Economic Viability of Sprinkler Irrigation System on Onion (*Allium cepa*) in Vavuniya (A Case Study in Nedunkerny)

T. Suceendra [1]*and A. Nanthakumaran [2]
[1]Department of Biological Science, [2]Faculty of Applied Science, Vavuniya Campus of the University of Jaffna, Kurumankadu, Vavuniya, Sri Lanka

Abstract

Water is a scare resource in Vavuniya district, where majority of the households is depending on agriculture. Improved water management techniques are needed to optimize yields. Objective of the study was to analyze the cost and returns of basin and sprinkler irrigation systems and to quantify the water used under sprinkler irrigation systems and basin irrigation. A questionnaire survey was conducted to collect the data from the randomly selected thirty farm households in basin and sprinkler irrigation systems in Nedunkerny area. Discounted cash flow technique was used to find out the economic viability of investment in sprinkler irrigation. The study showed that the average crop productivity was 4089 kg/ac under basin irrigation whereas it was 5000 kg/ac under sprinkler irrigation. The field water use efficiency for basin irrigation was 1.89kg/m^3 and for sprinkler irrigation, it was 2.89 kg/m^3. Sprinkler irrigation system saved the energy consumption by about 402 kwh/acre compared with basin irrigation. The profit of the onion crop cultivated under sprinkler irrigation was higher by about Rs. 65648/acre than the corresponding profit earned by basin irrigation. Sprinkler irrigation reduced the cost of irrigation by about 20%, cost of labour by 38% and pesticides cost by 31%. Moreover, compared to basin irrigation, sprinkler irrigation saved 45% in fuel and 23% in fertilizer cost. The net present worth, benefit-cost ratio and internal rate of return showed that the investment in sprinkler irrigation was economically viable even without subsidy. Therefore, the area with basin irrigation would be substituted by sprinkler irrigation which would lead to the use of water in an efficient manner.

Key words: Benefit-cost ratio, Discounted cash flow technique, Internal rate of return, Net present worth and Water use efficiency.

Introduction

The increase in population and production, rapid urbanization, industrialization, expansion of services as well as the diversity in agriculture lead to an increase in water consumption. One of the demand management strategies introduced relatively to control water consumption in agriculture is micro irrigation, which includes mainly drip and sprinkler irrigation method, proved to be an efficient method of water saving in irrigated agriculture. Micro irrigation was first experimented in Israel and by now micro irrigation technology is widespread in developed countries. A total area under sprinkler irrigation in the world was about 2158 million hectare by 1990 (INCID, 1998).

Vavuniya is primarily an agricultural district. The average annual rainfall of Vavuniya was about 1400 mm (District profile-Vavuniya, 2004). Normally, rainfall period restricted to 3-4 months in this area. Farmers mainly depend on agro well for their irrigation. On the other hand, rapid and unplanned urbanization in the past 2 to 3 decades had occurred in the Vavuniya district. Groundwater use has exceeded safe limit in most areas of the Vavuniya district (Sivakumar, 2008).This had led to severe shortages in the availability of water for Agriculture. With less water available for irrigation in Vavuniya district, improved water management techniques are needed to optimize yields. As the government of Sri Lanka has invested large sum of money on popularizing this technology, it is important to know the benefits of sprinkler irrigation over basin irrigation. By using that, additional area under basin irrigation would be converted to sprinkler irrigation systems in future. The

**Corresponding author:* sucee.thiru0107@gmail.com

sprinkler system of irrigation being costly and most of the farmers have only limited capital. Thus it is essential to investigate cost and benefits of this method of irrigation. Hence, the objective of the study was to analyze cost and returns on basin and sprinkler irrigation systems.

Materials and Methods

This research was carried out at Nedunkerny located in the Vavuniya district. The list of farmers involved in onion cultivation using basin method of irrigation and the list of farmers involved in onion cultivation using the sprinkler irrigation method were obtained from the Dept. of Agriculture and used as sample frame for this study. A questionnaire survey was conducted to collect the primary data from the randomly selected thirty farmers in each method of irrigation of basin and sprinkler irrigation method in Nedunkerny area. Though the onion cultivation was common using different method of irrigation in Vavuniya district, the Nedunkerny area was intensively cultivating onion using sprinkler as well as basin method of irrigation. Hence this area was selected for the study. The secondary data was collected from Department of Agriculture and Water board and drainage system, Vavuniya.

The quantity of water used for basin irrigated plot was calculated using the following formula.

Amount of water applied → Discharge rate of water pump x Time taken to irrigate one acre of the crop x Total number of irrigation

To validate the data, it was estimated the amount of water used for basin irrigation plot by using following formula also (water application efficiency of 70% was considered for calculation).

Amount of water applied → Area of the basin x Depth of the water level x No of basins x No of irrigation

To calculate the quantity of water used for sprinkler irrigated plot the following formula was used.

Amount of water applied = Sprinkler discharge rate x Irrigation time x No. of irrigation x No. of sprinklers per acre.

Discounted cash flow technique was used to find out the economic viability of investment in sprinkler irrigation. The criteria of net present value (NPV), benefit-cost ratio (BCR), internal rate of return (IRR) were selected to find out the economic viability of investment in sprinkler irrigation in onion cultivation. Equivalent Annualized Cost (EAC) method was used to calculate the amortized cost of the sprinkler system.

Capital recovery factor (CRF) = $(i)(1+i)^n / (1+i)^n - 1$

Annualized capital cost = Capital cost * CRF

EAC= Annualized capital cost+ Annual operation and maintenance cost

Where n: The average life span of sprinkler irrigation equipment, i: Discount rate

Source: Palanisami *et al.*, undated

The t-test was carried out for each parameter by using Minitab software to find out whether there was significant difference between two irrigation methods.

Net Present Value: Future net returns were discounted to their net present value by using the following formula.

$$NPW = \sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+i)^t} \quad \ldots\ldots (1)$$

Benefit cost ratio: The benefit-cost ratio is the ratio between the sum of discounted net benefits of returns and the sum of discounted cost. BCR was calculated by using following equation.

$$BCR = \frac{\sum_{t=1}^{t=n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{t=n} \frac{C_t}{(1+i)^t}} \quad \ldots\ldots (2)$$

Where, Bt = benefit in year t; Ct = cost in year t; t = 1, 2, 3 ....n; n = project life in years; i = rate of interest.

Source: Narayanamoorthy (1997)

Results and Discussion

Performance of sprinkler and basin irrigation system

It was found that the average yield under sprinkler irrigation system was 5000 kg/ac whereas 4089 kg/ac under basin irrigation system. The t-test showed that it was a significant difference in yield between two irrigation methods (p= 0.017). Further it showed that the yield in case of sprinkler irrigation system was 22 % higher as compared to basin irrigation systems. The mean quantity of irrigation water used for sprinkler systems and basin irrigation were 1728 m^3 and 2160 m^3 per acre, respectively (p= 0.000). Water use efficiency 2.89 kg/m^3 was obtained in case of sprinkler irrigation system as compared to 1.89 kg/m^3 for basin irrigation systems. The results indicated the differences in the two irrigation systems. Converting from basin to sprinkler irrigation saved 432 m^3 of irrigation water and increased 911 kg of yield per acre. Because of flooding of water under basin irrigation method, large quantity of water was wasted in the form of evaporation and seepage losses, runoff and thus, the application efficiency was always lower while applying water by basin method (Narayanamoorthy, undated). Thushyanthy and Sivakumar (2008) also identified the same result in Jaffna district for cabbage.

Investment on irrigation system

Cost of cultivation of onion in different irrigation methods were given in Table 1.

The cost of cultivation was different mainly because of variation in per acre fuel cost, labour cost, fertilizer cost and pesticides cost. The initial cost (p= 0.000) and maintenance cost (p= 0.000) were significantly higher for sprinkler irrigation system than basin irrigation system. The total cost of cultivation was higher for basin system than sprinkler. Hence, the farmer earned additional gross income from sprinkler irrigation of

Table 1. Cost of cultivation of onion in different irrigation methods

Items of cost (Rs/ac)	Basin irrigation Cost(Rs)	% of total cost	Sprinkler irrigation Cost(Rs)	% of total cost
Operational/Variable costs				
Seed cost	12850	9	12850	11
Wages of labour	81042	54	49711	42
Fertilizer cost	7940	5	6070	5
Pesticides cost	7500	5	5130	4
Fuel cost	25969	17	14060	12
Total variable cost	135301	91	87821	74
Land rent	140	1	1200	1
Interest on variable capital			1000	1
Annual operation and maintenance cost	1650	1	3933	3
Amortized cost on sprinkler irrigation system			13409	11
Amortized cost of water pump	11738	8	11738	10
Total fixed cost	13528		31280	
Total working cost	148829	100	119101	100
Yield(Kg)	4089		5000	
Gross income	174080		210000	
Net income	25251		90899	

The average selling price of onion was considered as Rs 42 per kg
Source: Survey, 2012

Rs. 35920/ac. Thus, an average net return per acre from sprinkler irrigation was found to be 72 percent higher than basin irrigation.

The results showed the fuel requirement for sprinkler was 144 litres per acre whereas for basin 237 litres per acre. Sprinkler irrigation saved a substantial amount of water leading to less working hours of pump sets that ultimately reduced the requirement of fuels. The energy consumption was computed as given below: One HP pump sets runs for one hour consumes 0.746 kwh of energy. Accordingly,

Energy consumption (kwh/acre) = (HP of pump)* (0.746 kwh) *(Number of hours per irrigation)*(No of irrigation) (Palanisami *et al.*, ,undated)

The consumption of energy under sprinkler irrigation was only about 134 kwh/acre whereas 537kwh/acre under basin irrigation. The saving of energy was 402 kwh/acre. The fertilizer cost (p=0.015) and pesticides cost (p=0.013) were significantly lower for sprinkler irrigation system than basin irrigation system. Further the results showed that labour requirement, weeding and ploughing costs for sprinkler irrigation were relatively low compared to basin irrigation (Table 1)

Financial viability of sprinkler and basin irrigation systems

At 12 % discount rate, the net present worth of benefit was Rs 80505 for basin. The Benefit Cost ratio for the basin irrigation was 1.14. The internal rate of return of basin irrigation system was found at a low rate of 14 percent. The NPW of sprinkler investment was about Rs. 239408.00/ac without subsidy and Rs. 302651.00 /ac with subsidy. This means that the subsidy enables the farmers to get an additional benefit of Rs. 63243.00/ac. The BCR was 1.46 without considering subsidy. The same increased to 1.66 when subsidy was included. Relatively higher BCR realized with subsidy indicated the vital role of subsidy in enhancing the economic viability of sprinkler irrigation. Internal rate of return was about 18% without subsidy and 21% with subsidy. Since, NPW was positive, BCR was greater than one, IRR was greater than the opportunity cost of capital (interest rate of 12 percent), the installation of sprinkler irrigation system for the onion crop was financially feasible even without subsidy.

Returns per unit of water and energy

The yields per unit volume of water were worked out to 2.89kg/m^3 for sprinkler and it was 1.89kg /m^3 for basin. It was found that the return under sprinkler irrigation system was Rs 210000.00/ac whereas Rs 174080.00/ac under basin irrigation system (p=0.000).So the returns per unit volume of water were worked out to Rs121/m^3 for sprinkler and it was Rs 80 /m^3 for basin. From the analysis of cost and return for the onion cultivation, the sprinkler method of irrigation produced higher returns when compared to conventional basin irrigation methods. Thus, the farmer could go for installation of sprinkler methods of irrigation on their fields as it saved human labour and water and helps to increase returns. This study confirmed that sprinkler irrigation could be adopted to Vavuniya district which comes under Northern dry zone.

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