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THE APPLICATION OF ENVIRONMENTAL ENGINEERING SYSTEM FOR CROPS AND LIVESTOCKS

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ABSTRACT

The study was the relationship of the size of the wind turbine blades (A) to the rate of pumping (Q) from shallow wells or water tank and the relationship of wind speed (v) to the rate of pumping (Q) from shallow wells or water tank. This model of waste recovery was application engineering system that applied to crops and livestock in vertical integration to reduce the horizontal land and the vertical wind turbine pumped water that it was done from plastic bin. The type of crop and animal farming must be completed by the fully of the five food groups. The model was implemented with animal farming of vertical integration by to build chicken coops on Tilapia and catfish ponds to be used like chicken manure and vegetable waste was food of Tilapia fishes and Catfishes. Fish types were durable and could coexist in a natural separation. The plants were grown as Kale, Rice, Chinese cabbages, Lettuce, Morning glory, Soybeans, Green beans, Peanuts. The results showed the relationship of A (m^2) and Q (m^3/s) that the rate of pumping of vertical axis wind turbine was proportional to the size of the wind turbine blades as the equation was Q = 0.1152 (A) - 0.0555 with R^2 = 0.798 at the lowest average wind speed was 2.17 m/s and suction lift was 0.20 m. The result also showed the relationship of v (m/s) and Q (m^3/s) that the increasing of wind speed was proportional to the increasing of the rate of pumping as the equation was Q = 0.337 (v) - 0.3865 with R^2 = 0.89 at the wind turbine blades was 3.58 m^2 and suction lift was 0.20 m. The result also showed the maximum pumping rate of the vertical axis wind turbine was 0.561 m^3/s at the wind speed was 2.893 m/s, the minimum of suction lift was 0.20 m, and the maximum size of the wind turbine blades was 3.580 m^2. Results obtained from this model for economic problem solving was 178, 080.00 baht/year of total of revenue from sale of vegetables and livestock products. Total profit was 69, 439.00 baht/year. Compared with traditional horizontal monoculture farming, this program could horizontal land saving, the water pipe saving, electricity saving, water saving, animal feed saving, fertilizer saving, and saving to the expenses of the family was 160, 700.00 baht/year. Also results obtained from this model were 50.64% of IRR, 1.51 of B/C ratio, and 0.66 year of payback period.

Keywords: Environmental Engineering, crops, livestock, vertically integrated farming, vertical wind turbine.

INTRODUCTION

Deterioration in the quality and quantity of the environment was caused by human activities. Environmental problems have two aspects; the reduction of natural resources and degradation of environmental quality from the activities of human. Pollutions caused by human action were in air, water, and soil. Air pollution and the global climate change have caused by combustion, energy-using and fuel consumption (IPCC, 2001). Water in the rivers was more polluted. Water pollution was due to chemical, fertilizer and animal waste that human dumped them into canal and rivers. Soil pollution caused by animal manure, fertilizer, chemicals, garbage and waste. Livestock productions and agriculture have emitted some greenhouse gases from fertilization, feed production, transportation, and energy use in housing, respiration and digestion of livestock (Prayong, *et al*., 2013). Thailand is interested in developing renewable energy. Wind energy is a renewable energy, clean energy and haven't impact on the environment. Wind energy can be used to produce renewable energy to electrical energy. Production of wind energy is cheaper than the cost of electricity from solar energy. Wind turbine technology is one of the factors in clean energy that are important and should be studied. The productive processes should release the least greenhouse gases to avoid such problems and save the earth (Thanee, *et al*., 2009). The growth rates of human population drivers the demand of livestock production and agriculture. Livestock and agriculture meet a variety of food needs for people (Thornton, *et al*., 2009). They are important nutrient sources of carbohydrates, proteins, fats, vitamins, and minerals in the form of rice, meat, eggs, oil, and vegetable processed products (Lauhajinda, 2006).

The study shows the relationship between the size of the wind turbine, the wind velocity, and the rate of pumping water. To be able to use wind power as a renewable energy that was appropriate for wind speeds in the area for the management of water resources in agricultural areas. And evaluate ways to reduce household expenditure by anaerobic wastewater treatment from the fish pond to fill it back into the pond for reducing the cost of water. And wastewater would be used instead of chemical fertilizer for growing vegetables. The anaerobic wastewater treatment processes created biogas that was used to trap lighting for fish and chicken feeding.

METHODOLOGY

Model development was a condo cropping and livestock farming in vertical integration to reduce the horizontal land by application of engineering systems. This model of development was application engineering system that applied to crops and livestock in vertical integration. This model was used to create food for 3-5 people in one family only. The rest of eating the

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vegetables, meat and eggs would be sold to generate income for the family. The type of crop and animal farming must be completed by the fully of five food groups as shown in Figure-1. The model was implemented with animal farming of vertical integration to build chicken coops on tilapia and catfish ponds to be used like chicken manure and vegetable waste was food of Tilapia fishes and Catfishes as shown in Figure-2.

Figure-1. The condo cropping must be completed by the fully of the five food groups.

Figure-2. The Condo livestock farming in vertical integration were floor 4 as layer, floor 3 as boiler, floor 2 as tilapia fishes, and floor 1 as catfishes.

Fish types were durable and could coexist in a natural separation. The plants were grown as Kale, Rice, Chinese cabbages, Lettuce, Morning glory, Soybeans, Green beans, Peanuts. This model was also management control of environmental problems to a minimum. The engineering systems were using wind power, which was free of charge, renewable electricity and oil. The vertical wind turbine was pumping water that was done from plastic bin. As well as anaerobic wastewater treatment from the fish pond to fill it back into the pond for reducing the cost of water. And wastewater would be used instead of chemical fertilizer for growing vegetables. Biogas was a by-product of wastewater treatment processes were used to light the lamp to lure insects into traps for feeding to fishes and chickens as shown in Figure-3. The amount of crop and animal farming was considered to sufficient consumption for reducing the cost of living. The rest of the food for living was sold within the community to increase revenue.

Figure-3. The engineering systems were the drip irrigation systems and water spray, the vertical wind turbine was pumping water, and wastewater treatment processes.

Study area

The research area was located in the Techno village, meaunwai-bankoh subdistrict, muang district, Nakhon Ratchasima province. The total areas of meaunwai-bankoh subdistrict were 6, 254 rai. The land was divided was 2, 562 rai of residential, farming 2,056 rai, business or commercial 870 rai, education 82 rai, religious place 40 rai, government places 12 rai, the public places 23 rai, water 45 rai, and etc. 564 rai. Number of households and population was 9, 865 households and 21, 148 mans, respectively.

Equipment used in operations research

Type of wind turbine used in this study was a type of vertical axis wind turbines and installed as shown in Figures-4.

Figure-4. The vertical axis wind turbine was adjusted the number of blades.

The vertical axis wind turbines were made from plastic bins that have been discarded. Plastic bins would be split in half and were used into the blades of wind turbines. The water piston made of PVC pipe at various suction lifts. The axis of wind turbines and the water piston were connected to the gear pump used for water pumping.

The study was the relationship of the size of the wind turbine blades (A) to the rate of pumping (Q) from shallow wells or water tank. The research was conducted by changing the size of the wind turbine blade. The size of the wind turbine blades increasing were A1 = 0.895 m^2, A2 = 1.790 m^2, A3 = 2.685 m^2, and A4 = 3.580 m^2, respectively. The study was the relationship of wind speed (v) to the rate of pumping (Q) from shallow wells or water tank. The wind speed was measured using Anemometer. In addition, the study also was the relationship of suction lifts of the piston (h) and the rate of pumping (Q) that the range of piston pumps decreasing were h4 = 0.85 m., h3 = 0.60 m., h2 = 0.45 m., h1 = 0.20 m., respectively. The numbers of agricultural areas and animals in project were calculated by determining for each meal to the family at 3-5 people, the yield per unit and cycle of crop and livestock farming (Cavana, *et al*., 2001, Yamane, 1973; Department of Livestock Development, 2005, and Center for Agricultural Information, 2004). The sampling numbers were 15 hens, 65 broilers, 1250 tilapia fishes, 1250 catfishes, 192 m^2 rice areas, and 41 m^2 vegetable areas. The size of the engineering systems to support for the crop and animal farming as 1880 liters of the wastewater treatment plant at 1 hydraulics retention times (HRT) (Prayong, 2012). The flow rate of water from the vertical wind turbine and machinery was pumped water and drip irrigation systems and water spray was 0.5 liters per second.

RESULTS AND DISCUSSIONS

Results obtained the relationship of A (m^2) and Q (m^3/s) that the size of the wind turbine blades increasing were A1 = 0.895 m^2, A2 = 1.790 m^2, A3 = 2.685 m^2, and A4 = 3.580 m^2, respectively. The rate of pumping of vertical axis wind turbine was proportional to the size of the wind turbine blades as the equation were Q = 0.1152 (A) - 0.0555 with R^2 = 0.7983, Q = 0.0621 (A) - 0.06 with R^2 = 0.9957, Q = 0.0878 (A) - 0.114 with R^2 = 0.8785, and Q = 0.0306 (A) - 0.0395 with R^2 = 0.8841 at the average wind speed was 2.170 m/s and suction lift were 0.20 m, 0.45 m, 0.60 m, and 0.85 m, respectively as shown in Figure-5.

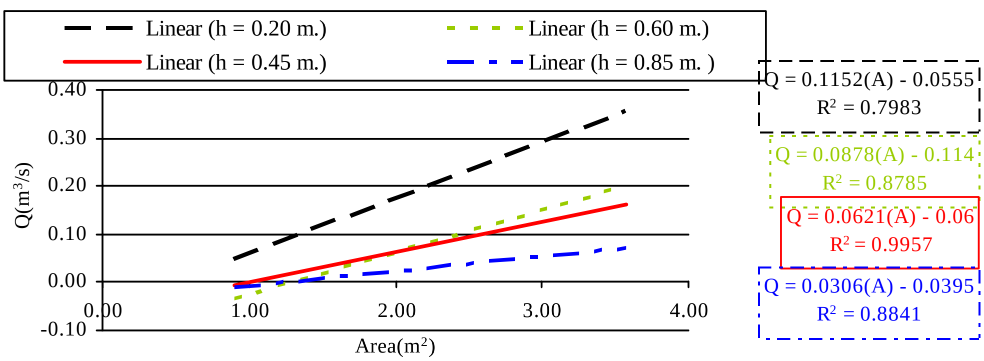

Figure-5. The relationship of the size of the wind turbine blades (A) to the rate of pumping (Q) in various suction lifts at the wind speed was 2.170 m/s.

The result also showed the relationship of v (m/s) and Q (m^3/s) that the increasing of wind speed was proportional to the increasing of the rate of pumping as the equation were Q = 0.337 (v) - 0.3865 with R^2 = 0.89, Q = 0.2028 (v) - 0.1025 with R^2 = 0.99, Q = 0.3095 (v) – 0.5867 with R^2 = 0.998, and Q = 0.1851 (v) - 0.3451 with R^2 = 0.94 at the size of wind turbine blades were 3.58 m^2, 2.685 m^2, 1.79 m^2, and 0.895 m^2, respectively at minimum of suction lift was 0.20 m as shown in Figure-6.

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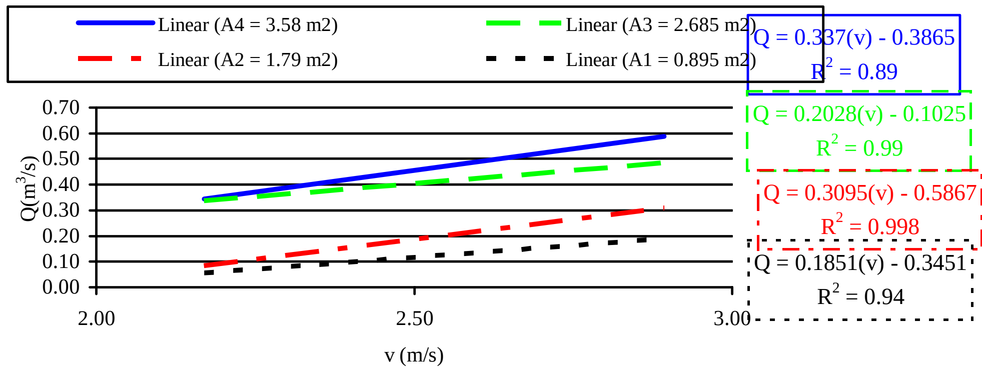

Figure-6. The relationship of wind speed (v) to the rate of pumping (Q) in various sizes of the wind turbine blades at the minimum of suction lift was 0.20 m.

The relationship of h (m) and Q (m^3/s) that the size of the wind turbine blades increasing were A1 = 0.895 m^2, A2 = 1.790 m^2, A3 = 2.685 m^2, and A4 = 3.580 m^2, respectively. The rate of pumping of vertical axis wind turbine was inversely proportional to the suction lift but was proportional to the increasing of the size of the wind turbine blades as the equation were Q = -0.5273 (h) + 0.6601 with R^2 = 0.949, Q = -0.6552 (h) + 0.5987 with R^2 = 0.8685, Q = -0.4917 (h) + 0.3686 with R^2 = 0.8545, and Q = -0.3088 (h) + 0.2236 with R^2 = 0.7771 at the average wind speed was 2.893 m/s and suction lift were 0.20 m, 0.45 m, 0.60 m, and 0.85 m, respectively as shown in Figure-7.

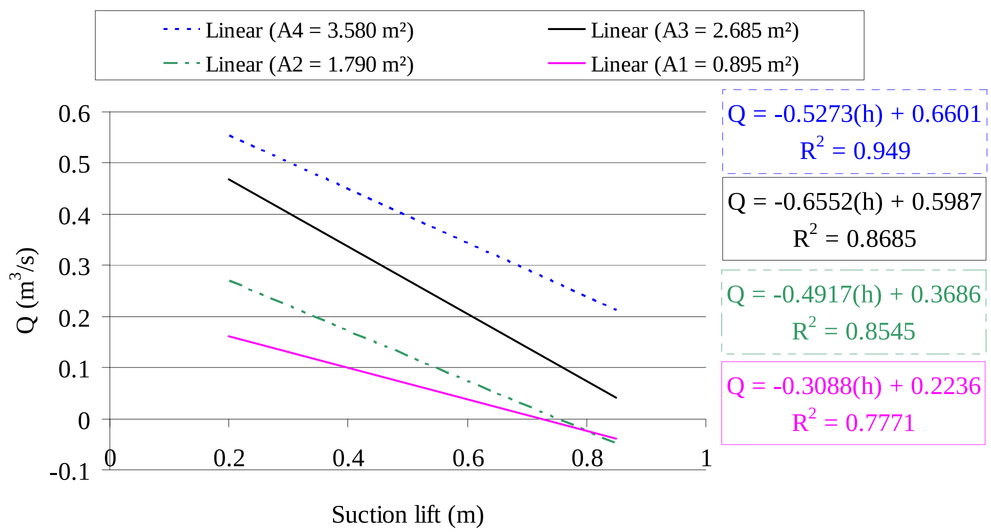

Figure-7. The relationship of suction lift (h) to the rate of pumping (Q) in various sizes of the wind turbine blades at the wind speed was 2.893 m/s.

The study were the relationship of the rate of pumping (Q), wind speed (v), the size of the wind turbine blades (A), and suction lifts of the piston (h). The results showed the rate of pumping of vertical axis wind turbine was proportional to the size of the wind turbine blades, and wind speed. The result also showed the rate of pumping of a vertical axis wind turbine was inversely proportional to the distance of the piston pumping or suction lift.

This model of development was application engineering system that applied to crops and livestock in vertical integration as shown in Table-1. Compared with traditional horizontal monoculture farming, this program could horizontal land saving, the water pipe saving, electricity saving, water saving, animal feed saving, fertilizer saving, and saving to the expenses of the family were 160, 700.00 baht/year as shown in Table-2. Table-3 showed the economic indicators that show the success of this project were profit, IRR, B/C ratio, and payback period from the crop and livestock farming vertically.

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Table-1. Revenue from sale of vegetables and livestock products.

Vegetables and livestock products	Baht/year	Total of revenue from the sale
Kale	4, 500.00	**22, 080.00**
Rice	4, 500.00	
Chinese cabbages	2, 160.00	
Lettuce	2, 100.00	
Morning glory	1, 800.00	
Soybeans	2, 700.00	
Green beans	2, 250.00	
Peanuts	2, 070.00	
Eggs	20, 000.00	**156, 000.00**
Chicken retires	900.00	
Boilers	35, 100.00	
Catfishes	50, 000.00	
Tilapia fishes	50, 000.00	
Total revenue	**178,080.00**	

Table-2. Reducing expenses from the project model.

Reducing expenses from the crop and livestock farming vertically	Baht/year
Horizontal land saving was 0.5 rai (50%)	- 25, 000.00*
Saving electricity and oil	- 3, 600.00
Water saving used for fish farming	- 3, 000.00
Animal feed saving used for fish and chicken farming	- 4, 200.00
The fertilizers saving used to grow vegetables	- 10, 900.00
The horizontal plumbing saving or irrigation system saving used to grow vegetables	- 6, 000.00
The livelihood of the family	- 108, 000.00
Total reducing expenses	**- 160, 700.00**

Note: * The rent for the land per rai = 50, 000.00 Baht/year

Table-3. Comparison of economy index from the project model.

Economy index	Livestock and crop farming
Profit (Baht/year)	69, 439.00
IRR	50.64%
B/C Ratio	1.51
Payback period (year)	0.66

CONCLUSIONS

The study were the relationship of the rate of pumping (Q), wind speed (v), the size of the wind turbine blades (A), and suction lifts of the piston (h). The results showed the rate of pumping of vertical axis wind turbine was proportional to the size of the wind turbine blades, and wind speed. The result also showed the rate of pumping of a vertical axis wind turbine was inversely proportional to the distance of the piston pumping or suction lift. Wind energy could be used to pump water for agriculture by using the vertical axis wind turbine. However, when the demand for water in large quantities. Wind turbine pump was not enough to meet the demand because it depends on the wind speed. This problem could solve by increasing the number of wind turbines to meet the water demand.

Results obtained from this model for economic problem solving were 178, 080.00 baht/year of total of revenue from sale of vegetables and livestock products, 69,439.00 baht/year of total of profit. Compared with traditional horizontal monoculture farming, this program could save horizontal land, the water pipe, electricity, water, animals feed, fertilizer, and the expenses of the family was 160, 700.00 baht/year. Also results obtained from this model were 50.64% of IRR, 1.51 of B/C ratio, 0.66 year of payback period.

The model could reduce water pollution by the water treatment plant and soil pollution by fish farming with chicken manure. The model also could reduced air pollution, global warming and garbage as plastic bin and fagot by took it to do the vertical wind turbine and machinery for pumping water and took the biogas from the wastewater treatment system was exploited.

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