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Wind Power for Irrigation Water Pump a Case study in Gedangan village

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Abstract- Water is a vital thing for the rice field. Field will never able to produce rice without sufficient water. Some methods are used to irrigate rice field, among others by using water pump, the method that also have been used in Gedangan village, Distric of Rembang, Nothern-East of Central Java Province. Based on data issued by Institute for Environment and Agricultural Research in 2010, the annual wind speed in the agricultural area of Gedangan village, minimum is 2.3 m/s and maximum is 9.2 m/s. This paper reported the study of using the prevailing wind speed to power the water pump for rice field irrigation purpose in Gedangan village. The combination between design and experimental were used in this study. In the experimental works were found that independent variable, such as wind speed and the revolution speed of the windmill, and dependent variable, such as amount of water flow out from the pump, have a relationship. The results show that wind power, with the above prevailing wind speed, only possible to power the water pump to irrigate the small-area of rice field.

***Keywords*:** rice field, wind, speed, water, irrigation

1. Introduction

Water is a vital thing for human life, not only for drinking and cleaning, but also for irrigation purpose which enable rice, vegetable, plants are growing well. In Gedangan village of Rembang District Northern-East of Central Java Province, water is abundance in the rainy season, but in the contrary in the dry season, water is hard to find, drought disaster occured. The drought usually coming when the second of cropping were begun, and often cause the corp fail. In the drought season, farmers in Gedangan village have to made every endevor to get water to make the their farm success.

To get water for irrigation purpose, farmers in Gedangan village usually take from Setro's reservoir. Setro's reservoir were constructed in 1970 for drinking water purpose of Rembang District. However, in line with the population growth, Setro's water reservoir were not used anymore for the dringking water resources, since the capacity was not sufficient enough. To obtain a lot volume of, in the year 2005 the Goverment reconstruct Setro's reservoir. Reconstruction of reservoir make the area become of around 10 hectares and have deep of water about 6 meters, or have capacity about 60.000 cum, the capacity which be able to take care of irrigation purpose for farmers surrounding.

Nevertheless, the elevation of the surface water of the reservoir lower than the elevation of rice field level, so that farmers need water pump to be able to hoist the water to the fields.

Those condition was inconvenience and hurt for farmers, since they have to spend more money to rent water pump and for fuel expences. Therefore, it requires a solution in order the farmers not suffer a loss in getting water to irrigate their fields.

Based on the applied and efficient technology, there some types of water pump which are not use engine that consume fuel, but use wind or solar energy, so that can reduce the cost. According to the Institute for Environment and Agricultural Research (2010), the average wind speed in the area of Gedangan village mininimum is 2.3 m/s, nad maximum is 9.2 m/s. This wind speed is enable to use as energy of water pump. For that reason, required to make a model of windmill which can be used as a power of water pump. The model of windmill must be simple and applicable, so that the farmers can make it by themself.

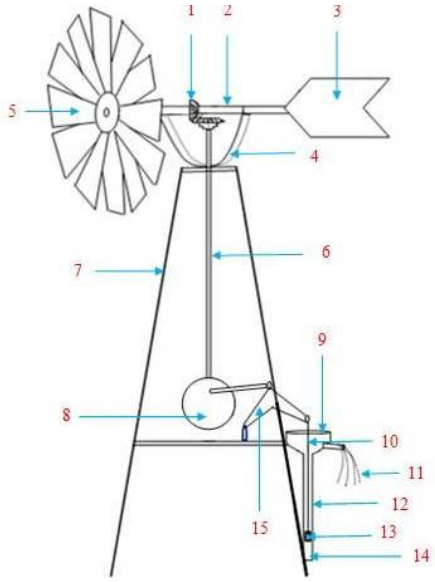
2. Research Methodology

2.1 Place and time of the research

Methodology used in this research was combination between design and experimental of windmill. Experiment was performed in the field located close to the Setro's reservoir in Gedangan village, and take time 24 hours. Measurement of wind speed and windmill revolution were conducted every 3 hours time interval during experiment. In the experiment was look into the correlation between independent variabel (wind speed and windmill revolution with some variation of widmill diameter), and dependent variabel that was water capacity resulted from the water pump.

2.2 Design of windmill

Figure 1 show the design of windmill features with water pump.



Note:
1. Gear / gear on
2. shaft
3. Tail
4. Bearing / Bearing
5. Mill
6. As
7. Tower / Tower
8. Gear / gear down
9. Storage
10. Stalk pump
11. Water
12. PVC Pipe
13. Rubber valve
14. Plastic valve
15. Crank

Fig. 1. Design of windmill

3. Results and Discussions

Wind speed in the location where the research was conducted is significant factor to determine the level of success both for the design of windmill and for the experiment. Institute for Environment and Agricultural Research divided the average annual wind speed around Rembang district into four areas of fields as shown in Table 1.

Table 1. Annual annual wind speed around Rembang district

Area of fields	Name of village	Minimum wind speed (m/s)	Maximum wind speed (m/s)
Northen	Punjul Harjo, Tireman, Gedangan, Tritunggal, Pasar Banggi, Kabongan Kidul	2.3	9.2
Eastern	Sridadi, Kasreman, Telogo Mojo, Padaran	1.9	6.5
Southern	Kedung Rejo, Weton, Kumendung, Turus Gede	0.5	4.0
Western	Magersari, Waru, Ngadem, Ngotet, Ketanggi, Mondo Teko	1.6	4.7

Source: Institute for Experimant and Agriculture Research (2010)

Beside the location, wind speed is also influenced by the contours of the ground surface and the altitude of the wind blow. Wind speed in urban areas where found many houses and high rise building is lower compare to the wind speed in open space area, and gust of wind little bid over the ground surface is lower than gust of wind that far from the ground surface. Ikhsan (2011) explains that in case the wind speed low, to obtain the wind speed of 5 to 7 m/s is required altitude of 5 to 12 meters from the ground surface. Factors that affected the wind speed are: time, place, contour of the ground surface, altitude, temperature, and density of the air.

3.1. Wind Speed Measurement

Two methods were perform in determining the wind speed, first method by using the tool call ‘Anemometer’, and the second method by visually reading the scale of wind speed call ‘Beaufort Scale’. Measurement using Anemometer divided into two groups, groups measure the wind speed, and group measure the wind pressure. Since between the wind speed and wind pressure have correlation each other, any type of Anemometer, in the same time, can give the information of wind speed and wind pressure. From the available type of Anemometer (cup, windmill, hot-wire, laser Doppler, sonic, ping-pong ball, plate, and tube) can read the measurement result in unit meter per second (m/s) or feet per minute (feet/min), kilometer per hour (km/hr) and knot. 1 knot equal to 1.852 km/hr.

Using Beaufort Scale, the wind speed can be estimated based on visual condition in land or in the ocean. There are three objects that can be used as an orientation of wind speed estimation, those are smoke, flag, and trees. Table 2. show the Beaufort Scale. Based on the field measurement, the maximum wind speed is 8.1 meter/second.

Table. 2. Beaufort Scale

No.	Wind speed			Condition in the land	Condition in the ocean
	Knot	Km/hr	m/sec		
0	< 1	< 1.6	< 0.44	Smoke vertically up	The ocean look like mirror
1	1 - 3	1.6 – 4.8	0.44 – 1.34	Smoke little bid gust by wind	There are ripples but not generate foam
2	4 - 6	6.4 – 11.2	1.78 - 3.13	Leafs move and can be feel in the face	Small wave occur
3	7 - 10	12.8–19.3	3.57 – 5.36	Small branch constantly move	Big wave occur
4	11 - 16	20.9-28.9	5.81 – 8.04	Dust, leaf, paper can fly, small branch move	Show the white of end wave
5	17 - 21	30.5-38.6	8.49 – 10.72	Small tree sway	Much white end wave and little bid sprinkle of water
6	22 - 27	40.2-49.8	11.17 - 13.85	Big banch move, telephon cable squeak, umbrella is difficult to open	Wave become bigger, much white end of wave, more sprinkle of water
7	28 - 33	51.4-61.1	14.30–16.98	Trees move	White foam of the break wave begin blow by the wind
8	34 - 40	62.7-74.0	17.43-20.56	Small branch break, difficult o walk	End of the wave begin roll up
9	41 - 47	75.6-86.9	21.01-24.14	Apart of building get away	High wave and roll up, water sprinkle make the view less
10	48 - 55	88.5-101.3	24.58-28.16	Tree pull out from it root, there are damages on building structure	Very high wave, foam are blow make the ocean look wahite
11	56 - 63	102.9-115.8	28.61-32.18	The damages spread uot	Extraordinary high wave
12	> 63	> 117.4	> 32.63	Enormous damage, rarely happen in land	Air space fully with sprinkle water, the color of the ocean become white, the view limited

3.2. Field Conditions

Direct observation in the field will help the research methods to be performed. Turns Swamp Setro is the only swamp which be located northeast village of Gedangan. This swamp has an area of 5 ha initially, as the government plans to build in this area so that the extent of taps increased to 8 ha. Its construction started in 1970 and completed in 1972. Having found a new source of raw water from Pamotan and Sale, then these taps are closed. The government made the redevelopment of the marsh in 2005 and use it as irrigated rice fields. because of the use of this swamp as irrigated rice fields sufficiently successful that the government undertake a gradual development and increase the area of the swamp until now the extent to ± 10 ha (BAPPEDA, 2010).

Setro Swamp development efforts aimed at improving agricultural productivity. Some types of plants are often grown in this region are rice, corn, melon and watermelon. Swamp water use for irrigated rice fields here using the help of diesel pumps, as shown below:

Fig. 2. Swamp Water Intake in Setro

Under the conditions of this field, then use the wind resource in the Village of Gedangan Rembang is possible to be made in the form of wind power water pumps for irrigation of rice fields windmill on a small scale.

4. Conclusions

From the results of the research some conclusion can be drawn as follows:

a. The problem of water level which lower than fields elevation can be solve by using water pump.
b. To cut off the water pump expenses, windmill can be used as water pump power instead of engine which need fuel consumption.
c. In order the water pump can be used in the lower speed of windmill, requires to pay attention on diameter of windmill leaf, angle of the leaf of windmill, total leaf, and leaf material.

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Note:

Village: in bahasa Indonesia is mean Desa, the lower level of administration system in Indonesia.

District: in bahasa Indonesia is mean Kabupaten the level of administration under Province.