixed costs were found to be lower in FMI gardens compared to gardens under DMI presumably due to lower farm inventory. The material cost was found to be highest in drip irrigated gardens (Rs 202,126) due to inclusion of drip system under this head. The arecanut gardens practiced application of farm yard manure in large quantities during the period of establishment to ensure supply of plant nutrients in adequate quantities. This was in the order of Rs 129,840 and Rs 92, 988 for DMI and FMI. This was prevalent under both the irrigation regimes. It was a regular practice among the arecanut growers to apply tank silt to arecanut gardens along with farm yard manure to ensure balanced plant nutrition. The expenditure on account of this came to Rs 38,900 and Rs 19,750 respectively for DMI and FMI gardens. The arecanut growers regularly applied neem cakes to young seedlings to control soil borne insects which otherwise would damage them.

Plant protection was another priority expenditure to ensure all the care and attention to protect the seedlings against pests and diseases during their tender age. Attack by mite and jassids was common during initial stages of growth. However, the expenditure incurred on plant protection was found to be minimal (Rs 1807 and Rs 2970). Fertilizer use was absent in arecanut cultivation. The arecanut growers are under the perception that chemical fertilizers gave rise to vegetative growth and hence avoid fertilizer application. Instead they preferred to apply farm yard manure and tank silt in larger quantities. Therefore, it is necessary to impart training to arecanut growers to induce fertilizer application in arecanut. Intercultural operations are performed by using bullock power or machine power to keep the gardens free from weeds. The expenditure on interculture was higher in FMI

Table 3. Economics of intercrops grown in arecanut plantations during establishment stage (Rs/ha).

		Drip irrigation			Flood irrigation			
	Cost components	Ragi I Year	Banana II Year	Ratoon III Year	Cotton I Year	Chilli I Year	Banana II Year	Ratoon III Year
1	Human labor	2175	3375	2675	5975	17250	3000	2550
2	Bullock labor	1125	1500	–	2250	1500	3875	–
3	Farm yard manure	1800	6375	8750	2625	4250	8500	4250
4	Fertilizers	1875	3750	3750	1775	2344	2813	3750
5	Seeds/planting material	200	2250	–	633	300	1969	–
6	Plant protection chemicals	–	1125	–	1125	3375	–	1125
	Total cost	7175	18375	17175	14383	29019	20157	11675
	Gross returns	15000	112500	75000	22500	60000	74376	61250
	Net returns	7825	94125	59825	8117	30981	54219	49575

Total cost of cultivation
- Drip irrigation - 42752
- Non drip irrigation - 75233

Net returns
- Drip irrigation - 161775
- Non drip irrigation - 142891

gardens compared to DMI gardens due to higher frequency of operations. The cost of irrigation was nil under both the situations as power is supplied free of cost by the government for pumpsets upto 10 HP. Slurry made of lime is used to paint the trunk of arecanut plants to protect against scorching sun.

The cost incurred upto seven years is considered as establishment cost. The cost of establishment included labor, materials and overheads. The major costs are material costs under both the situations. Establishment stage is crucial requiring much attention. The growers have taken all care to nurture the young plantations by supplying manure, fertilizers chemicals, neem cakes. The material cost under drip system is higher as compared to non-drip gardens due to additional expenditure incurred on installation of drip system. The expenditure on account of labor under DMI (Rs 44,981) was less than half of what it is under FMI (Rs 98,312) plantations. It demonstrated substantial saving in labor expenditure due to installation of drip irrigation system. Padmavatamma (1) reported that the establishment

Table 4. Details of income from intercrops and main crop (Rs/ha).

	I		II		III		IV	
Particulars	D	F	D	F	D	F	D	F
Net income from intercrops	7825	39098	94125	54219	59825	49575	–	–
Net income from main crop	–	–	–	–	–	–	–	–
Total income	7825	39098	94125	54219	59825	49575	–	–

Table 4. Continued.

	V		VI		VII		Total	
Particulars	D	F	D	F	D	F	D	F
Net income from intercrops	–	–	–	–	–	–	161775	142892
Net income from main crop	–	–	67567	47297	–	–	67567	47297
Total income	–	–	67567	47297	–	–	229342	190189

Table 5. Cost of cultivation drip irrigated and non-drip irrigated gardens (Rs/ha).

	Particulars	Drip	Percent	Flood	Percent
I	**Labor Cost**				
1	Basin formation and application of manure and mud	4068	4.68	4515	5.59
2	Intercultivation	1706	1.96	1642	2.03
3	Weeding	1471	1.69	3227	4.00
4	Watch and ward	3731	4.29	3858	0.78
5	Harvesting	2286	2.63	2059	2.55
6	Irrigation	–	–	3988	4.94
	Sub-Total	13262	15.25	19289	23.89
II	**Material Cost**				
1	Farm yard manure	9598	11.04	12608	15.62
2	Mud	2419	2.78	2571	3.18
3	Fertilizers	617	0.71	911	1.13
4	Neem cake	1225	1.41	–	–
5	Interest on working capital	1356	1.56	2477	3.07
6	Annual repairs	542	0.62	–	–
	Sub-Total	15757	18.12	18567	23.00
III	**Fixed-Cost**				
1	Land revenue	2.00	–	2.00	–
2	Land rent	5000	5.76	5000	6.19
3	Depreciation	7323	8.42	4190	5.19
4	Interest on fixed assets	8446	9.71	4357	5.40
5	Apportioned establishment cost	10617	12.21	8381	10.38
6	Interest on establishment cost	26542	30.53	20952	25.95
	Sub-Total	57930	66.63	42882	53.11
	Grand total (I+II+III)	86949	100	80737	100

cost under FMI worked out to Rs 132,633.70 and Rs 141,822 under DMI per acre of which labor cost was highest at Rs 33,750 and 31,750, respectively.

Role of Intercrops in Establishment. Arecanut is a perinnial crop with a long gestation period of 7 years. Once established, it continues to bear upto 60 years. Arecanut is widely spaced crop. The arecanut plants are planted at a distance of 2.4 × 2.4 m or 2.7 × 2.7 m spacing. The plantation does not develop full canopy during the period of establishment. The interspaces are available for cultivation of intercrops without adversely affecting the main crop. Over 60% of the land area is not effectively utilized by arecanut plants. The unexploited interspaces can be put into use by appropriate intercropping system to earn interim revenue during unproductive stage of plantation. The study explores to study financial/economic implications of intercropping systems in arecanut plantations during initial stages of development. A large number of crops are raised in arecanut gardens. The crops include cotton, chilli, banana. During the first year of planting, commercial crops like cotton and chilli are grown. Banana has become most preferred intercrop in arecanut gardens during establishment stage. Banana, a high value crop provides shade to young seedlings of arecanut. The crop does not adversely affect the growth and development of the main crop. Though, several crops are grown as intercrops, banana remained as a most profitable intercrop since the income from banana is highest. Banana is planted between arecanut plants. The number of plants that could be accommodated on one hectare of plantation is 1,500. For planting banana pits of 0.3 × 0.3 × 0.3 m size are dug between two arecanut plants or between two rows. The pits are filled with farm yard manure and mud before planting at 1 kg each per pit. The suckers are planted preferably during rainy season for better crop establishment. The arecanut growers in southern transition zone of Karnataka have fully exploited the two advantages of intercropping of banana in new arecanut plantations. Better awareness among arecanut growers to utilize unexploited interspaces helps in augmenting their income. Besides, intercropping helps in efficient utilization of resources like land, water and sunshine. The income obtained from intercrops could be utilized for meeting cultivation expenses of arecanut. Ratoon crop of banana was also practiced for better earning. The cultivation of intercrops starts from first year of planting and goes on for 3—4 years. The total cost of raising intercropping came to Rs 75,233 under FMI and Rs 42,725 (Table 3) under DMI. The net returns realised from intercrops and main crops were in the order of Rs

Table 6. Productivity and income of arecanut (Rs/ha).

	Particulars	Drip irrigation	Flood irrigation
1	Output	24.93	19.90
2	Value of output	336888	268916
3	Total cost of cultivation	86949	80737
4	Net income over total cost	249939	188179
5	Net income over variable cost	3,07,869	2,31,060
6	Benefit cost ratio	3.87	3.33

Table 7. Results of breakeven analysis of arecanut.

	Particulars	Drip irrigation	Flood irrigation
1	Average yield (q)	24.93	19.90
2	Fixed costs (Rs)	57930	42882
3	Variable costs (Rs)	29019	37855
4	Total costs (Rs)	86949	80737
5	Variable cost per q (Rs)	1164	1902
6	Price per q (Rs)	13513	13513
7	Breakeven point (q)	4.69	3 .69
8	Percent of average yield	18.81	18.54

190,189 and Rs 229,342 per hectare for FMI gardens and DMI gardens respectively (Table 4). The returns were higher on drip gardens due to higher productivity and lower cost of production of intercrops. The cost of establishment could be reduced to extent of 42.27 and 44.18% respectively on DMI and FMI gardens. Hence, it may be concluded that intercropping system helped to reduce financial requirement for establishment of arecanut gardens to a greater extent. These findings are in conformity with the findings of Padmavathamma (1) who reported that the income from intercrops helped areca growers to reduce establishment cost.

Maintenance Period

Cost of Maintenance of Arecanut Gardens during Bearing Period. The cost of maintenance of arecanut gardens under DMI and FMI was worked out at current input prices by using simple budgetary analysis. Simple statistical averages and percentages were computed for the purpose. The details of cost of cultivation of the two situations are presented in the Table 5. The total cost of cultivation of arecanut was estimated to be Rs 86,949 and Rs 80,737 respectively under DMI and FMI. The total cost of cultivation is higher under drip irrigation. However, the variable cost comprising labor and inputs was lower under drip irrigation (Rs 29,019) when compared to surface irrigation (Rs 37,856) by Rs 8,837. This is attributable to savings in labor cost. This testifies that adoption of DMI reduces cost of maintenance. Unlike under flood irrigation, labor requirement for irrigating the crop is zero under DMI. This is made possible with the introduction of automatic 'on' and 'off' system of drip irrigation system. The cost of weeding under drip irrigation was lower by over 50% as compared to gardens of flood irrigation. Drip irrigation system wets the limited area around the root zone of the plant thus minimizing weed infestation. Muthuchamy et al. (2) in their study on coconut in Coimbatore district of Tamil Nadu reported that adoption of drip irrigation resulted in labor saving to an extent of 50% as compared to FMI. Arecanut growers made substantial investment on farm yard manure. Growers incurred an expenditure of Rs 9,598 and Rs 12,608 respectively under drip irrigation and flood irrigation methods. Farm yard manure application was extensively practiced in the study area as growers believed that use of farm yard manure promotes healthy growth of plants and sustainable yields. Hence, arecanut growers had shown disinterest towards application of chemical fertilizers which is reflected in negligible expenditure on fertilizers (Rs 617 and Rs 911). Employment of human labor in arecanut plantations was another item of expenditure involving Rs 4,068 and Rs 4,515 accounting for 4.68 and 5.59% of the total cost of cultivation. The wages of labor in the study area have gone up in the recent past due to shortage of labor. This has caused higher expenditure on labor component. The third major item of expenditure is land rent which accounted for 5.76% of the total cost of cultivation. The rental value of land for a commercial crop like arecanut is generally higher. Under drip irrigation, substantial investment was made for creation of irrigation infrasrtucture and other fixed assets. This gave rise to higher depreciation and interest on fixed assets

Table 8. Distribution of income among arecanut growers (Rs/ha).

	Drip irrigation		Flood irrigation	
Decile groups	Cumulative income	Cumulative percentage share	Cumulative income	Cumulative percentage share
1	219842	6.50	138427	4.94
2	478009	14.13	319546	11.40
3	755830	22.35	528877	18.87
4	1047793	30.98	759612	27.10
5	1374680	40.65	1023180	36.50
6	1718968	50.83	1304016	46.53
7	2070546	61.23	1603087	57.20
8	2450150	72.45	1932785	68.96
9	2877313	85.09	2288483	81.65
10	3381677	100.00	2802791	100.00
	Gini ratio	0.13161		0.1937

Table 9. Sensitivity analysis of investment evaluation of drip irrigation.

	Drip irrigation				Surface irrigation			
Particulars	No change in cash flows	2% increase in costs only	5% increase in costs only	5% increase in costs & benefits	No change in cash flows	2% increase in costs only	5% increase in costs only	5% increase in costs & benefits
At 10%								
NPW	656931	647633	634725	689051	482529	475429	463594	510016
BCR	2.52	2.48	2.40	2.52	2.22	2.18	2.11	2.23
IRR	32.92	32.77	31.80	32.91	33.88	32.94	31.94	33.88
At 12%								
NPW	515829	507938	496102	541621	379971	372820	362089	398970
BCR	2.30	2.26	2.19	2.30	2.06	2.02	1.96	2.06
IRR	32.90	32.73	31.77	32.90	33.86	32.93	31.93	33.86
At 15%								
NPW	357796	350767	340244	375687	264004	257732	248323	236545
BCR	2.01	1.98	1.92	2.01	1.85	1.80	1.75	1.63
IRR	32.88	32.67	31.72	32.88	33.82	32.92	31.92	33.79

(Rs 7,323 and Rs 8,446). However, the expenditure on account of these two under flood irrigation was only half of the expenditure of drip irrigation (Rs 8,547). Depreciation on farm machinery, equipments, implements and tools has been computed by straight line method and included as cost to indicate the contribution of fixed assets to arecanut production. Similarly, interest on the value of fixed assets was computed at the prevailing interest rates (10%). Quite often the fixed costs are ignored in the short run for quick appraisal of cost and return structure of crop enterprises. However, these costs play important role in the long run and have to be recovered. Maintenance of gardens under drip irrigation is less expensive than gardens under surface irrigation.

Productivity and Income. The returns from arecanut cultivation was worked out by using current prices of input and output. The per hectare yields obtained on drip and flood gardens were 24.93 q and 19.90 q respectively. Drip irrigation has registered significantly higher output as compared to surface irrigation. There has been an increase of output by 25.28% over surface irrigation. The productivity gains under drip irrigation system was due to better water use, higher uptake of plant nutrients coupled with better aeration around the root zone. On the contrary, surface irrigation has resulted in wastage of water through percolation losses below the root zone leading to poor aeration with resulted in poor crop output. (Table 6).

The value of output came to Rs 336,888 and Rs 268,916 for drip gardens and non-drip gardens, respectively. The cost of cultivation was deducted from the gross value of output to arrive at net returns. The net returns came to Rs 249,939 and Rs 188,179 for DMI and FMI gardens. The net returns on drip gardens was greater than non-drip gardens by Rs 61,760. The increased net returns on drip gardens was due to higher crop productivity. The net returns over variable expenditure was still higher at Rs 307,869 and Rs 231,060 for drip and non-drip gardens respectively. The operating expenditure has generated substantial income. Input-output ratios have amply substantiated this view (Table 6).

Break-Even Analysis. The profitability is generally measured by subtracting costs from gross value of the produce. This methodology fails to indicate the level of output at which the grower incurs loss or earns profits. The past studies on this subject have been conducted by using simple tabular method of analysis without proper methodology to indicate the output level that the grower has to produce to make profits. It is in this context that the break-even analysis to evaluate empirically the profitability of arecanut assumes paramount importance. This technique is defined as a point at which there is no loss and no profit. The analysis is carried out by using the for-

Table 10. Sensitivity analysis of investment on drip irrigation with and without government subsidy.

Particulars	Without subsidy	With subsidy (50%)
I. At 10% Discount Rate		
NPW	656931	702048
BCR	2.52	2.82
IRR	32.92	39.85
II. At 12% Discount Rate		
NPW	515829	560781
BCR	2.30	2.60
IRR	32.90	39.82
III. At 15% Discount Rate		
NPW	357796	401589
BCR	2.01	2.30
IRR	32.88	39.78

mula given below.

$$BEP = \frac{\text{Fixed costs}}{\text{Output price / unit} - \text{Variable costs / unit}}$$

The results of the break-even analysis are presented in Table 7. The output obtained in drip gardens was greater than non-drip gardens. This is due to better water management practices coupled with less incidence of pests and diseases and better resource use efficiency. By adopting improved irrigation technology, the growers have been able to obtain higher output. Their counterparts who have not adopted this technology are foregoing benefit. The fixed cost of production was higher on drip gardens as compared to non-drip gardens. It is attributed to higher investment made in drip system. Further, the break-even output for drip gardens was determined at 4.69 q and 3.69 q for non-drip gardens. The growers with drip irrigation have to produce more output than their counterparts to recover the cost of drip irrigation. The break even output is slightly lower in non-drip gardens indicating that the farmers without drip could make profits even at lower output. But it is not so in drip gardens as they have made substantial fixed investment in drip irrigation and this has to be recovered in the long run. The break-even output was 18.81 and 18.54% of the average output in drip and non-drip irrigated gardens respectively. All arecanut growers are well above the breakeven point of output. Thus it can be inferred that arecanut growers are not incurring loss. Better price situation prevailing in the market has reduced the break even output level. The break even analysis indicated that it is enough to produce 4.69 and 3.69 q to cover the cost of production. However, to make profits, the growers are advised to produce output greater than BEP.

Economic Viability. Drip method of irrigation is a fixed investment committed at a time and returns spread over time. The cost and benefits are subjected to change over a period of time. Government subsides play potential role in adoption technology. To capture the effect of government subsidies, the financial analysis has been conducted separately with subsidy and without subsidy. The details pertaining to benefit cost analysis/discounted cash flow analysis have been shown in Table 4. The NPW is positive i.e. more than zero indicating economic viability of investment on drip irrigation. Going by NPW criterion, drip irrigated gardens have been able to generate surplus of Rs 357,797 over life period over and above the costs and opportunity cost. It is higher by Rs 98,793 over flood irrigation. The benefit cost ratio worked out to 1:2.02 for DMI and 1:1.85 for FMI. BCR indicates rate of return for each rupee of investment. DMI has guaranteed Rs 2.02 for every rupee of investment on it compared to Rs 1.85 in FMI. For investment on DMI to be economically viable, the value of BCR should be more than unity and going by this, DMI has demonstrated that the investment is economically sound yielding handsome rate of return over its life span. Internal rate of return measures the rate of return over the life period of DMI. The IRR of DMI is higher than that of FMI indicating higher rate of return on the investment thus implying economic soundness of DMI. Thr calculated values of IRR are 33 and 34 respectively for DMI and FMI. The values are greater than the opportunity cost of capital (discount rate) suggesting that investment on DMI is economically viable. The growers of arecanut can safely invest money on arecanut under drip irrigation technology at the existing rates of interest. Another discounted cash flow measure used in the study is payback period (PBP). This is determined by dividing the initial investment by net returns. This gives number of years required to get back the original investment. The payback period is 1 year for both DMI and FMI. Thus, four tests of economic viability demon-

strated that investment on DMI is economically viable. The findings are in line with the findings of Chinnappa and Umesh (3) who reported that the investment on arecanut under command area was economically feasible as evident by discounted cashflow techniques (NPW, BCR, IRR and PBP).

Sensitivity Analysis. The discounted cash flow techniques indicate the economic worthiness of investment on enterprises. While computing the DCF measures, it is assumed that cash flow will remain constant over a period of time. But in reality, this assumption does not hold good as a cost and benefit streams are subjected to change over a length of time since the prices of farm products and inputs vary. Under these circumstances, the DCF estimates are invalid. Hence, it is necessary to consider the change that are likely to occur in cashflows while calculating the DCF measures. To provide solution to these problems, sensitivity analysis is performed at different discount rates considering increase and decrease in cash flows by certain proportions (Tables 5 and 6).

Investment on arecanut is a long term investment proposal, the benefits of which is spread over many years. The cash flows are highly volatile as they are subjected to frequent changes in input and output prices. To capture the effect of such changes, sensitivity analysis was carried out. The analysis under different discount rates and different levels of price changes would indicate the stability of investment over the years. The result of sensitivity analysis assuming no changes in cost and benefits, 2% increase in costs only, 5% increase in costs only and 5% increase in costs and benefits has been presented in the Table 5. The net present worth was higher at all the discount rates than without subsidy. The net present worth with 12% discount rate was Rs 515,829 without subsidy but it is 560,781.14 with 50% subsidy. Hence, it may be concluded that the beneficiaries could obtain an additional benefit of Rs 44,952 per hectare. It is also observed that the NPW is indicating declining trend with increase in discount rates. The benefit cost ratio without subsidy was 2.52 at 10% discount rate which declined drastically to 2.01 at 15% discount rate. The benefit cost ratio however has shown declining trend with increase in discount rate. The higher benefit cost ratio with subsidy indicated the positive impact of subsidy on economic viability of drip system. The initial capital on drip system could be recovered fully during the first year itself as evident from the figures of NPW. This is an important finding of the study that needs to be disseminated to the farming community by the extension machinery as the farmers are under the belief that capital recovery for drip system needs more duration. Although there has been decline in NPW and BCR across different discount rates the net effect was only marginal under both the situations. The economic viability of drip system is not affected by temporal behavior of cost and the benefit streams and discount rates. The sensitivity analysis under different situations of cash flows and discount rates indicated that the investment on drip irrigation is economically feasible even without considering the capital subsidy (Table 6). The capital subsidy by the government served as a cash incentive for large-scale adoption of drip irrigation system especially for small and marginal holders.

Equity Issues. Distribution of income among the sample growers was examined with the help of Gini ratio. In the study, income refers to total income less total variable costs. The sample farmers were arranged in ascending order according to their net income and classified them into decile groups. Next, the share of the total income of each decile group was calculated and cumulative percentage was computed.

The details of income distribution among drip and non-drip farmers are given in Table 8. The income of drip farms was higher than non-drip farms. Closer look at the pattern of income distribution and Gini ratio revealed that there is perfect equity. The percentage share of total income was found to be directly proportional to the percentage of population. Similar was the trend observed among the non-drip farmers. Thus, it can be inferred that the technology did not have perceptible impact on equity. This was substantiated by Gini ratio.

Conclusion

The establishment of cost of arecanut gardens with drip irrigation came to Rs 530,839 / ha while it was Rs 419,046 for flood irrigation. Income from intercrops and main crop during establishment period helped to reduce establishment cost to an extent of over 40% under both the situations. Drip irrigated gardens registered 25% higher yields over gardens

with flood irrigation. The benefit cost ratio suggested that gardens under drip irrigation brought higher gross returns and net returns per rupee of investment. The study suggested that establishment of gardens with drip is highly capital intensive. As small and marginal farmers cannot afford such huge investments they should be helped through provision of higher subsidies. This would help to conserve water resource.

Further, the study suggested improved intercropping systems in consistent with soil, climate should be evolved to augment farm incomes in view of continuous falling arecanut prices.

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