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COMPARISON OF DRIP AND SPRINKLER IRRIGATION SYSTEM FOR THE CULTIVATION PLANTS VERTICALLY

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ABSTRACT

Growing vegetables for own consumption in a household contributed to people living in the city could be more self-reliant in food factors. Studies in many countries have shown that urban farming could help bring food security, poverty reduction and promote a healthy mind and body healthy as well. This research study aims to evaluate the approach to drip and sprinkler irrigation of crops that were of cultivated plants vertically and relationship of water usage of both systems to yield per planted area. The vertical area was constructed that the fields were 4 floors in condo form to save space. On each floor cultivation was up to 10 square meters, it was divided into two parts which used different types of watering plants i.e. drip irrigation system and sprinkler irrigation system. Sprinkler irrigation system has been watering using the amount of water as the program. The drip irrigation system reduced the water consumption to 50%. The drip irrigation system has major advantages that were watering high efficiency, use less water pressure, high yield, saving water. It provides higher crop yields when compared to the sprinkler irrigation system to the same of planting areas and quantity of water. The drip irrigation system could provide better performance than the sprinkler irrigation system. The drip irrigation was analyzed of economic value showed that PI values has greater than 1.0 and less than 2 year of payback period on the assessment of risk and depreciation for one year. The results also showed the analysis of IRR was 23.28% in the first year. This project was a worthwhile investment.

Keywords: irrigation, spray, drip, sprinkler.

INTRODUCTION

Development of country, from agricultural society to industrial society, has caused many changes in the economic, social, cultural and environmental during the past several decades. Especially in the consumer lifestyle and values of the people of turned to reliance on the market alone. The community lack the skills to self-reliance in the production of food for own consumption in a household and the environmental problems of community that was semi urban and agricultural. Problems were mainly caused from the community lacked of awareness and farmers rely on chemical fertilizers in cultivation alone. Chemical fertilizers caused the problems of soil degradation. The effluent of communities was discharged into rivers and canals that cause of wastewater problems. Electrical energy consumption and oil for the crop caused climate change. Growing vegetables for own consumption in a household contributed to people living in the city could be more self-reliant in food factors. Studies in many countries have shown that urban farming could help bring food security, poverty reduction and promote a healthy mind and body healthy as well. Growing vegetables was also important activities that help build a good relationship to happen in the city (Prayong, 2012).

This research study aims to evaluate the approach to drip and sprinkler irrigation of crops that were of cultivated plants vertically and relationship of water usage of both systems to yield per planted area. This study collected the opinions of people in the community and was developed to practice in the area. Planting of this study did not use chemical fertilizers, but used water from the fish pond that were fed with chicken feces to reduce costs and clean energy from the wind turbine that was also used to pump water without the oil or electric to support the reduce global warming.

Water is very important for growing crops. There are several methods used for watering plants, each method has different advantages and disadvantages. Determining a plant watering system to suit the needs of users was difficult because there were several factors that must be considered together. Watering system that prevalence is currently such as drip, micro sprinkler, and spray. Results from each model were appropriate to varies depending on the type of the crop, cultivation, environment, investment, and the amount of water plants need. Spray irrigation had some of the advantages and some of the disadvantages of each type of irrigation. Like drip irrigation, Spray irrigation was considered a type of low-pressure irrigation and it was also generally considered low volume. Spray irrigation was delivered through tube system to a series of nozzles attached to risers. These risers may be fixed or designed to up feed or down feed as shown in Figure-1. Watering system, such as a crank or push to use more water, which was popular in the South or East of Thailand. It did not need a water filtration system because the pore of outlet had very large. This system was available in the source of planting that has abundance of water. But if the water was limited conditions or area of cultivation has drought. Need to adapt the way a modern watering by increasing investment.

Figure-1. Sprinkler irrigation and drop sprinkler
Source: http://en.wikipedia.org en.wikipedia.

A drip irrigation system is watered the plants at the root zone of plants. It would drip water slowly into the soil in a low rate. A drip irrigation system provided fertilizer to the water through a network of valves, pipes, tubing, and emitters. It was done through narrow tubes that deliver water directly to the base of the plant as shown in Figure-2. Due to water hole was very small, so often clogged easily. Installation of this system must take into account a good filtration system. This watering system was designed specifically for areas with drought. A drip irrigation system uses less space. It would enable farmers to grow crops on household consumption throughout the year.

Figure-2. Drip irrigation and dropper
Source: http://en.wikipedia.org en.wikipedia.

Basic principles of plant growth, each plant needs six factors in different characteristics. Six factors that contribute to plant growth and yield were light with moderate intensity, the optimum temperature for each plant, Nutrients needed, water, Air for respiration and source of nutrients, and soil that was adhesion of the root system and a collection of various nutrients.

Data were referenced by the Office of Agriculture Nakhon Ratchasima province, Thailand found that the productivity of the traditional growing crops of the farmers in Nakhon Ratchasima province was shown in Table-1.

Table-1. The productivity of the traditional growing crops.

Type of plants	**Productivity** (kg./m^2)
Rice	0.284
Green beans	0.133
Soybean	0.163
Peanut	0.238
Kale	0.750
Chinese Cabbage	0.750
Lettuce	0.625

Investment analysis was the planning of value-adding, long-term corporate financial projects relating to investments funded through and affecting the project of capital structure Campbell and Stephen (1997). This project used payback period, B/C ratio and IRR were index for the feasibility study.

The internal rate of return, IRR, of a project was the rate of return which equates the net present value of the projects cash flows to zero; or equivalently the rate of return which equates the present value of inflows to the present value of cash outflows. The internal rate of return (IRR) solves the following equation:

$$\sum_{t=1}^{n} \frac{X_t}{(1+IRR)^t} - I = 0 \quad (1)$$

In determining whether to accept or reject a particular project, the IRR decision rule is

- Accept a project if IRR > r_p
- Reject a project if IRR< r_p
- Indifferent if IRR = r_p
- For mutually exclusive projects accept the project with highest IRR if IRR > r_p

where r_p is the required return on the project.

Payback Period was the period of time required for the return on an investment to "repay" the sum of the original investment. Payback period intuitively measures how long something takes to "pay for itself." All else being equal, shorter payback periods are preferable to longer payback periods. To calculate a more exact payback period (Williams, *et al*., 2012):

$$\text{Payback Period} = \text{Amount to be Invested}/\text{Annual Net Cash Flow} \quad (2)$$

Campbell and Stephen (1997) according to apply the payback period criterion, it is necessary for management to establish a maximum acceptable payback value PP*. In practice, PP* is usually between 2 and 4 years. In determining whether to accept or reject a particular project, the payback period decision rule is:

- Accept if PP < PP*
- Reject if PP > PP*
- Indifferent where PP = PP*
- For mutually exclusive alternatives accept the project with the lowest PP if PP<PP*

The profitability index, was used when projects had only a limited supply of capital with which to invest in positive NPV projects. This type of problem is referred to as a capital rationing problem. Given that the objective is to maximize shareholder wealth, the objective in the capital rationing problem is to identify that subset of projects that collectively have the highest aggregate net present value. To assist in that evaluation, this method

requires that we compute each projects profitability index PI.

$$PI = \frac{NPV}{I} \quad (3)$$

Then rank the projects PI from highest to lowest, and then select from the top of the list until the capital budget is exhausted. The idea behind the profitability index method was that this would provide the subset of projects that maximize the aggregate net present value (Campbell and Stephen, 1997).

MATERIALS AND METHODS

This research was conducted at community that was a semi-urban, semi-agricultural. Location of study area was located on an area of approximately 400m^2 that was adjacent canal in Soi 30 kunya, bankoh subdistrict, muang district, Nakhon Ratchasima province, Thailand as shown in Figure-3. Sandy clay soil was used for cultivation. Weather in each day, it was a factor that makes plant grows. This research was studied in areas with the relative humidity 68.78±4.90 (%), air pressure 1012.79±1.63 (NPA), maximum temperatures 34.82±3.44 (°C), minimum temperatures 24.06±2.53 (°C), time with the sun 4.71±0.02 (hour), accumulation rain 2.85±0.77 (mm.) and wind 24.71±6.97 (km /hour).

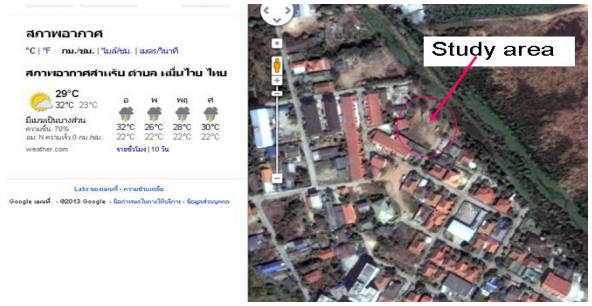

Figure-3. Study area was in Muang, Nakhon Ratchasima, Thailand. Source: https://maps.google.co.th/maps.

The researcher calculated the area of the cultivation to enough with one family that have three people. Determine what kinds of crop grown that need to the nutrients a full five groups. And created the fields were 4 floors in condo form to save space. On each floor did cultivation up to 10 square meters, it was divided into two parts which used different types of watering plants which were drip irrigation system and sprinkler irrigation system. This study was cultivating plants in each of floor as the following: the first floor was cultivated the three types of beans that were green beans, soybeans and peanuts, the second floor was cultivated the lettuce, the third floor was cultivated the Chinese cabbage and the last floor was cultivated the kale. Comparison of watering to the two systems that were sprinkler and drip irrigation was shown in Figure-4.

Figure-4. The positions were used to size measurement.

Sprinkler irrigation system has been watering using the amount of water as the program. The drip irrigation system reduced the water consumption to 50%. Evaluate the effectiveness of watering system, measured plant height, stem size of plants and weight of plants harvested as shown in Figure-5. It has data collection to total costs includes fixed costs and variable costs. It also collected data to revenue from the sale of agricultural produce to people in the community and the market that was near the project. The results of economic analysis were assessed the possibility for an extension to the community with a payback period, IRR and PI.

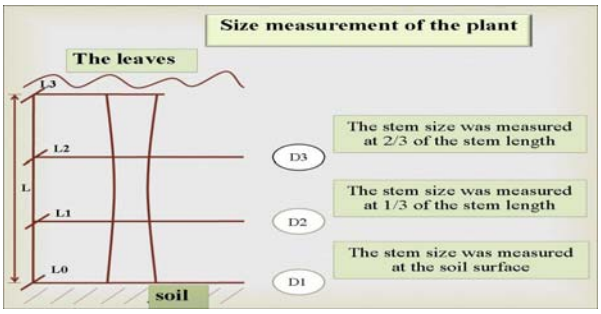

Figure-5. The positions were used to size measurement (Prayong, *et al*., 2012).

RESULTS AND DISCUSSIONS

Yields (kg) of planting per unit of area (m^2) and the amount of water used watering (liter)

The study shows planting in the vertical space on 10 square meters per floor of condo area that has the number four floors. The planting in vertically could save space in the horizontal crop. Drip and sprinkler irrigation system were not significantly different to the growth of all plants studied both the size and height of the stem of the plant. Comparison of yields of planting per unit of area with the amount of water used watering that was main factor. The productivity of normal irrigation was analyzed from agriculture of Nakhon Ratchasima province, Thailand. The results of study showed the relation of planting in productivity per area per water using unit as shown following and in Figure-6.

$$\frac{vegetable \quad production(kg)}{area(m^2) \quad \times \quad water \quad usin g(liter)} \quad (4)$$

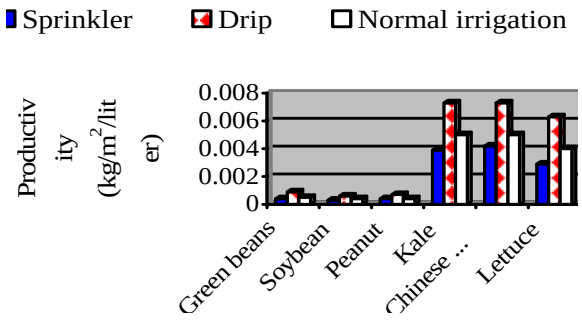

Figure-6. Yields (kg) of planting per unit of area (m^2) and water using (liter) in the vertical space.

The result also showed yields and the water using for planting in the vertical space with sprinkler and drip irrigation were in Table-2 and Table-3. Productivity of planting both sprinkler and drip irrigation were less than planting normal irrigation. Because of the planting with normal irrigation used of chemical fertilizers and was usually planted in the plains. But this cropping was planted in the condo where the plants receive sunlight was not perfect. The condo received the sunlight in just a short time during the morning and afternoon when the sun shines diagonally into condos only. While vertical cropping of this study did not use chemical fertilizers, but used wastewater of fish pond instead fertilizers that fish was fed with chicken manure. It made plants were not completely received nutrients equivalent the cropping used fertilizer directly. The advantage was that it had not chemical residues in crops and vegetables were grown. This study could be used as an alternative cropping for urban communities and it also reduces the cost of cropping. Table-3 showed the water using for planting per unit of area per productivity. Which it can utilized in the preparation of water or water management to meet the desired yield of planting.

Table-2. Yields (kg) of planting per unit of area (m^2) in the vertical space.

Vegetables	Productivity per area $\left(kg/m^2\right)$	
	Sprinkler irrigation	**Drip irrigation**
Green beans	0.10	0.11
Soybean	0.12	0.13
Peanut	0.17	0.20
Kale	0.60	0.70
Chinese Cabbage	0.65	0.70
Lettuce	0.45	0.65

Table-3. The water using for planting in the vertical space with sprinkler and drip irrigation.

Vegetables	The water using per productivity per area $\left(liter/kg. \cdot m^2\right)$		
	Sprinkler irrigation	**Drip irrigation**	**Normal irrigation***
Green beans	2360.00	1075.91	1786.41
Soybean	3611.67	1669.23	2667.07
Peanut	3264.68	1387.24	2336.40
Kale	255.00	137.14	204.80
Chinese Cabbage	235.38	137.14	204.80
Lettuce	341.33	160.00	245.76

Note:* The productivity of normal irrigation was analyzed from agriculture of Nakhon Ratchasima province, Thailand.

Comparison of the advantages and disadvantages between the drip irrigation system and the sprinkler irrigation system found that the drip irrigation system has major advantages that were watering high efficiency, use less water pressure, high yield, saving water, labor and time in the watering. It provides higher crop yields when compared to the sprinkler irrigation system to the same of planting areas and quantity of water. Plants received regularly water on specific at roots. By the drops of water related of crop root radius. Applications need to be maintained as a matter of clogging. The drip irrigation system is available with a variety of plants and soil to all areas in Thailand. Figure-7 and Figure-8 showed the rate of water using for planting in the vertical space with sprinkler irrigation and drip irrigation, respectively.

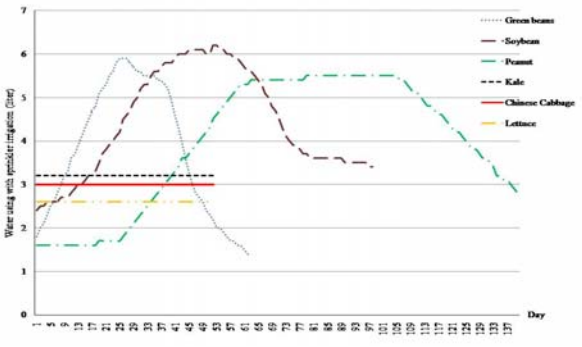

Figure-7. The water using for planting in the vertical space with sprinkler irrigation.

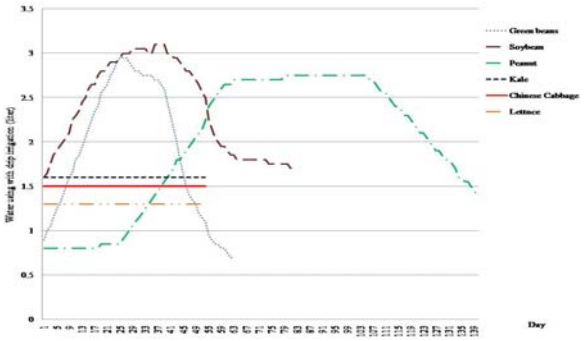

Figure-8. The water using for planting in the vertical space with drip irrigation.

Economic value of the crop in vertical with the drip irrigation system

The study of the quantity of water used to cultivate and harvest from planted by the drip and sprinkler system. The result showed the water using in drip irrigation system has the highest yield per volume as equal water. So the drip irrigation was analyzed of economic value. The data collection relating to revenues and expenses in order to calculated the payback period, PI, and IRR as shown in Table-4. The results of this study showed PI values has greater than 1.0 and less than 2 year of payback period on the assessment of risk and depreciation for one year. The results also showed the analysis of IRR was 23.28% in the first year. If interest rate on bank loans was 18.00%, the margins between the IRR on first year with the interest rates on bank loan was 5.28%. Therefore, this project was a worthwhile investment.

Table-4. Analysis of payback period and profitability index.

Fixed costs (Baht)	**Variable costs** (Baht/kg)	**Total costs** (Baht)	**Revenue** (Baht/year)	**PI**	**Payback period** (year)
1,000	1,500	2,500	7,710	3.08	0.32

Note: Depreciated in one year

CONCLUSIONS

The drip irrigation system has major advantages that were watering high efficiency, use less water pressure, high yield, saving water. It provides higher crop yields when compared to the sprinkler irrigation system to the same of planting areas and quantity of water. The drip irrigation system could provide better performance than the sprinkler irrigation system.

The drip irrigation was analyzed of economic value showed that PI values has greater than 1.0 and less than 2 year of payback period on the assessment of risk and depreciation for one year. The results also showed the analysis of IRR was 23.28% in the first year. This project was a worthwhile investment.

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