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Economic Analysis of Drip Irrigation for Coconut (*Cocos nucifera*) – A Case Study in North Western Province, Sri Lanka

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ABSTRACT

This research was conducted to help coconut farmers in making decisions regarding investments in Drip Irrigation Systems (DIS). It provides an economic rationale for investing in DIS. The paper examined the economic worth of investment in DIS in North Western Province. The data were collected from 13 coconut estates using a pre-tested questionnaire, direct observation, field visits and personal interviews. Three different project evaluation criteria; Net Present Value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR) were used to determine the worth to invest in the DIS. Cost of production and benefits were calculated in the present value using discounting factor at an interest of 12%. Differential rates of interest rates (6%, 8%, 10%, 15%, and 20%) were assumed to represent the opportunity cost of capital. There are some leading drip irrigation design companies in Sri Lanka, accordingly, the fixed cost for one acre of coconut land varies from Rs.70, 000.00 to Rs.146, 666.00. Almost all selected estates have recorded a positive NPV (Rs.21,322.48 to Rs.968,457.17), BCR over one (1.03 to 3.61) and IRR greater than the selected interest rate (17% to 47.2%) reflecting the economic viability of the investment. The sensitivity analysis has also confirmed that almost all selected estates have a positive NPV and BCR over one under three different scenarios. It can be concluded that the economic viability of drip irrigation technology is very high and is capable of generating a sufficient return to pay back the capital investment within one to three years.

KEYWORDS: Benefit-cost ratio, Drip irrigation, Internal rate of return

Introduction

Sri Lanka is primarily an agricultural country, and its agricultural production depends on the adequate availability of irrigation water supplies. One of the major challenges of agriculture development is the way of producing enough food for an increasing population using less water for agriculture (Udagedara and Suigirtharan, 2018). In conventional irrigation methods, the wastage in water application is large at the field level. These losses can be reduced to a fair extent by adopting micro-irrigation methods. According to the literature, drip irrigation is the most efficient among all other irrigation methods (Painkra, 2013).

Currently, in Sri Lanka, drip irrigation is used by farmers for various plantation crops (*i.e.* coconut, fruit crops like papaya, banana, watermelon, pineapple etc.); vegetables (*i.e.* bitter gourd, snake gourd, cucumber, chilli) and in protected agriculture.

In drip irrigation, the required and measured quantity of water and fertilizer are frequently applied as discrete drops, continuous drops, tiny streams or fine spray through emitters, on or below the soil surface.

The first Drip Irrigation System (DIS) was introduced to Sri Lanka in the 1970s. The government and other donor agencies have invested considerable sums of money in the development of drip irrigation on a pilot basis since the late 1990s. The Agricultural Development Authority (ADA) in association with various micro-irrigation supplying companies played a major role in promoting drip irrigation technology among small farmers from 1998 onwards (Aheeyar et al., 2005). There are more than ten leading companies involved in the micro irrigation business as suppliers in Sri Lanka. The cost of the DIS varies depending on the brand of the product and crop to be irrigated.

Although research and developments are carried out, the farmer level of utilization is not satisfactory. According to some survey studies, the major reason behind this situation is the slow application of water through drip irrigation. This unables to satisfy farmers who are used to conventional surface irrigation methods that demand a large quantity of water. This concept has led to the belief among farmers that water provided by drip irrigation is insufficient for healthy plant growth (Aheeyar et al., 2005). Limited comprehensive studies have been done so far with regard to the social and economic feasibility of these technologies. Because of that, there are limited reliable economic feasibility records especially for the coconut farmers to adopt DIS available in Sri Lanka.

Coconut is the most widely grown plantation crop in Sri Lanka, spread over 400,000 ha of land area (Central Bank of Sri Lanka, 2016). The annual nut production was 2500 million in 2017 (Central Bank of Sri Lanka, 2017). The coconut industry generates employment for nearly 500,000 people and is contributing to nearly 0.7 % of Gross Domestic Production and 1.0% of foreign exchange earnings (Central Bank of Sri Lanka, 2017).

The coconut palm has concurrent vegetative and reproductive phases and its productivity is significantly influenced by environmental variables (Nainanayake et al., 2008). Rainfall has been identified as a factor with a significant influence on the monthly variation of coconut yield in Sri Lanka (Abeywardhana, 1998). Depletion of soil moisture due to drought is the main cause for triggering physiological and biochemical changes within the coconut palm, leading to the reduction in nut yield. In some coconut growing countries such as India, irrigation has been practised in coconut plantations to improve productivity (Nelliat and Padmaja, 1978). In Sri Lanka, drip irrigation of coconut has shown possibilities of increasing productivity. However, very little research data is available on the performance of coconut palm under drip irrigation (Nainanayake et al., 2008).

Therefore it was decided to carry out an economic analysis of DIS for Coconut (*Cocos nucifera*) in North Western Province, Sri Lanka.

The general objective of this study was to assess the socio-economic feasibility of drip irrigation technology in coconut cultivation.

Specific objectives of this study were to evaluate attitudes and knowledge of farmers about DIS and evaluate the economic viability of the drip irrigation techniques using identified investments appraisal techniques: Benefit-Cost Ratio (BCR), Net Present Value (NPV), Internal Rate of Return (IRR) and Pay Back period.

Methodology

This research study was carried out in North-Western Province during the period from June to November 2019.

Sample Selection

Drip irrigated coconut estates which were higher than one ac extent in North Western Province were taken as the population.

Data Collection

In the survey, sixteen (16) coconut estates facilitated with DIS over five (05) hectares were found in North Western Province. Among them, only thirteen (13) estates had maintained reliable data records. Accordingly, those thirteen (13) estates were selected being the sample as well as the population in the study. Data were collected from those 13 coconut estates using a pre-tested semi-structured questionnaire. The questionnaire consisted of five sections which includes, (i) general information, (ii) attitudes and knowledge of farmers about drip irrigation method, (iii) crop production activities, (iv) information about drip system and (v) information about farm income. Attitudes and knowledge of farmers on the drip irrigation method were rated using the five-point Likert scale. Each statement rated 1 to 5 in which case 1=strongly agree and 5=strongly disagree.

Data Analysis

While estimating cash inflows and cash outflows of the drip investment the following assumptions were made (Narayanamoorthy, 2004); (1) the income stream from DIS was treated as uniform over its entire life (due to lack of temporal information) (2) crop cultivation practices are uniform over the period (3) the life span of DIS was considered as 10 years (4) cost of production and benefits were calculated in the present value using discounting factor at an interest of 12% (5) differential rates of interest rates (6%, 8%, 10%, 15% and 20%) were assumed to represent the opportunity cost of capital.

Four investment appraisal techniques wereused in finding the present worth of the future values of a project: BCR, NPV, IRR and payback period (Bakhsh et al., 2015 and Luhach et al.,2004). The NPV and BCR at different interestrates were calculated using total income.

Annual costs were the sum of total variable costs, irrigation investment cost, and a yearly operation and maintenance cost of DIS beginning from the second year.

Total revenue,total variable costs, and the operation and maintenance cost for each year of the 10-year useful life span of the DIS were discounted backto a present value using equations 1, 2 and 3. The total investment cost for the DIS was assumed to be made completely within the first year. NPV, BCR and IRR were calculated usingequations 1, 2 and 3.

$$\text{NPV} = \sum_{t=1}^{n} \frac{Bt-Ct}{(1+r)t} \quad [1]$$

$$0 = \sum_{t=1}^{n} \frac{Bt-Ct}{(1+IRR)t} \quad [2]$$

$$\text{BCR} = \sum_{t=1}^{n} \frac{Bt}{(1+r)t} / \sum_{t=1}^{n} = \frac{Ct}{(1+r)t} \quad [3]$$

Where,
r : Interest rate
t : No of years
Bt : Benefit in each year
PV : Present Value
Ct : Cost in each year

Sensitivity Analysis
Sensitivity analysis was carried out to understand the level of sensitiveness of the investment in drip irrigation with uncertainties. Sensitivity analysis was done with three scenarios including a 10 % increase in costs of cultivation, a 10 % decrease in benefits and 10 % increase in cost and a 10 % decrease in benefits.

Results and Discussion

Attitudes and Knowledge of Farmers on DIS

Almost all respondents had awareness of the Drip Irrigation (DI) method in general. For instance, from the farmers, 77 % agreed that crops were received optimum irrigation requirements. Almost all respondents surveyed agreed that the coconut yield, size of nuts were increased and labour cost was decreased. From the respondents, the majority (85%) pointed out that the initial cost of DIS was high and 62 % mentioned that there was a disturbance to the cultural practices including weed management, intercropping and harvesting due to the layout of the system.

The income appraisal techniques; NPV, BCR, Payback period and IRR of all coconut estates for which DIS was adopted were computed (Table 1).
Almost all coconut estates showed positive NPV (Rs.21322.48 – Rs.864320.90) and recorded BCR over one (1.026 – 3.606).

All coconut estates have received the capital investment within three years (0.8 – 2.9 years) and the IRR was greater than the selected 12 % interest rate (17 % - 47.2 %) (Table 1).

Table 1: NPV, BCR, IRR and Payback Period at 12% Interest Rate

Estate No	NPV /000 (Rs)	BCR	Pay Back	IRR (%)
1	829.8	2.60	1.7	43.4
2	864.3	3.61	1.6	47.2
3	968.4	2.90	1.7	37.8
4	238.2	1.39	2.7	24.5
5	785.8	2.01	0.8	32.8
6	569.9	1.47	1.6	20.4
7	149.3	1.24	2.7	21.0
8	213.2	1.03	2.8	17.1
9	798.6	1.09	2.5	29.0
10	-317.1	0.64	2.9	-
11	831.2	2.20	0.9	23.6
12	788.8	1.06	2.6	27.0
13	458.7	1.84	1.1	33.0

Coconut was economically viable even at a 20 % discount rate if there is no change in the cost of production and gross income during the life period (Table 2).

Table 2: NPV, BCR, IRR and Payback Period at 20% Interest Rate

Estate No	NPV /000 (Rs)	BCR	Pay Back	IRR (%)
1	596.8	2.48	1.7	43.4
2	623.2	3.36	1.7	47.2
3	692.7	2.72	1.7	37.8
4	143.2	1.29	2.9	24.5
5	558.6	1.92	1.6	32.8
6	391.9	1.42	1.6	20.4
7	83.7	1.17	2.9	21.0
8	-12.5	0.98	3.1	17.1
9	33.4	1.04	2.6	29.0
10	-317.7	0.64	2.9	-
11	578.9	2.05	1.0	23.6
12	27.5	1.09	2.8	27.0
13	314.5	1.73	1.1	33.0

The results of the sensitivity analysis showed that reduction in NPV and BCR was higher when expected benefits were decreased by 10 % than a 10 % increase in the cost of cultivation.

Coconut estate No. 8, 9, 10 and 12 have shown negative NPV values and BCR were less than one. The reasons for the above low performance were identified. No.8 estate has only 46 % of the recommended number of palms and labour wage rates were higher compared to the other estates of estate no 9 (Rs.1300/Day). DIS of No.10 estate was not maintained properly (less number of palms/unit area due to infilling of vacancies) resulting in a low yield under the potential. Estate No.12 was an organic coconut estate, therefore costs for fertilizer and labour were higher than other estates (Table 3).

Table 3: Sensitivity Analysis of NPV and BCR under Different Scenarios

		Scenario1	Scenario2	Scenario3
1	NPV ('000)	778.07	695.08	643.32
	BCR	2.37	2.34	2.13
2	NPV ('000)	831.15	744.72	711.55
	BCR	3.28	3.25	2.95
3	NPV ('000)	917.49	820.65	769.68
	BCR	2.64	2.61	2.37
4	NPV ('000)	178.03	154.21	94.02
	BCR	1.27	1.26	1.14
5	NPV ('000)	707.66	629.08	550.87
	BCR	1.82	1.80	1.64
6	NPV ('000)	449.01	392.01	271.03
	BCR	1.34	1.32	1.20
7	NPV ('000)	87.65	72.71	10.98
	BCR	1.13	1.12	1.02
8	NPV ('000)	-61.27	-63.40	-145.98
	BCR	0.93	0.92	0.84
9	NPV ('000)	-37.86	-45.85	-163.58
	BCR	0.97	0.96	0.87
10	NPV ('000)	-405.20	-373.49	-461.58
	BCR	0.58	0.58	0.52
11	NPV ('000)	761.78	678.66	609.22
	BCR	2.00	1.98	1.80
12	NPV ('000)	-47.47	-55.36	-181.72
	BCR	0.97	0.96	0.87
13	NPV ('000)	404.23	358.36	303.85
	BCR	1.67	1.66	1.51

All selected estates were received an average price of Rs.42.00 for coconut in 2018. In the calculation of NPV, a twenty per cent (20 %) increment was made to the average price reflecting a price of Rs.50.40 and with twenty (20%) decline resulting in a price of Rs.33.60. Even though the price was decreased by 20%, most of the estates showed positive NPV values (Figure 1).

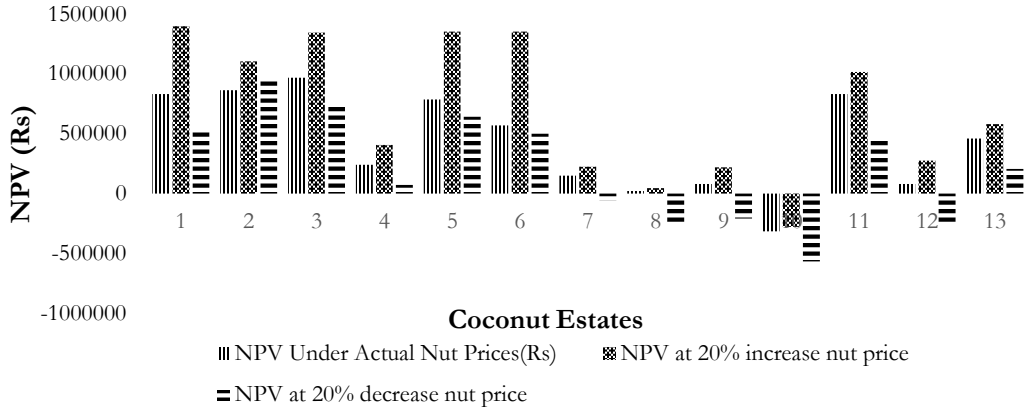

Figure 1: NPV of All Selected Coconut Estates at Average Nut Price, 20% Increase and 20% Decrease from the Average Nut Price

Usually, the cost of cultivation varies with the cost of fertilizer and labour. Therefore, NPV was calculated for all selected estates by increasing 10 % fertilizer and labour costs. Almost all estates have recorded positive NPV values (except No.6 and 10 estates). Estate No.10 has shown negative NPV values due to the low yield. Estate No.6 has shown a negative NPV value only for 10 % increased labour cost, due to the presence of a permanent worker who was paid Rs.50,000 per month except other daily workers (Figure 2).

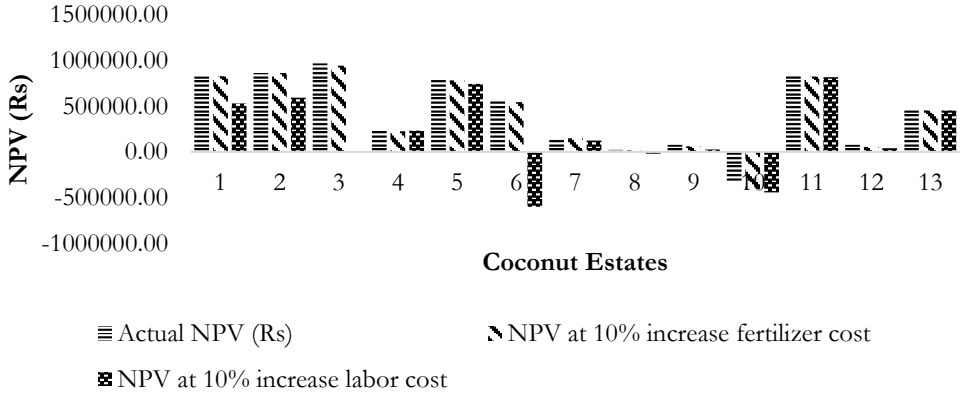

Figure 2: Actual NPV, NPV at 10% Increase Fertilizer Cost and NPV at 10% Increase Labour Cost of Selected Coconut Estate

Overall, the sensitivity analysis under various scenarios indicates, that the DIS investment remains economically viable in most instances.

Conclusions

Almost all coconut growers interviewed in this survey were reported positive results with the DIS and confirmed that DIS would be a profitable investment. It is compatible with theresult of Cetin *et al*., (2004). Because of this technique, crop water requirements can preciselybe supplied continuously and also it saves labour. DIS can provide a sufficient income to pay back the initial investment within one to three years.

DIS is not much popular in Sri Lanka, because of the perception of farmers that the amount of water is insufficient due to the emission as tiny drops by drippers to the crop. Another reason is lacking knowledge of farmers about the maintaining of DIS. Additionally, the willingness of farmers to shift from conventional to DIS is very low due to the high initial cost of DIS.

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