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# Technical feasibility and the Performance of Sprinkler Irrigation system in Mannar, Sri Lanka

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## Abstract

*The study was undertaken to evaluate the efficient use of sprinkler irrigation system by farmers. Fifty farmers were randomly selected among the farmers who were given sprinkler irrigation system on subsidy basis and collected the data using structured questionnaire in Mannar district from August 2013 to January 2014. Data were statistically analyzed using Microsoft Excel and Minitab 15 software. Results revealed that nearly 73% of the farmers were using the system effectively while the rest 27% did not use at all. Net income from cultivated crops such as groundnut, onion, greengram, greenchilli and cabbage using sprinkler irrigation system were higher than that of the conventional method by 59%, 45%, 47%, 32% and18% respectively. Yield of these crops cultivated under sprinkler irrigation system was significantly different ($p<0.05$) from the yield of those respective crops cultivated with conventional method of irrigation. Uniformity coefficients such as percentage for Christiansen's uniformity coefficient and distribution uniformity coefficient for sprinkler irrigation systems in the study area were estimated as 94% and 93% respectively. Over all uniformity of sprinkler irrigation system was in the recommended level. Hence there is potential for the adoption of sprinkler irrigation technology which could increase the yield and the farmer's income by increasing the extent of cultivation with the available water resource.*

**Keywords:** Sprinkler irrigation, subsidy, net income, uniformity coefficient.

## Introduction

Studies from different countries have confirmed that irrigation plays a paramount role in increasing the yield and enhancing cropping intensity[1]. Christy Nilani *et al*., stated that increasing water scarcity in Sri Lanka, together with evidence of its inefficient use and increasing competitive demand has given momentum to the call to treat water as an economic good[2]. The increased demand for industrial and domestic water resulted in a reduction in water diversions to agriculture. Therefore, the government gives all importance to irrigation needs of the country by adopting modern micro irrigation methods[3]. Sprinkler irrigation was proved to be an efficient method in saving water and increasing water use efficiency as compared to the conventional surface method of irrigation[4].

Kay reported that the sprinkler irrigation technology increased the yield of different crops when compared to the traditional methods[5]. Use of sprinkler irrigation technology resulted in increased yield up to 20% in Pakistan[6], and 11to 30% in India[7]. According to Suceendra and Nanthakumaran the investment on sprinkler irrigation system was economically viable even without subsidy in Sri Lanka[8].

Sprinkler irrigation system had been given as subsidy for nearly half a percentage of farmers who involved in agriculture in Mannar district. Hence, there is a need to find out the efficient performance of the system by the farmers. The objective of this study was to evaluate the performance of sprinkler irrigation system.

## Material and Methods

The area selected for the study was Mannar district which was a typical agricultural area in Sri Lanka. The district covers 2,002 sq. km, approximately 3% of the total land area of Sri Lanka. Western part of the district, including the Mannar Island forms a part of Sri Lanka's arid zone while the rest of the areas of the district falls within the dry zone of Sri Lanka, where tropical dry climate is prevalent. Annual rainfall of the district is between 1000 –1250 mm. The area experiences heavy rains from October to December, during North East monsoonal season. Comparatively, amount of rainfall receives during the rest of the months is extremely low. In Mannar district, nearly 33,330 ha of land were used for agriculture where 19,480 ha of land were being cultivated with paddy while about 30400 ha for high land crops and 10,450 ha for perennial crops. Lift irrigation from wells was utilized for the subsidiary food crops such as chilli, groundnut, red onions, big onions and grain legumes, exotic and local vegetables[9].

In this study, a field level questionnaire survey was conducted at farmer's level in Mannar district. A list of 86 farmers obtained sprinkler irrigation system from the Department of Agriculture and other organization was used as a sample frame for this study. 50 farmers from the list were randomly selected and

interviewed to collect primary data. Secondary data were collected from Department of Agriculture, District Secretariat, Non Governmental Organizations namely Zoinist Organization of America (ZOA) and World Vision, Mannar.

The efficiency of sprinkler irrigation was assessed using the parameters of uniformity coefficient, crop yield and net income. For the net income analysis groundnut, onion, greenchilli, greengram, cabbage were considered because these were the major crops cultivated using sprinkler irrigation systems by the farmers in this study area. Cost of cultivation, yield and net income of crops cultivated using sprinkler irrigation system were compared with those of conventional method. For this investigation 50 samples were taken and the data were statistically analyzed using MS Excel and Minitab 15 software.

For the uniformity coefficient analysis, catch cans were placed in a circular arrangement over the area between lateral settings. Cans were spaced one foot distance for five feet radius from the sprinkler in each direction. Water caught was measured for five minutes volumetrically using a measuring cylinder. The average application rate for each catch can location in a plot was calculated. These measurements were replicated into three times. The average rate of discharge was calculated at a particular pressure. For this investigation 50 samples were taken. The following sets of assumptions were taken in conjunction with the operational characteristics of the sprinklers:

All sprinklers of identical design have identical performance characteristics. In computing the can catch of the different spacing combinations used, it is assumed that the application rate is below the water absorption capacity of the soil therefore, no runoff results. The loss of water via evaporation was considered negligible.

The uniformity coefficient of sprinkler irrigation system and net income analysis were carried out using the following equation.

$$Cu=100(1-(\sum d/mn)) \quad (1)$$

Where, Cu- Uniformity coefficient, d-deviation of individual observations from the mean, m- mean of observations and n - number of observations[10].

A set of recommendations for the minimum requirements on uniformity coefficient showed in table-1[11].

DU = (Average catch in the low quartile x 100) / Average catch overall (2)

Where: DU - distribution of uniformity coefficient[12].

The evaluated systems were classified according to the DU values, showed as a table-2[13].

Gross income and net income were calculated by using following equation,

Gross income = Average price of crop yield (Rs/kg) x Average yield (kg/ac) (3)

NPi = VPi-VTi (4)

Where: NPi-net income, VPI-final production value of crop and VTi-variable cost of production and utilization of the irrigation system[14].

**Table-1**
**Uniformity classification of sprinkler irrigation system based on uniformity coefficient values**

| Uniformity coefficient, UC (%) | Classification |
|---|---|
| Above 90 % | Excellent |
| 90%-80% | Good |
| 80%-70% | Fair |
| 70-60% | Poor |
| Below 60% | Unacceptable |

**Table-2**
**Uniformity classification of sprinkler irrigation system based on Distribution Uniformity coefficient values**

| Distribution uniformity, DU (%) | Classification |
|---|---|
| >87 | Excellent |
| 75-87 | Good |
| 62-75 | Acceptable |
| <62 | Unacceptable |

## Results and Discussion

**Performance of sprinkler irrigation system:** Survey results showed that nearly 73% of the farmers were using sprinkler irrigation system while nearly 27% of the farmers did not use at all. The main reasons for not using were that they did not have the knowledge of using it and the appropriate water pump with high horsepower. Among the users of this system nearly 17% of the farmers expanded the extent of cultivation under sprinkler irrigation systems by purchasing an additional unit on their own while about 68% of the farmers expressed their willingness to expand the system.

**Uniformity coefficient of sprinkler irrigation system:** Table-3 showed the different uniformity coefficient value of the

sprinkler irrigation system. Christiansen's uniformity coefficient for the sprinkler irrigation system was above 90%. Comparing to the recommended value of sprinkler irrigation system, the uniformity was excellent thus the sprinkler irrigation was technically feasible for that field condition. Distribution uniformity coefficient for sprinkler was greater than the recommended level of 87% and considered as excellent. Hence it indicated the better performance of sprinkler irrigation system.

**Table-3**
**Uniformity coefficient percentage values of sprinkler irrigation**

| | Uniformity coefficient (%) | |
|---|---|---|
| | **Christiansen's uniformity coefficient** | **Distribution uniformity coefficient** |
| Sprinkler irrigation | 94 | 93 |

Source: Field survey (2013)

**Net income analysis and estimated P values for different crops:** Performance of sprinkler irrigation system and conventional irrigation system were compared using the cost of cultivation components table-4. It was found that the average yield for groundnut under sprinkler irrigation system was 1746 kg/ac whereas it was 1214 kg/ac under conventional irrigation system. Table-4 showed that increase in yield of 532 kg/ac (30%) was obtained in sprinkler irrigation system. For onion, increase in yield was about 872kg/ac (17%) whereas green gram, green chilli, cabbage yield were increased in around 158Kg/ac (27%), 906 Kg/ac (18%) and 1464Kg/ac (13%) as compared to conventional irrigation system.

The estimated P value of total cost for each crops were greater than 0.05. Thus there was no significant difference between total cost of cultivation under sprinkler irrigation and under conventional method. Estimated P values of gross income, net income and yield for each crop were less than 0.05. It could be inferred that there was significant difference between gross income, net income and yield of sprinkler irrigation and conventional method of irrigation.

## Conclusion

The study indicated that, for all the crops studied, the use of sprinkler irrigation technologies resulted in a significant improvement in gross income, net income and yield, over the conventional methods of irrigation. Net income of groundnut, onion, green gram, green chilli and cabbage were higher than those of the conventional method by 59%, 45%, 47%, 32% and 18% respectively. Percentage of Christiansen's uniformity coefficient and distribution uniformity coefficient for sprinkler irrigation were 94% and 93%, confirming that the overall uniformity of sprinkler irrigation system were in the recommended level. It implies that sprinkler irrigation method is technically feasible in the study area.

Provision of subsidy would encourage the farmers to adopt sprinkler irrigation system for a larger extent of crop cultivation. Further the training on the sprinkler irrigation system usage and the credit facilities to purchase appropriate water pumps could also contribute for the adoption of this technology.

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**Table-4**
**Estimated P values of particular**

| | | Mean | | | Standard deviation | | |
|---|---|---|---|---|---|---|---|
| **Crop** | **Value** | **Sprinkler irrigation** | **% of increase by sprinkler system** | **Conventional irrigation** | **Sprinkler irrigation** | **Conventional irrigation** | **P-value** |
| Ground nut | Total cost (Rs/ac) | 78580 | 4 | 81360 | 4694.4 | 6989.1 | 0.313 |
| | Gross income (Rs/ac) | 171108 | 30 | 118972 | 6777.1 | 7551.6 | 0.000 |
| | Net income (Rs/ac) | 92528 | 59 | 37612 | 9618.0 | 12203.1 | 0.000 |
| | Yield (Kg/ac) | 1746 | 30 | 1214 | 69.2 | 77.1 | 0.000 |
| Onion | Total cost (Rs/ac) | 229420 | 2 | 234920 | 14582.9 | 17783.1 | 0.460 |
| | Gross income (Rs/ac) | 391468 | 17 | 324293 | 11194.9 | 11254.3 | 0.000 |
| | Net income (Rs/ac) | 162048 | 45 | 89373 | 16847.1 | 18907 | 0.000 |
| | Yield (Kg/ac) | 5084 | 17 | 4212 | 145.4 | 146.2 | 0.000 |
| Green gram | Total cost (Rs/ac) | 48880 | 3 | 50210 | 4915 | 7558.1 | 0.648 |
| | Gross income (Rs/ac) | 123966 | 27 | 90312 | 10944.1 | 2289.68 | 0.000 |
| | Net income (Rs/ac) | 75086 | 47 | 40102 | 12937.9 | 7673.58 | 0.000 |
| | Yield (Kg/ac) | 582 | 27 | 424 | 51.4 | 10.75 | 0.000 |
| Green chilly | Total cost (Rs/ac) | 106452 | 9 | 116106 | 8975.65 | 14449.5 | 0.093 |
| | Gross income (Rs/ac) | 323050 | 18 | 264160 | 6713.17 | 7180.8 | 0.000 |
| | Net income (Rs/ac) | 216598 | 32 | 148054 | 6713.17 | 7180.8 | 0.000 |
| | Yield(Kg/ac) | 4970 | 18 | 4064 | 103.28 | 110.5 | 0.000 |
| Cabbage | Total cost (Rs/ac) | 58380 | 8 | 62750 | 2455.85 | 3962.04 | 0.092 |
| | Gross income (Rs/ac) | 326100 | 13 | 282180 | 24116.4 | 10244.2 | 0.000 |
| | Net income (Rs/ac) | 266890 | 18 | 219430 | 25842.5 | 11250.6 | 0.000 |
| | Yield (Kg/ac) | 10870 | 13 | 9406 | 803.9 | 341.5 | 0.000 |

Source: Field survey (2013)