A STUDY ON IRRIGATION EFFICIENCY FOR PADDY IN SEKUDUK CHUPAK PADDY PLANTATION SCHEME

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A STUDY ON IRRIGATION EFFICIENCY FOR PADDY IN SEKUDUK CHUPAK PADDY PLANTATION SCHEME

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For my beloved family
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ABSTRACT

The purpose of this study is to find out the irrigation efficiency of Sekuduk Chupak Paddy Plantation Scheme by using Conventional Irrigation Efficiency. The value of irrigation efficiency is determined by taking the ratio of Net Irrigation Requirement (NIR) to the Net Irrigation Application (NIA) and expressed as percentage. Surface irrigation or pond irrigation is the applied irrigation system at the scheme. There are 3 irrigation ponds at the scheme, namely Pond A, Pond B and Pond D. From the results, the irrigation efficiency for irrigated areas is considered very low with measured values of 12%, 27% and 22% respectively. These values show that the efficiency level of irrigation system at the scheme is not close or within the range as mentioned earlier by the local authorities, at an average between 30% - 50%. Several factors related to low irrigation efficiency are inappropriate hydraulic structure design, lacking in use of monitoring devices, poor irrigation schedule and management system and lack of cooperation between the in-charged officers and the local farmers working on the scheme. Several recommendations are needed to help improve the irrigation efficiency at Sekuduk Chupak Paddy Plantation Scheme and achieve its targeted efficiency level in the future.
ABSTRAK

Tujuan kajian ini adalah untuk mengetahui kecekapan pengairan Skim Penanaman Padi Sekuduk Chupak dengan menggunakan kaedah Kecekapan Pengairan Konvensional. Nilai kecekapan pengairan ditentukan dengan mengambil nisbah Keperluan Pengairan Bersih (NIR) kepada Penggunaan Pengairan Bersih (NIA) dan dinyatakan dalam bentuk peratusan. Pengairan permukaan atau kolam merupakan sistem pengairan yang diaplikasikan di dalam skim ini. Terdapat 3 kolam pengairan di skim, iaitu Kolam A, Kolam B dan Kolam D. Daripada hasil pengiraan, kecekapan pengairan untuk skim ini dianggap sangat rendah, masing-masing dengan nilai 12%, 27% dan 22%. Nilai-nilai tersebut menunjukkan bahawa tahap kecekapan sistem pengairan di skim itu tidak terletak berhampiran atau dalam julat kecekapan seperti yang diwartakan oleh pihak berkuasa tempatan, dianggarkan antara 30% - 50%. Antara faktor-faktor yang menjurus kepada kecekapan pengairan yang rendah adalah rekabentuk struktur hidraulik yang kurang sesuai, penggunaan alat-alat pemantauan yang terhad, jadual pengairan dan sistem pengurusan yang tidak efisien serta kurangnya kerjasama antara pegawai bertugas dan petani tempatan yang bekerja di dalam skim ini. Cadangan serta langkah penambahbaikan amat diperlukan bagi membantu meningkatkan tahap kecekapan pengairan di Skim Penanaman Padi Sekuduk Chupak serta mencapai tahap kecekapan yang disasarkan di masa hadapan.
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineer</td>
</tr>
<tr>
<td>CIE</td>
<td>Conventional Irrigation Efficiency</td>
</tr>
<tr>
<td>DID</td>
<td>Department of Irrigation and Drainage</td>
</tr>
<tr>
<td>DOA</td>
<td>Department of Agriculture</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
</tr>
<tr>
<td>Ha</td>
<td>Hectare</td>
</tr>
<tr>
<td>ICID</td>
<td>International Commission on Irrigation and Drainage</td>
</tr>
<tr>
<td>IE</td>
<td>Irrigation Efficiency</td>
</tr>
<tr>
<td>IP</td>
<td>Irrigation Productivity</td>
</tr>
<tr>
<td>Kg</td>
<td>Kilogram</td>
</tr>
<tr>
<td>MOMA</td>
<td>Ministry of Modernisation of Agriculture</td>
</tr>
<tr>
<td>mm</td>
<td>Millimetre</td>
</tr>
<tr>
<td>T</td>
<td>Tonne</td>
</tr>
<tr>
<td>WP</td>
<td>Water Productivity</td>
</tr>
<tr>
<td>WUE</td>
<td>Water Use Efficiency</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 General

Paddy, known as seed that comes from the gene of *Oryzasativa* and *poaceae* family, is a staple food for half of the population on earth. The consumption of rice is mainly in the continent of Asia, where two billion people obtained 60-70% of their calories from rice and its products. Besides that, rice has also deeply embedded in cultural heritage of Asian societies in such condition like been ingrained into culture and tradition. Since the production of rice paddy and other associated harvest activities has employed more than one billion people in Asian rural areas, it has been an important economic sector in most Asian countries.

Irrigation is known as an artificial application of water to the soil where crops are being planted on it. Irrigation systems are often designed to maximize efficiencies and
increase crop productivity. There are three classes of irrigation systems namely pressurized
distribution, gravity flow distribution and drainage flow distribution respectively. Pressurized
systems include sprinkler, trickle and similar in which water is to be distributed into the field
through pressurized pipe networks. Meanwhile, gravity flow systems distribute water at the
field level by a free surface, known as surface irrigation method. Irrigation by using drainage
control system or sub-irrigation is conceptually interesting, but not commonly applied.

Irrigation efficiency is defined as a critical measure of irrigation performance in terms
of water required to irrigate a paddy field, farmland, basin or an entire watershed (Howell,
2003). Irrigation efficiency is also an important indicator of effective water resource
management. Improving irrigation efficiency means that less amount of water has to be
irrigated into the field, thus increasing the ratio of more crops produced per water drops.
Knowledge on efficiency of irrigation system is essential for the society views of irrigated
agriculture, where the benefits of supplying high quality and abundant food supply are
required to meet our demand with the increasing world population.

1.2 Problem Statements

The increasing consumption and demand for rice is getting higher every year. Changes
in human lifestyle or the need to increase rice production in many countries is one of the
factors contributing to this situation. Increasing world population growth, where it is expected
to be 50% by 2050 will require more production of paddy, thus requiring better irrigation
system for paddy plantation. However, research done by International Commission on
Irrigation and Drainage (ICID, 2004) show that there has been declining percentage of
contribution for crop production especially paddy from 1960 until 2000 in Malaysia.
1.2.1 Wet Paddy Yield in Kuching Division

For this study, wet paddy is considered. Table 1.1 shows the area planted yield per hectare (ha) and production of wet paddy in Kuching Division in year 2008 for three different areas mainly Kuching, Bau and Lundu. Meanwhile, the average yield of wet paddy in Kuching Division for year 1999-2008 is presented in Table 1.2.

Table 1.1: Area, yield and production of wet paddy in Kuching division 2008

<table>
<thead>
<tr>
<th>District</th>
<th>Area planted (ha)</th>
<th>Yield per hectare (kg)</th>
<th>Production (tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuching</td>
<td>1207</td>
<td>3626</td>
<td>4377</td>
</tr>
<tr>
<td>Bau</td>
<td>585</td>
<td>3256</td>
<td>1905</td>
</tr>
<tr>
<td>Lundu</td>
<td>722</td>
<td>1478</td>
<td>1067</td>
</tr>
<tr>
<td>Total</td>
<td>2514</td>
<td>2923</td>
<td>7349</td>
</tr>
</tbody>
</table>

Source: Department of Agriculture (DOA), Malaysia, 2008

Table 1.2: Average yield of wet paddy (kg per ha) in Kuching division 1999-2008

<table>
<thead>
<tr>
<th>Year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount (kg per ha)</td>
<td>1050</td>
<td>1773</td>
<td>1682</td>
<td>2565</td>
<td>2738</td>
<td>1930</td>
<td>2843</td>
<td>2905</td>
<td>2841</td>
<td>2923</td>
</tr>
</tbody>
</table>

Source: Department of Agriculture (DOA), Malaysia, 2008

1.2.2 Irrigation Efficiency for Paddy Plantation

Currently, the irrigation efficiency for paddy plantation in Kuching Division is estimated to be at 30% - 40%, according to Department of Irrigation and Drainage (DID Sarawak, 2010). This is considered low for the total amount of field area occupied for wet paddy plantation.

International Commission on Irrigation and Drainage (ICID, 2010) revealed that the current irrigation efficiency of rice in Malaysia is around 35% - 45% with water productivity
index of about 0.2kg of unit rice/m$^3$. The average yield for irrigated rice in 1994 was 3.8 tonne per unit hectare (T/ha).

There is a pressing need to improve the water use efficiency of all irrigation projects in the country. At present, the irrigation efficiency of paddy plantation is about 50% for the larger schemes while some of the smaller schemes may be operating at an efficiency of less than 40%. Through some alternatives and efforts, it is hoped that irrigation efficiency can be raised to a higher level of about 60% - 65% by the year 2010 (DOA, 2008).

Ministry of Modernisation of Agriculture (MOMA Sarawak, 2009) stated its objective to achieve 35% - 70% of rice self-sufficiency by year 2010. Thus, it is important to improve current low irrigation efficiency of rice paddy in order to obtain the objective. Supply of quality paddy seeds, rehabilitate drainage and irrigation schemes, increase the productivity of existing paddy areas through promoting and adopting of modern technology, and also encouraging private sector participation in large-scale paddy production either by granary or mini estate are among the strategies to achieve desired rice self-sufficiency.

Therefore, improvement in water productivity is very much needed to increase irrigation efficiency and obtain higher crop yields. Compared to the crop water consumption, the current irrigation efficiency for rice paddy plantation is still considered low in Malaysia, particularly Sarawak. As the largest state in the country, Sarawak has more potential in enhancing plantation schemes of paddy. Studies or researches should be conducted to find out what are the related factorsto low efficiency level of irrigation system and propose some recommendations on this matter.
1.3 Objectives

The objectives of the study are:

i. To identify targeted irrigation efficiency at Sekuduk Chupak Paddy Plantation Scheme;

ii. To determine the current irrigation efficiency at Sekuduk Chupak Paddy Plantation Scheme;

iii. To find out what are the related factors that lead to low irrigation efficiency of paddy plantation at the scheme;

iv. To propose recommendations in order to improve irrigation efficiency of paddy plantation at the scheme.

1.4 Scope and Limitations

The study area is located at Sekuduk Chupak Paddy Plantation Scheme (refer Figure 1.1 for the Locality Map). The project which costs around RM 3,500,000.00 was completed in 1988, have pond irrigation systems with weir. The Layout Plan of the scheme as provided by Department of Irrigation and Drainage (DID, Sarawak) is attached in Figure 1.2.

The overall scheme covers 6 villages namely Kampung Chupak, Kampung Sekuduk, Kampung Ma’ang, Kampung Payang, Kampung Panchor Dayak and Kampung Sungai Riset. There are 203 farm families involved in this scheme. It has a net area of 236 Ha and a total area planted of 229 Ha. The land utilization is high with 97% has been planted with crops. Figure 1.3 shows a view of Sekuduk Chupak Paddy Plantation Scheme.
According to DID officers, there are only three ponds functioning at the scheme namely Pond A, Pond B and Pond D respectively until the current period. Pond A and Pond B are the main sources of irrigation water for scheme portion located near Kampung Payang while Pond D covers for scheme portion sited within Kampung Sekuduk. Currently, the total area for irrigated portion of the scheme is approximately at 38322 m². Pond A covers the land area of 3960 m² while Pond D is of 15057 m². Pond B has the largest irrigated area, approximately at 19305 m². Sungai Sekuduk and Sungai Chupak are the main water sources for the pond irrigation which traverse along the plantation scheme.

In this study, evaluation on irrigation efficiency was carried out only at irrigated areas planted with paddy. Paddy growing season or growth period considered for this study is taken in year 2009. It is based on historic crop records, meteorological and available rainfall data. Irrigation efficiency was assessed by using several methods of calculation, such as conventional method and other alternative approaches. This involves the volume of water applied to the scheme, water diverted from the irrigation pond, irrigation required by paddy, yield production and paddy water use or crop evapotranspiration.

Some of the irrigation data was collected from Department of Irrigation and Drainage (DID, Sarawak) and others by computation. Irrigation efficiencies for irrigated areas planted
with paddy were compared and analysed. Details of calculations and methods used were discussed in Chapter 3.

1.5 Study Outcomes

By the end of this study, the findings will help to strengthen our understanding on irrigation system and figure out what are the factors which contribute to low irrigation efficiency. With better irrigation management system and improved efficiency, the use of water will be more effective and this shall minimize the difference amount between crop water requirement and actual water being applied. As a result, it will help to maintain the ecological system and environmental condition of the irrigation drainage basin. This will eventually contribute to higher crop production and improve the livelihood of people living nearby the scheme area.

1.6 Brief Outline

The study shall focus on the irrigation efficiency of the above mentioned scheme by using Conventional Irrigation Efficiency (CIE) method, by taking the ratio of Net Irrigation Requirement (NIR) to the Net Irrigation Application (NIA). The second chapter shall cover the literature review or theoretical aspects of the study. Further, the following chapter will be mainly on the methodology and study flow process. The results shall be discussed and analysed in Chapter 4. Finally is the conclusion of study and recommendations is covered in Chapter 5 to help improve the study and also included are suggestions for the future research.
2.1 General

Irrigation efficiency is known as basic engineering term used in irrigation science to characterise irrigation water use, and to promote better or improved use of water resources, particularly those used in agriculture and turf or landscape management (Heermann et. al, 1990). According to Howell (2003), irrigation efficiency can also be categorized in several terms namely irrigation system performance, the uniformity of water application and the response of the crop to irrigation practices. It is important to note that the terms "irrigation efficiency" or "application efficiency" should not be confused with the term "water use efficiency" (WUE), generally for a measure of yield per unit water applied.
2.2 Irrigation Efficiency

Irrigation efficiency is defined as the ratio of the amount of water consumed by the crop to the amount of water supplied through irrigation methods such as surface, sprinkler or drip irrigation (Machibya et. al, 2004).

According to Burt et. al (1997), irrigation efficiency or somehow frequently used as some authors, application efficiency is used only to indicate amount of applied water stored in the crop root zone. This stored water is then available for crop water use or a beneficial use, the evapotranspiration process. However, this narrow definition does not consider that some deep percolation may be required to maintain a salt balance. This deep percolation, which is not a preferable consideration for the actual crop water use, is also known as beneficial use.

Referring to American Society of Civil Engineer's On-Farm Irrigation Committee (ASCE, 1978), irrigation efficiency as the ratio of the volume of water which is beneficially used to the volume of irrigation water applied. Beneficial used water may include crop evapotranspiration, crop cooling, deep percolation needed of leaching for salt control, frost control, and as an aid in certain cultural operations. Differences in definitions are due to several aspects such as accounting for runoff and deep percolation, purposes either for an individual irrigation or for an individual farm, irrigation project or basin.

Keller and Bliesner (2000) mentioned that irrigation efficiencies are also expressed as a percentage between 0% - 100%. However, 100% irrigation efficiency is not theoretically attainable due to immediate evaporation losses during irrigation period. Despite, there could be easily close to 95% efficiency if a crop was under-watered. In this case, assuming that there was no deep percolation, all water applied and not immediately evaporated would be used by the crop.
Under-watering a crop will theoretically result in high irrigation efficiency. However, this may not be a very effective way of farming and could actually lead to an inefficient use of resources. This could be due to inefficient usage of fertilizer, a weak crop that is more susceptible to pest pressures and thus, requiring additional chemical application, or sub-par yields that would require additional cropped acreage to maintain farm income (Viets, 1962).

2.3 Factors Leading to Low Irrigation Efficiency

Efficient irrigation management, proper infrastructures and irrigation schedule play major roles in order to achieve high efficiency level of irrigation system. Study done by Phengphaengsy and Hiroshi (2005) on paddy fields in the Lower Mekong Basin discovered that low irrigation efficiency is caused mainly by an inappropriate hydraulic structure design and poor irrigation schedule. Types of material used should be properly selected for suitable crop purpose. Irrigation management system also has great influence on efficiency level as it may affect the scheme water requirement and water delivery to the fields.

Food and Agriculture Organization (FAO, 2010) claimed that the quality and quantity of the source of water can have a significant impact on the irrigation practices. A water supply with a relatively small discharge is best utilized in an irrigation system which incorporates frequent or continuous application. Depths applied per irrigation tend to be smaller compared to systems of having a large discharge which is available less frequently. The quality of water affects decisions similarly. Salinity is generally the most significant problem but other elements like boron or selenium can be important. A poor quality water supply must be utilized more frequently and in larger amounts than one of good quality.