

## ECONOMIC FEASIBILITY OF TRICKLE IRRIGATION IN TEA: SOME PRELIMINARY RESULTS

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An attempt was made to evaluate the economic feasibility of trickle irrigation of tea from the results of field trials. Incremental benefit/cost analysis for a hectare of clonal tea showed that two weekly trickle irrigation had the highest value of benefit/cost ratio i.e. 7.7 for economic analysis and 4.4 for financial analysis for both young and mature tea, assuming that water is freely available close to the tea land and no expenses are incurred in transporting water.

### INTRODUCTION

The tea plant *Camellia sinensis* (L.) is an evergreen perennial and produces green leaves throughout the year. It is grown as a rainfed shrub in about 244, 715 hectares of land in Sri Lanka and is a principal foreign exchange earner. In 1983, about 179.3 million kilograms of tea were exported which accounted for 33.1% of the total foreign exchange earnings. About 85% of the total tea area is under relatively old tea raised from genetically heterogenous seeds usually referred to as seed tea. Seed tea has a deep tap root, sometimes extending up to 4-5 meters. The remaining 15% of the area is under vegetatively propagated tea known as clonal tea which has a shallow root system when compared to that of seedling tea. The harvested crop in tea is a part of its vegetative growth and mainly consists of the terminal bud and two adjacent leaves.

The total annual rainfall is adequate for tea production in most of the tea growing areas in Sri Lanka, but the distribution of monthly rainfall is often inadequate. During the dry months when evaporation exceeds rainfall (January to April), the yields show a marked drop in tea production indicating water to be a limiting factor for crop growth. The growth rate and yield does not return to normal for 3-4 weeks even after the beginning of rains. During prolonged drought, many clonal plants fail to recover even after the onset of rains causing high mortality rate (Willatt, 1970). This is more pronounced in newly planted tea as the root system is not very well established. The lower yield in dry months result in a loss of foreign exchange and causes problems in maintaining a regular workforce and to work the factories at maximum capacity. Infilling due to heavy mortality in newly planted areas causes additional expenses and delays early establishment as well as harvest.

Work done in several tea growing countries confirm that substantial yield increases can be obtained with irrigation and that irrigation of tea is economically viable (Shaxon, 1969 ; Biswas, 1979). However, not much work has been done in Sri Lanka to examine the economics of irrigating tea. The objective of this paper is to discuss the economics of irrigation of tea in Sri Lanka.

### METHODOLOGY

The economic viability of irrigating tea could be assessed by computing the benefit-cost ratio. In order to accomplish this, it is necessary to convert the capital costs of irrigation equipment, operation and maintenance costs and the associated benefits (reduction in mortality and increase in yields) into the same dimension. The method that is commonly adopted is to capitalize all costs (both capital and maintenance) and benefits associated with irrigation from the beginning to the end of the economic life span of the equipment into present values at the time of initiation as given in equation 1.

$$PV = \sum_{n=1}^n \frac{FV^n}{(1+r)^n} \quad (1)$$

where

PV	=	present value
FV	=	future value
r	=	discount rate
n	=	time period

The benefit-cost ratio is the ratio of the present value of benefits to the present value of the costs.

The above analysis could be conducted both in financial and economic terms. In financial analysis, market prices are used and hence it reflects the private profitability of the investment to the management. Economic analysis reflects the returns of an investment to society as a whole. In determining economic returns shadow prices are used for valuation purposes (Little and Mirrlees, 1968). The use of shadow prices is required since market prices do not reflect real values due to market imperfections, rigidities, monopoly elements etc. which cause a divergence between the market and shadow prices.

### THE DATA

The data used for the analysis were obtained from experiments conducted in young as well as mature tea at the Tea Research Institute, Talawakele, where the annual average rainfall is about 2220 mm mainly distributed from late April to July and from September to December. The planting material used in the experiments was the clone TRI 2025 which is moderately high yielding and moderately drought resistant (Calnaido and Kanapathipillai, 1967).

For the experiments conducted in young tea, the plants were raised in polythene bags and subsequently transplanted in the field in September 1981 at a spacing of 1.2 X 0.6 m, when they were 10 months old and the following treatments were commenced : (a) Irrigation daily on surface, (b) irrigation once a week on the surface, (c) irrigation once in two weeks on the surface, (d) irrigation daily in sub-surface, (e) irrigation once a week in the sub-surface, (f) irrigation once in

two weeks in the sub-surface, (g) no irrigation. The treatments were replicated thrice. Sub-surface irrigation was by trickle irrigation through a S-Ion pipe of 2.5 cm in diameter driven into the soil about 7.5 cm from base of plant.

The mature tea plants were four years old at the commencement of the experiment in 1982. The experiment was laid using a randomized block design with four treatments replicated three times. The treatments were (a) daily irrigation up to field capacity, (b) weekly irrigation up to field capacity, (c) bi-weekly irrigation up to field capacity, and (d) no irrigation.

## RESULTS AND DISCUSSION

### Cost of irrigating tea

Table 1 shows the capital and running costs of irrigating one hectare of young tea for three months at 14 day intervals. As the differences in the number of casualties of tea among the three irrigation types were not significant only the 2 weekly sub-surface system was evaluated in the case of young tea. The latter system saves about 400-500 ml of water in each application over a two week period (the amount of water applied per plant per application was about 2150 ml for the surface application while for the sub-surface application it was 1730 ml). The efficiency of sub-surface application is high due to the water being directly added to the root zone of the plant.

The equipment can be used to irrigate 6 hectares of young tea at this frequency. Irrigation of young tea is done only for two years after which the equipment can be shifted to a new site since the equipment lasts for about 10 years. It can also be sold at the end of the second year in which case it has a salvage value.

The capital and running costs of irrigating mature tea at two weekly, weekly and daily irrigations are given in Table 2. Even here irrigation is done for three months of the year. The equipment is portable and can be used to irrigate 6 hectares of mature tea at 14 day intervals, 3 hectares at 7 day intervals and one hectare daily.

Three scenarios were examined for their economic feasibility as follows :

1. Two years of sub-surface bi-weekly irrigation of young tea and a further ten years of daily irrigation of mature tea.
2. Two years of sub-surface bi-weekly irrigation of young tea and a further ten years of weekly irrigation of mature tea.
3. Two years of sub-surface bi-weekly irrigation of young tea and a further ten years of bi-weekly irrigation of mature tea.

The capital costs for this evaluation were determined using data in Tables 1 and 2 by proportional allocation. Since the equipment for young tea can irrigate 6 hectares, the cost of a hectare was taken as one sixth of the capital cost. Also the life span of the equipment is 10 years and cost for the 2 years is taken as one fifth each of total capital costs for the first and the second year respectively. The running costs vary only with frequency of irrigation and these are already computed for one hectare and it is a recurring cost for all the 12 years. The capital cost for irrigating one hectare of mature tea was also obtained by proportional allocation depending upon the frequency. A problem of allocating capital across years does not arise here since the equipment is assumed to be used for a full 10 years life span.

### The benefits of irrigating tea

The benefits of irrigating young tea arise mainly from a reduction of mortality. In the third year of the crop, a crop loss of about 25 per cent is expected if no irrigation is available. The benefits from irrigating mature tea accrue from increased yield. In the Talawakele region, where the experiments were conducted, unirrigated tea gives a cycle average of about 2000 kg of made tea per hectare. The yield increases obtained for bi-weekly, weekly and daily irrigations are 12.2, 14.9 and 8.6 per cent respectively over that of unirrigated tea (with an average yield of 2000 kg per ha) and this same response is assumed for each year of irrigation over the life span of the equipment. Also in the sixth year of planting, tea is pruned, and, as a result no crop is harvested for 4-5 months.

TABLE 1—*Capital and running costs of irrigating young tea (rupees)*

<i>Item</i>	<i>Cost in market prices</i>
<b>Capital Costs</b>	
1 Pump (prime mover, petrol/kerosene)	5,000 00
2 Filter	1,000 00
3 Main line (130 m—Alkathene)	1,300 00
4 Lateral line (Alkathene)	2,000 00
5 Emitters (800)	1,200 00
6 Sub-surface applicator (S-lon pipe 1875 m)	2,000 00
7 Accessories	600 00
<b>Total</b>	<b>13,100 00</b>
<b>Running Costs (for one hectare)</b>	
1 Fuel (3 months)	400 00
2 Labour wages (20 man days for 3 months)	500 00
<b>Total</b>	<b>900 00</b>

Source A Ananthacumaraswamy, 1984.

TABLE 2—*Capital and running costs for irrigating mature tea (rupees)*

<i>Item</i>	<i>Cost in market price</i>
<b>A.—Capital Costs</b>	
1. Pump (prime mover petrol/diesel) ..	10,000.00
2. Filter ..	1,000.00
3. Main line—260 m (Alkathene 1.25 cm) ..	2,500.00
4. Lateral line 500 m (Alkathene 0.62 cm) ..	2,550.00
5. Emitters (2,600) ..	8,000.00
6. Accessories ..	750.00
<b>Total</b> ..	<b>24,800.00</b>
<b>B.—Running Costs (for a hectare)</b>	
<i>(i) Two Weekly Irrigation—</i>	
1. Fuel (3 months) ..	1,000.00
2. Labour wages (30 man days for 3 months)	750.00
<b>Total</b> ..	<b>1,750.00</b>
<i>(ii) Weekly Irrigation—</i>	
1. Fuel (3 months) ..	1,100.00
2. Labour wages (50 man days for 3 months)	1,500.00
<b>Total</b> ..	<b>2,600.00</b>
<i>(iii) Daily Irrigation—</i>	
1. Fuel (3 months) ..	3,000.00
2. Labour wages (144 man days for 3 months)	3,600.00
<b>Total</b> ..	<b>6,600.00</b>

Source: A. Ananthacumaraswamy, 1984.

For evaluating financial returns, average net and gross sale price of Rs. 31 and Rs. 35 per kilogram respectively were used. The benefit of irrigating young and mature tea is thus the cost saved in infilling in the third year and the increased yield from the third year up to the 12th year.

The present values of the incremental costs and benefits at market prices and the financial benefit-cost ratios computed at 15% discount rate are given in Table 3.

TABLE 3—*Present values of incremental costs and benefits and the incremental benefit - cost ratios (financial)*

<i>Treatment</i>		<i>Incremental Costs (Rs.)</i>	<i>Incremental benefits (Rs.)</i>	<i>Benefit-cost ratios</i>
Daily irrigation	..	38883.7	42697.6	1.10
Weekly irrigation	..	17624.1	66658.6	3.78
Two weekly irrigation	..	12624.1	52862.5	4.39

The results in Table 3 indicate that the financial benefit-cost ratios are 1.1, 3.78 and 4.39 for daily, weekly and two weekly irrigations. While the benefit-cost ratios are high for the last two options, two weekly irrigation appears best out of the three scenarios examined.

Distinct from the financial benefit-cost ratios presented above which were computed using market prices, economic benefit-cost ratios computed using shadow prices indicate the viability of irrigation from a national point of view. The shadow prices of importance in this study are those of labour, tea (Herath, 1982, 1983) and the emitters used in the irrigation system which are imported. The shadow wage was taken as 0.75 of market wage. The emitters were valued at Rs. 2.00. The f.o.b. price of tea was used as its shadow price since it is an export commodity. The economic benefit-cost ratios computed on the above assumptions are given in Table 4 which shows the economic benefit-cost ratios to be quite high. The best irrigation practice on economic grounds appear to be two weekly irrigation with an economic benefit-cost ratio of 7.7. The results are quite promising and in fact possibilities exist of even raising these further if locally available materials could be substituted such as bamboo instead of S-lon pipes and electricity instead of imported fuel. The results also indicate that spreading irrigation to a greater area by reducing frequency is preferable to greater intensity of irrigation and covering a more limited area.

TABLE 4—*Present values of incremental costs and benefits per hectare and the benefit - cost ratios (economic)*

<i>Treatment</i>		<i>Incremental cost (Rs.)</i>	<i>Incremental benefits (Rs.)</i>	<i>Economic benefit-cost ratios</i>
Daily irrigation	..	33597.89	70659.4	2.1
Weekly irrigation	..	14811.36	87146.4	6.4
Two weekly irrigation	..	11093.94	86291.81	7.7

The high benefit cost ratios arise mainly because of the high f.o.b. price of tea. Further, in these exercises water which is an important input was not valued. This study was made with the assumption that water is available closer to the tea land to be irrigated. Therefore, only the cost of pumping water is taken into account without considering the cost of water itself. However, a limitation in this study is that the water source will not be close to the planted area in most instances. Even if water has to be priced at some stage, the benefit-cost ratios could remain high enough for all practical purposes. The higher economic benefit-cost ratios indicate that even subsidization of tea irrigation by the state is economically justified.

## CONCLUSIONS AND IMPLICATIONS

The financial and economic benefit-cost ratios computed indicate all of them to be high thus justifying irrigation of tea as a viable proposition. The economic returns however are much higher and in fact for 2 weekly irrigation it was as high as 7.7.

The differences in the financial and economic benefit-cost ratios imply that the returns to the country as a whole are much higher than returns to private holdings. Thus even subsidizing irrigation to some level by the government can be justified.

The above results however are based on limited experiments and thus the results need to be carefully interpreted. Irrigation of tea is not widespread in Sri Lanka and further investigation is necessary to establish the generality of the findings. However, these early results indicate irrigation to be economically viable and hence potentially useful area for further exploration.

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