Study of Channel Efficiency and Water Requirements of Cubo Irrigation

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Abstract. The study aimed to determine the channel efficiency and water requirements of existing irrigation of Cubo in Pidie Jaya District, Indonesia. The descriptive method is used in the research by observing the efficiency of primary and secondary channels. The average channel efficiency value is used to estimate irrigation water requirements. The results showed the efficiency of the primary channel is 59.41%, the efficiency of the secondary channel is 56.04%, and the average channel efficiency is 57.73 %. Net farm requirement (NFR) is 1.04 l/s/ha, diversion requirement (DR) is 1.81 l/s/ha and irrigation water requirement of 1,090 ha is 1.97 m^3/s. When compared with channel efficiency in general, channel efficiency in this irrigation area is relatively low due to lack of maintenance of channels and the presence of water losses due to illegal tapping of water.

Keywords: *Water availability, water requirements, irrigation efficiency*

1 Introduction

The irrigation Cubo, Trienggadeng, that was included in Pidie Jaya district started built since the fiscal year 1975-1976. The irrigation was a simple network until the fiscal year 1980-1983 and completed in the fiscal year 1989-1990. The irrigation area has a potential area as wide as 1,545 ha, whereas functional area as wide as 1,090 ha. The water resource used for the irrigation comes from Krueng Inong that is one of the upstream of Krueng Panteraja that located at river area in Aceh. Currently, farmers at the Cubo, Trienggadeng, irrigation face several problems. In the first planting season that is October, the farmers can irrigate the whole functional area as wide as 1,090 ha. While in the second planting season that is May, water shortage occurred that only 50% of the functional area can be planted. To cover the water shortage, there are several retention basins around the irrigation area which is utilized to accommodate excess water during the rainy season.

The availability, effectivity, and efficiency of the irrigation network infrastructure in the region are needed. This is due to the abundant amount of water in the wet season because of high rainfall and vice versa in the dry season. The availability of water is the main factor in the success of irrigation. Even though the amount of water available is sufficient, but if the consistency of water distribution efficiency is not maintained will cause the available water will not cover the entire area. One of the successes of the performance of the irrigation networks can be seen from the consistency of the value of irrigation efficiency itself.

Ajnn.net (2017) [1] assess that the irrigation project of Cubo in Bandar Baru sub-district in Pidie Jaya must be evaluated. The decline in efficiency may be due to the bad management of the irrigation area. Bad and irregular operations and maintenance that result in a decrease in the

IGC 2018, October 03-05, Banda Aceh, Indonesia

DOI 10.4108/eai.3-10-2018.2284360

amount of water due to increased water loss. Young [2] said that bad of irrigation management can increase the loss of water because seepage, percolation and inappropriate distribution of water, the increasing of rice field development associated with consumption rice and increased the number of residents.

Therefore, the main point on improving paddy field resources is to increase the productivity result. The result of the productivity is still classified as low and still had a chance to be improved because based on the research of Suharno, Djasmi, & Kartono [3] showed that several varieties of rice can give results that reach 6 t/ha by applying technology of irrigation systems and Suharno, Djasmi, & Kartono [3] reported that through improvements in technology cultivation, proper planting time and pest control, by planting superior varieties the results obtained can reach 4.4–7.2 t/ha. The difference in scores between the results of the research with the production at the farm induced by the use of low quality seed, the use of not recommended technology, and the existence of the restricting factors that is the low soil fertility.

The drainage of water from upstream to downstream need adequate infrastructure of irrigation such as dam, the primary and secondary channel, division boxes, measurement building, tertiary channels, and a farming level channel. The whole facilities of irrigation are a unity, if there are damages in certain parts it will affect the performance of the existing system, resulting in decreased irrigation efficiency and effectiveness, the availability of potential water resources and agricultural land is increasingly scarce and limited. The limited water resources in Cubo while the need for water for various uses is increased causing water demand to increase.

The more limited and competitive availability of water resources not only will have a negative influence on the lives of the community but also in the social and economic aspect. Most of the water needs outside the agricultural sector are to meet household and industrial consumption which tends to increase in line with economic progress.

According to Rachman [4] irrigation management is an effort to distribute water fair and evenly, but in its implementation often face on some problem, namely: 1) the growth of water group area without any control, 2) the location of the rice field is not taken into account in the distribution of water and downstream technology recommendation, 3) wild tapping of water in the flowing process continues without sanctions, 5) rice productivity is varied between parts upstream and downstream. It can be said that this problem cannot be separated from institutional capacity or element of the policy that has not been functioning effectively in raising awareness of the importance of water management to the community. The assumption that irrigation water is public good tends to lead to inefficient in using water. Economically, obscurity regarding the rights in the use of water and obligations in water management cause water user association organizations are less effective, institutional mechanisms in the allocation of water resources do not function, giving rise to inefficiency water usage.

The needs of irrigation water decided by the age and the types of crops will be planted, and also the current weather, so that the management of the irrigation channel will follow the cropping pattern. The management of the irrigation network will be adjusted to the availability of irrigation water. If the demand is bigger than the availability of water, so that optimize analysis is needed to maximize the functional area or maximum advantage in one-year planting.

2 Method

The research carried out in irrigation of Cubo farming areas in three sun-districts that are Bandar Baru with an area of 1,365 ha, Panteraja with an area of 222.25 ha, and Trienggadeng with an area of 1,376 ha. This research carried out in December 2017. The mapping was done in Remote Sensing Laboratory and Faculty of Agriculture of the University of Syiah Kuala.

Based on Central Bureau of Statistics BPS of Pidie Jaya (2016) [5], the geographical area of Pidie Jaya is 1,162.84 km2 in width consisting of 952 km2 of land area, sea area as wide as 210.84 km2. This region in astronomically is on coordinates 4.91- 5.30 northern latitudes and 96.02-96.36 east longitude.

The research used the descriptive method by collecting primary and secondary data. The primary data was obtained by doing direct field observation and interview with the farmers. The implementation of this study consisted of the preparation of research, the preparation of land, the water supply for the land, the water demand for the land preparation, retrieval needs and withdrawal discharge of water, data analyzed was precipitation data, regional discharge plan of Cubo irrigation water channel, the speed of water channel, the needs of irrigation water, water withdrawal discharge, water loss and efficiency of channel.

3 Result And Discussion

3.1 Primary Channels

Based on the observation, the primary channel discharge data in the Cubo irrigation area in Pidie Jaya can be seen in Table 1.

Table 1. The Primary Channels Efficiency

No	Building	Discharge channels (m^3/s)		Efficiency (%)
		Inlet	Outlet	
1	BCB.1	0.900	0.432	48.00
2	BCB.2	0.540	0.432	80.00
3	BCB.3	0.432	0.270	62.50
4	BCB.4	0.360	0.236	65.63
5	BCB.5	0.315	0.195	61.90
6	BCB.6	0.260	0.165	63.46
7	BCB.7	0.220	0.180	81.82
8	BCB.8	0.090	0.060	66.67
9	BCB.9	0.090	0.036	40.00
10	BCB.10	0.054	0.013	24.07
	Average			59.41

Note: BCB = Building of Cubo

Based on primary channels discharge data (Table 1), the channel with 14,522.5 m in length and an average of percent efficiency was 59.41% indicates that the highest efficiency is at the BCB.7 that is 81.82 % with the condition of the building was in a good and efficient. The lowest is on BCB.10, that is 24.07%. It is suspected that this caused by high evaporation and wild percolation. It is also related to lack of maintenance of channels and the presence of water losses due to illegal tapping of water.

3.2 Secondary Channels

Based on the observation discharge data, the secondary irrigation channel in Cubo of Pidie Jaya can be seen in Table 2.

Table 2. Efficiency secondary channel

No	Building	Discharge channels (m^3/s)		Efficiency (%)
		Inlet	Outlet	
1	BPS.1	0.020	0.011	53.85
2	BPS.2	0.016	0.008	47.62
3	BPS.3	0.011	0.008	66.67
	Average			56.04

BPS = Building of Paya Sepat

Based on secondary channels discharge data (Table 2), the channel with 2,370 m in length and an average of percent efficiency was 56.04% indicates that the highest efficiency is at the BPS.3 that is 66.67%. With the condition of the buildings of the secondary channel is still in a good state. The lowest efficiency is at BPS.2 that is 47.62%. It is because of the condition of the buildings at the secondary channel is in poor condition and wild percolation or seepage vertically that resulted in the loss of water is increasing.

3.3 Irrigation Water Need Analysis

Irrigation water is the amount of water generally took out of the river or reservoir and streamed through the irrigation systems to keep the balance amount of water on farmland [6]. The amount of water demand in order to meet the needs of water irrigation taken from a dam in Jiem-Jiem is as follows:

3.4 The Rice Crop Consumption Analysis

From the measurement, the coefficient of rice field growth in every phase can be seen in Table 3.

Table 3. The measurement of the value of a rice plant

Growth phase	The rice plants	
	Puddle 5 cm	**Puddle 10 cm**
Vegetative Phase	0.96	1.03
Vegetative Phase	0.88	1.10
Reproductive Phase	0.84	1.03
Maturation Phase	0.56	0.71
Average	0.81	0.71

Table 1 shows that the coefficients of the rice crop were bigger, either on 5 cm and in 10 cm puddle, during the vegetative grow, and the smallest was during the maturation phase that was 0.71 and 0.56. This is in accordance with literature Dep.PU (1987) in Soewarno (2000) that the coefficient of the rice crop according to FAO, in the initial growth and reproduction phase as much as 1.10 and the maturation phase (harvest) as much as 0.95.

3.5 Analysis Net Water Requirement in the Rice Field (NFR)

The plant nurseries usually coincide with tillage, but due to lack of labor, it is sometimes was done about 5 days after tillage. Seedling nurseries usually require 20-25 days, the area needed is 5% of the total area. While the water needed for seedlings were approximately 6 mm/day. The net of water needs in the rice fields to plant rice based on the calculation results is 1.04 mm/day.

3.6 Water Need Analysis in Forming Land for Planting Rice (IR)

For rice cultivation, the ground must first be processed. The land needs to be watered so that the land became flaccid. The amount of water needed in this period ranged from 150-250 mm. The irrigation water was needed most during this process, moreover, if there was no rainfall and insufficient time for tillage. The village was generally carried out 20 to 30 days before planting started. The tillage was done in two stages, namely plowing and raking. A large amount of water, high demand for water for the preparation of the land generally very determines the needs of maximum irrigation water. The result of high demand measurement for water during the preparation was 9,89 mm/day.

3.7 The Demand for Diversion Water (DR)

High demand for water in the door of the irrigation much related to the high demand for water in the rice fields. The results of the calculation to meet the amount of water that must be available at the take-up gate to irrigate agricultural land are 1.61 l/sec/ha.

3.8 Irrigation water requirement of Cubo Irrigation

Irrigation water needs for an irrigation area of 1090 hectares based on the values of NFR, IR, and DR values are 1.97 m^3/s. Field observation results indicate that the availability of water has not been able to meet the water needs for irrigation in this area. It is due to the low of channel efficiency and the presence of water losses due to illegal tapping of water.

4 Conclusion and Suggestion

4.1 Conclusion

Based on the analysis and measurement have mentioned in this research, it can be concluded that:

1. The average channel efficiency is 57.73 % consisted of the primary channel efficiency (59.41 %) and the secondary channel efficiency (56.04 %).
2. Net farm requirement (NFR) is 1.04 l/s/ha, diversion requirement (DR) is 1,81 l/s/ha and irrigation water requirement of 1,090 ha is 1.97 m^3/s. When compared with channel efficiency in general, channel efficiency in this irrigation area is relatively low due to lack of maintenance of channels and the presence of water losses due to illegal tapping of water.

4.2 Suggestion

Some important things that need to be done to overcome the shortage of irrigation water are repairing irrigation canals. Furthermore, providing counseling to farmers not to take water illegally from primary and secondary channels.

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