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Cost-Benefit analysis of ferti-drip irrigation in arecanut (*Areca catechu* L.)

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Abstract

The experiment on ferti-drip irrigation was conducted at Central Plantation Crops Research Institute, Regional Station, Vittal, Karnataka, India during December 1996 to May, 2006 with four levels of fertilizers viz., 25, 50, 75 and 100 percent of recommended fertilizer dose (100:40:140 g N: P_2O_5: K_2O/palm/year), three frequencies of fertigation viz., 10, 20 and 30 days in 4x3 factorial RBD with two additional controls in two year old arecanut plantation (cv. Mohitnagar). The cost of cultivation during bearing stage in conventional method of arecanut cultivation was Rs. 60,242, while with fertigation it reduced to Rs. 26,377. The increase in net returns with 75 % NPK fertigation at 10 days interval over absolute control was 149%. Mean data of four years (2002-2005) indicated that 75% NPK fertigation at 10 days interval was highly profitable with highest net returns per rupee investment of 4.57 followed 75% NPK fertigation at 20 days interval (4.44). The study revealed that ferti-drip irrigation is highly profitable in arecanut. With adoption of ferti-drip irrigation the advantages accrued were reduced labour charges on fertilizer application, weeding and irrigation and diesel charges due to less operational hours.

Key words: Arecanut, annuity value, drip irrigation, ferti-drip irrigation, net returns

Introduction

Although India is the largest producer of arecanut (*Areca catechu* L.), its productivity is very low, 1214 kg/ha (2002). Besides, arecanut cultivation is beset with recurring problems due to reduced productivity, delayed commercial yields, soil fertility depletion, small holding size, price fluctuations and pest and diseases. Several workers reported that the cost of cultivation in arecanut per year is very high amounting to Rs. 45,000 to 60,000/ ha (Jayasekhar, 2004; Tamil Selavan, 2004). Arecanut, being the most profitable cash crop, irrigation and fertilizers have positive and significant effect on economics (Dinesh Kumar and Mukundan, 1996). The low productivity ultimately results in high cost of production and less benefit cost ratio. Thus, cost effective input management is essential to reduce the cost of cultivation and thereby ensuring a remunerative price to growers. Area under drip irrigation has been increasing during the last decade due to increased productivity and greater water and nutrient savings. Drip irrigation has proved to be a success in arecanut (Abdul Khader *et al.*, 1988). Ferti-drip irrigation has advantage of saving labour and flexibility in fertilizer application in relation to crop demand besides increasing fertilizer use efficiency (Goldberg *et al.* 1976, Miller *et al.*, 1981). Sivappan and Lamm (1995) reported that drip irrigation could achieve water saving of 40-80% and benefit: cost ratio of 2-5 over traditional method of irrigation in India. Similarly, economic evaluation of drip irrigation in fruit crops in Orissa revealed that this system conserves considerable amount of water and accrues better returns despite higher initial investment (Behera and Sahoo 1998). With this background, an attempt has been made to test the economic viability of ferti-drip irrigation in arecanut.

Materials and Methods

The experiment was conducted at the Experimental Farm of Central Plantation Crops Research Institute, Regional Station, Vittal, Karnataka (India) during December 1996 to May, 2006. The place is located at 58 m above MSL with an average rainfall of 3800 mm, and mean maximum and minimum temperatures of 36°C and 21°C, respectively. The soil of the experimental site is laterite with a pH of 5.6 and available soil nutrient status

of 143 ppm N, 10.1 ppm P and 53 ppm K at 0-25 cm. The experiment was laid out with 14 treatments and three replications in 4x3 factorial RBD with two additional controls in two year old arecanut plantation (cv. Mohitnagar). The ferti-drip system consisted of one 5000L tank, sand filter, ventury, screen filter and two pressure gauges. One lateral line was provided for each treatment with a valve to control the treatment application. The treatments included four levels of fertilizers viz., 25, 50, 75 and 100 percent of recommended fertilizer dose (100:40:140 g N: P_2O_5: K_2O/ palm/year), three frequencies of fertigation viz., 10, 20 and 30 days. Two controls viz., absolute control (without fertilizer application) and normal fertilizer application were included for better appraisal of the results. The sources of fertilizers used were Urea, Diammonium phosphate (DAP) and Muriate of Potash (MOP). Fertilizers were injected in to the drip system through ventury in case of fertigation treatments. In case of 100% NPK soil application, fertilizers were applied in two splits i.e., 1/3rd in June and 2/3rd in September-October. The arecanut was planted with a spacing of 2.7 m x 2.7 m. The crop was drip irrigated at 100 % ET during post monsoon season and the fertilizer was applied from December to May. Three emitters were placed 60cm away from the base of the palm on three sides.

For estimating cost of production the annuity value approach was followed (Gattinger, 1981). The total investment was amortized into an annuity value bearing 10 % interest rate, which was added to annual maintenance cost for arriving at cost of cultivation, net returns and net returns on rupee spent. Similarly, in case of drip irrigation, annual fixed cost for the system was calculated and added to annual maintenance cost. For working out the cost and return, the following norms were followed.

1. A period of 5 years has been considered as the pre-bearing period for arecanut. Economic life span under good management has been assumed as 35 years.
2. Establishment cost included land clearing, local fencing, digging of pits, planting and planting material and bore well in case of drip irrigation and labour cost for all operations.
3. The cost of cultivation included cost of inputs like fertilizers, manure, pesticides etc and labour cost for different operations like application of inputs, spraying, irrigation and harvesting.
4. Drip irrigation system was installed during 1996. The establishment cost of drip system was Rs. 50,000/ha and its life span was considered as 10 years for calculating annual fixed cost of drip system. Annual fixed cost for drip and annuity were added to annual maintenance cost every year.

The annuity was calculated using the following formula

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

Where,

A= Annuity value

P = Total investment

i = rate of interest

n = life of palms

Annual fixed cost for drip and the annuity value thus obtained were added to annual maintenance cost to arrive at total annual cost of cultivation. The farm gate price of Rs. 70 per kg of chali was considered for computing the gross returns of the produce obtained from each treatment. The net returns were worked out after deducting the cost of cultivation from the gross returns and expressed in Rs ha^{-1}. The net profit per rupee investment for different treatments was worked out as the quotient of total cost of cultivation over the net profit per hectare for a given treatment and expressed in Rs Re^{-1}. The yields after stabilization i.e. after 8th year were considered for economic analysis.

Results and Discussion

Cost of cultivation

The year wise estimated cost of cultivation of arecanut per hectare as per treatment was given in Table 1. The year to year variation in cost of cultivation was mainly due to differences in recommended cultivation practices for different ages of palm. The establishment cost for first five years in case of ferti-drip irrigation was Rs. 2,02,400/- (Table 2). The annuity on establishment cost in this study was Rs. 10,617/ha, while the annual fixed cost of drip irrigation system was Rs. 13,500/ha. However, the entire drip irrigation system needs to be replaced after 10 years. The cost of cultivation per hectare during bearing stage in conventional method of arecanut cultivation was Rs. 60,242/-, while with fertigation at 75% NPK it reduced to Rs. 26,377/-. Thus when compared to conventional method of basin irrigation and fertilizer application the saving in annual maintenance cost with fertigation was to the tune of Rs. 33,865/- (Table 2.). There was 46% and 41% saving in labour and input cost, respectively with ferti-drip irrigation over

conventional method. This savings was mainly due to reduction in fertilizer cost, diesel charges and labour charges on irrigation and fertilizer application (Fig 1.). Mahalakshmi *et al.* (2001) also reported reduced cost of production per kg of banana to as low as Rs. 0.83 with savings in water and fertilizer. The chali yield of arecanut is given in Table 3.

Table. 1. Costs of investment and maintenance (ferti-drip system) (Rs./ha)

Particulars	Age of arecanut palms		
	1st	2 - 5	6 & above
Labour charges			
Digging pits and planting	14000		
Drainage opening	9600		
Fertilizer application (Control 2)	1200	1200	1200
Weeding	960	960	960
Irrigation	1600	1600	1600
Plant protection			
a) Bordeaux spray	-	-	4800
b) Pesticide spray	1600	1600	1600
Harvesting			3300
Drying/storage			1600
Dehusking			1400
Total (fertigation)	27760	4160	15260
Total (Control 2)	28960	5360	16460
Input cost			
Seedlings	13000		
Manures (FYM)	10000		
Fertilizers (NPK)			
25%		80 5	805
50%		1611	1611
75%		2417	2417
100%		3242	3242
Copper sulphate and Lime			1700
Miscellaneous	2000	2000	2000
Diesel	5000	5000	5000
Total : Fertigation	57760		
25%		11965	24765
50%		12771	25571
75%		13577	26377
100%		14402	27202
Control2 (100% Soil application)	58960	15602	28402

Net returns

At the existing market rate of Rs. 70/kg chali, fertigation increased the net income considerably (Table 3). Fertigation with 75 % NPK at 10 days interval registered maximum net returns of Rs 2,30,668/- ha^{-1} followed by applied at 20 days frequency (Rs. 2,24,214/-). The increase in net returns with 75 % NPK fertigation at 10 days interval over absolute control was 149%. The fertigation treatments resulted in 28 – 149% increase in net returns over absolute control. The increase in net returns with 75 % NPK fertigation at 10 days interval over control 2 (drip irrigation with 100% NPK soil application) was 17% apart from savings in 25% of recommended fertilizer dose and labour charges on fertilizer application to the tune of Rs. 4,500/- per hectare.

Table 2. Estimated cost of cultivation for arecanut (Rs ha^{-1})

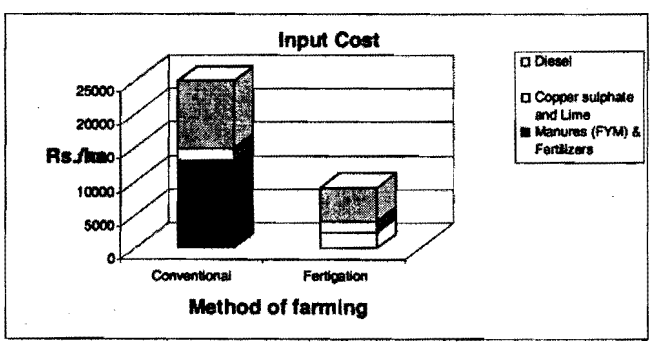
Particulars	(Rs./ha)
Fertigation method	
1. Establishment cost during pre-bearing stage(5 years)	1,02,400
2. Cost of drip system with bore	1,00,000
3. Total establishment cost including drip system	2,02,400
4. Annuity value for establishment cost	10,617
5. Annual fixed cost of drip irrigation system	13,500
6. Labour charges for annual maintenance	15,260
7. Input charges for annual maintenance (75% NPK)	11,117
8. Total annual maintenance cost (75% NPK)	26,377
Conventional method	
1. Establishment cost during pre-bearing stage	316568
2. Annuity value for establishment cost	32923
3. Labour charges for annual maintenance	33,300
4. Input charges for annual maintenance (100% NPK)	26,942
5. Total annual maintenance cost (100% NPK)	60,242
Saving in fertigation (75% NPK) over conventional method	
1. Labour charges	18,040
2. Input charges	15,825
3. Total saving in annual maintenance charges	**33,865**
Input	**Price per unit**
Seedling	Rs. 10 /each
Urea	Rs. 4.80 /kg
DAP	Rs. 10.00 /kg
MOP	Rs. 4.52 /kg
FYM	Rs. 700 /tonne
Copper Sulphate	Rs. 60 /kg
Lime	Rs. 8.0/kg
Labour charges (per manday)	Rs. 80.00
Chali (Dry kernel)	Rs. 70.00/kg

Net return per rupee investment

All fertigation treatment and control 2 were found highly profitable (Table 3). Mean data indicated that 75% NPK fertigation at 10 days interval was highly profitable with highest net returns per rupee investment of 4.57 followed 75% NPK fertigation at 20 days interval (4.44). Net returns per rupee investment was lowest in absolute control (1.92). However this was also profitable due to drip irrigation. Chandrakumar *et al.*, (2001) also observed highest profit per rupee invested with 150 g of N and K fertigation at 1 : 2 ratio. Similar observations of better returns in arecanut by following drip irrigation were reported by Abdul Khader *et al.* (1988) and Dinesh Kumar and Mukundan (1996) and in other crops by Sivappan and Lamm (1995). Due to wide fluctuation of arecanut prices in the market, the returns were calculated at different market prices. Even at lowest market rate of

Table 3. Effect of ferti-drip irrigation on yield, net returns and net return per rupee investment in arecanut (Mean of four years 2002-2005)

Fertilizer dose (% of Rec. NPK)	Fertigation frequency (days)	Mean Chali yield (kg/ha)	Cost of production (Rs ha^{-1})	Gross returns (Rs ha^{-1})			Net returns (Rs ha^{-1})			Net return per rupee investment (Rs Re^{-1})		
				Rs. 45/kg Chali	Rs. 70/kg Chali	Rs. 90/kg Chali	Rs. 45/kg Chali	Rs. 70/kg Chali	Rs. 90/kg Chali	Rs. 45/kg Chali	Rs. 70/kg Chali	Rs. 90/kg Chali
25%	10	3125	48882	140625	218781	281250	91743	169899	232368	1.88	3.48	4.75
	20	2954	48882	132930	206809	265860	84048	157927	216978	1.72	3.23	4.44
	30	3172	48882	142740	222052	285480	93858	173170	236598	1.92	3.54	4.84
50%	10	3308	49688	148860	231532	297720	99172	181844	248032	2.00	3.66	4.99
	20	3071	49688	138195	214942	276390	88507	165254	226702	1.78	3.33	4.56
	30	2983	49688	134235	208829	268470	84547	159141	218782	1.70	3.20	4.40
75%	10	4017	50494	180765	281162	361530	130271	230668	311036	2.58	4.57	6.16
	20	3924	50494	176580	274708	353160	126086	224214	302666	2.50	4.44	5.99
	30	3222	50494	144990	225556	289980	94496	175062	239486	1.87	3.47	4.74
100%	10	3272	51319	147240	229075	294480	95921	177756	243161	1.87	3.46	4.74
	20	3579	51319	161055	250551	322110	109736	199232	270791	2.14	3.88	5.28
	30	2428	51319	109260	169988	218520	57941	118669	167201	1.13	2.31	3.26
Control 1 (Absolute)		2008	48077	90360	140560	180720	42283	92483	132643	0.88	1.92	2.76
Control 2 (100% NPK soil application)		3561	52519	160245	249270	320490	107726	196751	267971	2.05	3.74	5.10



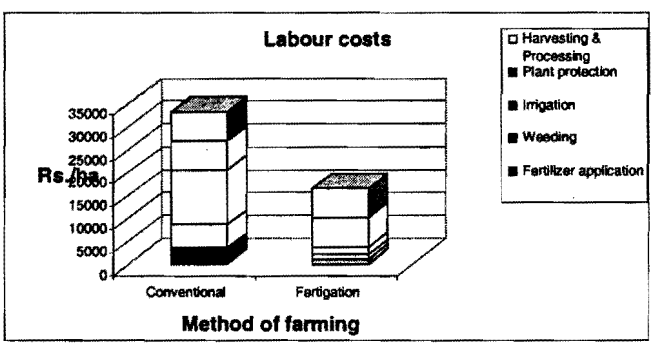


Fig. 1. Break up of expenditure on input and labour costs in fertigation and conventional methods

Rs. 45/kg chali, adoption of ferti-drip technology was found to be profitable. However only drip irrigation without fertilizer application gave less than unity net returns per rupee invested (0.88).

The study revealed that ferti-drip irrigation is highly profitable in arecanut. With adoption of ferti-drip irrigation the advantages accrued were reduced labour charges on fertilizer application, weeding and irrigation and diesel charges due to less operational hours.

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