17

Irrigation: Types, Sources and Problems in Malaysia

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1. Introduction

Irrigation is always synonym with agriculture. From ancient to modern era, irrigation has been around for as long as humans have been cultivating plants. Archaeological investigations were proved that from ancient Egyptians until the middle of 20th century, irrigation technology are gradually improved in conjunction with advancement in water technology, water transfer and agriculture systems. In simple terminology, irrigation can be defined as the replacement or supplementation of rainwater with another source of water. It is a science of artificial application of water to the land or soil. The main idea behind irrigation systems is that the lawns and plants are maintained with the minimum amount of water required. Irrigation has been used for many purposes, among them are for maintenance of landscapes and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. However when relates to agriculture, irrigation is one of a major section to assist in the growing of agricultural crops. Additionally, irrigation also protecting plants against frost, suppressing weed growing in grain fields and helping in preventing soil consolidation. The implementation of an irrigation system will help conserve water, while saving time, money, preventing weed growth and increasing the growth rate of your lawns, plants and crops.

This article discusses on the irrigation in Malaysia- which is one of a major water regulation technology which helps to improved to about 14300 farmers in Malaysia. The irrigation history in Malaysia can be traced back as the end of the eighteenth century. Starting from Kerian Irrigation scheme in Perak constructed in 1982, there are currently 932 irrigation schemes covering 413700 ha are currently operated throughout Peninsular Malaysia including 20 irrigation schemes in Sabah. These scheme comprising eight granary schemes (210 500 ha), 74 mini-granary (29 500 ha) and 850 non-granary schemes (100 633 ha). The non-granary schemes are scattered all over the country and their sizes vary between 50 ha and 200 ha (Norsida & Sami Ismaila Sadiya, 2009).

Since the formation of the Department of Irrigation and Drainage in 1932, irrigated areas for paddy cultivation have progressively increased. By the year 1960, about 200 000 ha had been developed, the emphasis then being to supplement rainfall for single crop cultivation. During the 1960's and early 1970's, the advent of double cropping of rice cultivation required the development of adequate water resources for the off season crops. During the 1980's, the priority for irrigation took a new dimension with the need to rationalise rice cultivation relevant to production cost and profit considerations (Alam, et.al. 2011). The government evolved a policy to confine irrigation development to the eight large irrigated areas in the country, designated as granary areas totalling 210 500 ha and comprising the irrigated areas of Muda, Kada, Seberang Perai, Trans Perk, Northwest Selangor, Kerian-Sungai Manik, Besut and Kemasin-Semarak.

2. Background

Malaysia receives an annual average rainfall of more than 2500 mm, mainly due to the Southwest and Northeast monsoons. The country is therefore rich in water resources when compared to the other regions of the world. The average annual water resources on a total land mass of 330,000km^2 amount to 990 billion m^3. Out of which, 360 billion m3, or 36% returns to the atmosphere as evapotranspiration, 566 billion m^3, or 57% appear as surface runoff and the remaining 64 billion m^3, or 7% go to the recharge of groundwater (Alam,et. al. 2010; Mohd Ekhwan, et.al. 2010). Of the total 566 billion m^3 of surface runoff, 147 billion m^3 are found in Peninsular Malaysia, 113 billion m^3 in Sabah and 306 billion m3 in Sarawak.

Water is used for a variety of purposes. Consumptive water use is largely for irrigation, industrial and domestic water supply and to a minor extent for mining and fisheries. Instream water uses which are non-consumptive in nature include hydropower, navigation, recreation and fisheries.

Malaysia has a long tradition of support for irrigated rice development, both to retain a degree of self-sufficiency in rice production and to help alleviate poverty among smallholder rice farmers. Currently, irrigation is predominately for paddy cultivation and a minor position for the cultivation of cash crops. Paddy cultivation is mostly carried out by individual farmers working on small plots of about 1 to 1.5 ha. Irrigation facilities for double cropping are mainly focused on the eight main granary schemes and the 74 mini-granary schemes, with an average cropping intensity of 170%. The current irrigation efficiency is around 35 to 45% with water productivity index of about 0.2 kg of rice/m^3. The average yield for irrigated rice in 1994 was 3.8 T/ha.

In major irrigation schemes the flooding type of irrigation is generally practiced for paddy cultivation where the water depth can be controlled individually by the farmers. Major irrigation schemes are designed with proper farm roads to cater for farm mechanisation especially for ploughing and harvesting. Most of the irrigation schemes are provided with separate drainage facilities. The issues of salinity, waterlogging and waterborne diseases are not reported as significant (Mohd Ekhwan, et. al. 2009).

The farmers pay a nominal irrigation charges which vary from US$. 3 to US$ 15 per hectare per year. However, the collected fees cover only 10 to 12% of the actual operational cost. The government does not seek full cost recovery because the farming community is made of poor persons. Besides, the government also support includes substantial subsidies for fertilizer and credit, a guaranteed minimum price, and a price bonus, as well as considerable investment in public irrigation works. A total of 917 million US$ have been spent on irrigation development by the government since 1970 (Malaysia 1976).Yet Malaysia is a relatively small rice producer. Paddy supplies only one percent of GDP and five percent of agricultural value-added (Jayasuriya & Shand 1985).

The Fifth Plan (1986-90) reduced the rice self-sufficiency goal from 80-85 percent of consumption to 60-65 percent of consumption by year 2000, and concentrated public investments in eight "granary" areas covering 220,000 ha. The continuing national decline in rice production shows that even with high subsidies ($220 per ton in 1988), the reduced self-sufficiency targets are not being achieved. Gross paddy production fell from 2.1 million tons in 1979 to 1.6 million tons in 1987, and has fallen further since. Rice consumption fell from 1.34 million tons in 1979 to 1.23 million tons in 1987.

In the 1980s, the Government took a bold decision to confine further irrigation development works to the eight major granary areas of the country. Irrigation and drainage facilities were intensified and extended to the tertiary level to improve on-farm water management to enable the cultivation of high yielding varieties of rice. This period also saw the successful introduction of farm mechanization, and the rapid replacement of labour-intensive transplanting to direct seeding methods (Radam & Ismail. 1995). In the 1990s, major efforts were made in the upgrading of infrastructures to support farm mechanization and direct seeding, including improvement to farm roads, field drainage and land levelling. Estate type management for more organized and economic operation as against individual farmer operation was promoted. At the same time, some of the smaller irrigation schemes which are unattractive for rice cultivation are encouraged to diversify into alternative non-paddy crops and aquaculture.

The total physical paddy area (covering irrigated and non-irrigated) in Malaysia is about 598,483 ha in 1993. About 322,000 hectares or 48 percent of the total paddy areas in the country are provided with extensive irrigation and drainage facilities while the remaining are rain fed areas (Table 1). Of the irrigated areas, 290,000 hectares are found in Peninsula Malaysia, 17,000 hectares in Sabah and 15,000 hectares in Sarawak. About 217,000 hectares of the irrigated paddy areas in Peninsular Malaysia have been designated as main granary areas while another 28,000 hectares located all over the country are classified as mini-granary areas. The paddy growing area is expected to decline with time as a result of conversion of paddy land for other landuse including urbanisation. It is forecasted that paddy growing area will decline to about 475,000 ha in the year 2005 and 450,000 ha by the year 2010 (Table 2).

3. Irrigation types and schemes in Malaysia

Irrigation water demand which totaled 9.0 billion m^3 in 1990 accounted for about 78 % of the total consumptive use of water. Until 1960, irrigation schemes were designed for single crop rice production during the wet season as a supplementary source of water supply. Since then, irrigation development has rapidly expanded into the double cropping of paddy to meet the dual objectives of increasing food production and to raise the income levels of the farmers. There are some 564,000 hectares of wet paddy land in Malaysia, of which 322,000 hectares is capable of double cropping. Farmers in irrigation and drainage areas are

State	Irrigated Areas	Non-Irrigated Areas	Total
Perlis	22. 039	3, 648	25, 687
Kedah	93, 670	24, 857	118, 527
Pulau Pinang	14, 895	225	15, 120
Perak	49,029	4, 225	53, 284
Selangor	19, 583	106	19, 689
Negeri Sembilan	8, 680	1, 449	10, 129
Melaka	6, 183	3, 435	9, 618
Johor	3, 055	746	3, 801
Pahang	17, 388	13, 796	31, 184
Terengganu	14, 843	12, 173	27, 016
Kelantan	40, 032	25, 382	65, 414
Sabah	17, 163	33, 639	50, 802
Sarawak	15, 136	153, 076	168, 212
Total	321, 696	276, 787	598, 483

Table 1: Distribution of paddy areas, 1993 (hectares)

Item	1995	2000	2005	2010	Average annual growth rate (%)			
					1995-2000	2000-2005	2005-2010	1995-2010
Rubber	1, 679.0	1, 560.0	1, 395.0	1, 185.0	-1.5	-2.2	-3.2	-2.3
Oil palm	2, 539.9	3, 131.0	3, 461.0	3, 637.0	4.3	2.0	1.0	2.4
Cocoa	190.7	163.8	160.0	160.0	-3.0	-0.5	0.0	-1.2
Paddy[1]	672.8	521.2	475.0	450.0	-5.0	-1.8	-1.1	-2.6
Coconut	248.9	213.8	193.2	175.5	-3.0	-2.0	-1.9	-2.3
Pepper	10.2	9.2	8.5	8.1	-2.0	-1.6	-1.0	-1.5
Vegetables[1]	42.2	48.3	63.7	86.2	2.7	5.7	6.2	4.9
Fruits	257.7	291.5	329.8	373.2	2.5	2.5	2.5	2.5
Tobacco[1]	10.5	9.3	7.8	6.2	-2.4	-3.5	-4.5	-3.5
Others[2]	99.1	106.4	111.4	130.0	1.4	0.9	3.1	1.8
Total	5, 751.0	6, 054.5	6, 205.4	6, 211.2	1.0	0.5	0.0	0.5

Source: Economic Planning unit, Ministry of Agriculture Malaysia
Notes: [1]Paddy, vegetables and tobacco are based on planted area.
[2]Others include sugarcane, coffee, sago, tea and floriculture.

Table 2. Changes in Agriculture land use 1995-2012

required to pay water rates ranging from RM 10-15 per ha which represent less than 10 % of the annual recurrent operation and maintenance cost.

In general, the long-term objectives of irrigation development are:

- to provide infrastructure for 74 secondary granary areas in order to raise the cropping intensity from 120 to 170 percent by 2010;
- to provide infrastructure for the main granary areas in order to raise the cropping intensity from 160 to 180 percent by 2010;
- to convert 120 small paddy schemes to other crops by 2010;
- to develop 20 small reservoirs, 100 groundwater tube-wells, and 4 dams by 2010 in order to provide reliable irrigation by introducing new technologies and modern management to increase crop production.

In Malaysia, there has been a long history of planting rice under rainfed conditions in pocket areas located along the flood plains of rivers. In the early 1900s, large scale irrigation systems were first introduced, notably in the Kerian Irrigation Scheme and the Wan Mat Saman Scheme. In 1932 the Department of Irrigation and Drainage (DID) was established and together with the Department of Agriculture (DOA), formed the prime movers of organized and systematic irrigation development in the country. These include the development of new areas as well as upgrading of existing schemes. In the 1960s, double cropping was widely introduced to meet the twin objectives of increasing food production and income levels of the rural poor. Water resources development became an important component of irrigation projects with the construction of storage dams, barrages and pumping stations, followed by extensive network of irrigation canals, drains and farm roads.

In the 1980s, the Government took a bold decision to confine further irrigation development works to the eight major granary areas of the country. Irrigation and drainage facilities were intensified and extended to the tertiary level to improve on-farm water management to enable the cultivation of high yielding varieties of rice. This period also saw the successful introduction of farm mechanization, and the rapid replacement of labour-intensive transplanting to direct seeding methods. In the 1990s, major efforts were made in the upgrading of infrastructures to support farm mechanization and direct seeding, including improvement to farm roads, field drainage and land levelling. Estate type management for more organized and economic operation as against individual farmer operation was promoted. At the same time, some of the smaller irrigation schemes which are unattractive for rice cultivation are encouraged to diversify into alternative non-paddy crops and aquaculture.

Generally, there are many types of irrigation types implemented for agriculture sectors. They cover from traditional-low scale methods to modern high tech approaches. Ditch Irrigation is a rather traditional method, where ditches are dug out and seedlings are planted in rows. The plantings are watered by placing canals or furrows in between the rows of plants. Siphon tubes are used to move the water from the main ditch to the canals. This traditional system of irrigation is popular for small scale paddy farmers but currently was improved by agency responsible to paddy sector such as MUDA, KEMUBU and Trans Perak. In these types of irrigation, major water sources were gathered from major rivers diversion scheme or regulated by reservoir at the upstream site. For example, Penampang Irrigation Scheme situated in the West Coast of Sabah. This scheme covers an area of 520 Ha. Water from the Moyog River is pumped by three sets of pumps each having a capacity of 850 liters/sec which enabled double cropping being practiced by the farmers.

4. Source

In the monsoon areas like Malaysia, the farmer traditionally planned his crop production primarily on the basis of expected rainfall. In years of good rainfall, farmers needed no irrigation. Flooding was often prevalent with the need to provide adequate drainage. In years of low rainfall, supplemental irrigation was needed to protect the paddy fields. Expansion of canal systems occurred most rapidly at most major river basins such as Perak River (Trans Perak Irrigation Scheme), Kelantan River (KEMUBU Irrigation Scheme) and Besut River (KETARA Irrigation Scheme). It can be seen that most of the expansion took place in deltas and along river floodplains, with little or no technical change, and without any major hydro-technological works. Canaling also served the crucial purpose of communication (and provided places for homesteads), flood regulation allowed to better control flood-based agriculture.

Other irrigation water source is from large reservoirs or storage dams (McCully 1996). Advances in the technology of large dam and reservoir construction in South East Asia became the foundation for surface irrigation system development Malaysia. During the so-called construction period the expansion of irrigation occurred largely through the construction of dams, reservoirs, and canal distribution networks. Currently there are 47 single-purpose and 16 multipurpose dams with a total storage capacity of 25 billion m^3. Among major scheme is MUDA irrigation located in the State of Kedah. The MUDA Irrigation Scheme comprises the construction of three dams, a tunnel connecting two of the reservoirs, ancillary structures and a system of irrigation canals in the States of Kedah and Perlis to provide water for two crops of paddy a year on an area of 261,500 acres (Yashima 1987). About half of this area is at present served by an irrigation system, which, however, supplies water for a single crop of paddy; the rest of the acreage is entirely dependent on the monsoon. The scheme is designed, on full development, to produce an increase in net farm benefits amounting to US$30 million per year.

5. Problems

i. Irrigation Operational Performance

Irrigation is always associated with proper water resources, mainly from river and rainfall. Although Malaysia is rich in waters, there are certain dry months (May-August) where water can be dropped creating so called “agriculture drought”. Therefore, to ensure continuous water supply, all irrigation schemes operated must be at operational performance. However, some of this irrigation works are below expectations. For example the Krian Scheme facilities are not operating according to plan.

The technical changes in rice farming--particularly the move to direct seeding--associated with mechanization have had marked effects on demand for irrigation water. They make it much more important for farmers to be able to control the amounts and timing of water deliveries. And in practice they also mean that planting and harvesting dates are less uniform than they used to be, so that neighboring farmers no longer demand water at the same time as one another. It is technically impractical to meet the increasingly individualized water demands of mechanized farms through gravity-based, surface-flow systems like those supported in this scheme. Because the project schemes cannot fine-tune and micro-plan water deliveries, the canals in general deliver more water per hectare than necessary. To achieve the control they need over amounts and timing of water, farmers in MUda and parts of Northwest Selangor buy and install their own low-lift pumps to lift water from public canals and drains. Although this costs them more than the public irrigation water, pumping is preferable to the prospect of reduced yields or a lost crop due to insufficient or untimely water supply.

ii. Inefficient agricultural water use

Increased competition for water between sectors already affects agriculture in Malaysia and the trend is towards an intensification of the problem due mainly to the rapid growth of the domestic and industrial sectors. Water scarcity and the interdependency between water use sectors are pushing Malaysia to develop integrated water resources management programmes. Water quality and the increased importance of water conservation and protection are also major growing concerns. Agriculture uses about 68% of total water consumption in Malaysia but irrigation efficiency is 50% at best in the larger irrigation schemes and less than 40% in the smaller ones. There is also no recycling of irrigated water. All of these factors challenge the sustainability of water resources.

The failure to develop adequate operation and maintenance mechanisms to ensure the sustainability of the irrigation schemes (mostly large, public schemes) has led to irrigation management transfer or increased participation of users in the management of the schemes. This is achieved through the development or improvement of water users associations. In case of Malaysia, this country has undergone deep societal and socio-economic transformations, characterized by: fast economic growth (until recently at least), especially in the industrial and services sectors; liberal macro-economic policies, development of trade reforms and privatization in the public sector and institutions; development of the civil society; and growing awareness of environmental issues and problems. In general, it is estimated that these profound changes in the environment, dominated by the need to adapt to water scarcity chiefly by the adoption of demand management strategies, call for a deep transformation of the irrigation sub-sector by the adoption of the following measures.

Modernization of irrigation schemes as a part of a broader transformation of the water and agricultural sectors, responds to a complex set of institutional, technical, operational and economic issues, and would consist of a complex set of institutional, technical, operational and agricultural changes, generally associated with changes in water pricing and cost recovery. There is a general agreement on the specific objectives of the improvement of the performance of irrigation systems, in terms of delivering water to farmers in a more efficient, flexible, reliable and equitable manner. However, progress in Malaysia is rather slow when compared with other countries. Concepts related to service-oriented irrigation are not yet widespread or understood.

6. Future scenario

The growth of population and the expansion of the industrial and manufacturing sector have led to a rapid increase in water demand in the country. The domestic and industrial water demand has increased from about 1.3 billion m3 in 1980 to 2.6 billion m3 in 1990 and is projected to reach 4.8 billion m3 by the year 2000. The irrigation water demand is increasing less rapidly from about 7.4 billion m3 in 1980 to 9.0 billion m3 in 1990 and is expected to reach 10.4 billion m3 by the year 2000. The aggregate total water demand is therefore estimated at 15.2 billion m3 by the year 2000 as compared to 11.6 billion m3 in 1990 with the domestic and industrial water supply sector registering the highest percentage increase.

In this respect, the irrigation sector is also expected to face mounting pressures from the domestic and industrial water supply sector over its share of the water resources in a river basin wide context. In water-stressed basin, there is a need to develop interbasin or even interstate transfer of water subject to technical and economic feasibility. In practical situations, it is often found that many of these proposals can be cost prohibitive, even for domestic and industrial water supply projects under the present pricing policy and structure. Hence in the near future, many of the water allocation conflicts between agriculture and non-agriculture sectors may have to be resolved through a policy of reconciliation (Pulver & Nguyen, 1998). Every effort should be made to improve water use efficiency or to cut down undue losses as compared to the construction of massive new capital works. Where the conditions are favourable, groundwater resources could also be developed to supplement surface water resources for agricultural and non-agricultural purposes.

7. Conclusion

The challenge to produce more rice with less water, economically and in ways that will be adopted by farmers in a context of reformed agricultural and water policies and integrated water resources management appears formidable yet is vital for the food security of the Region. This will require considerable investments in economic as well as human resources.

A range of options are available for increasing the productivity and efficiency of water in surface irrigated rice ecologies. More radical options departing from traditional systems are also available and may be required. Over the past decades, substantial gains have already been achieved and farmers have demonstrated that, provided that they are empowered, have the economic incentives and an adequate production tool and irrigation service, they could quickly adopt substantial changes in their water management practices. However, new institutional and technical approaches have had limited impacts in the field.

The most appropriate strategies to adopt will vary over time and space and will have to be designed carefully with the involvement of the farmers, but will need to be resolutely forward-looking and perhaps revolutionary. Identifying the policies, management practices and technologies needed at farm, system and basin level will require a multi-disciplinary approach, substantial investments in collection and analysis of new and relevant information and research, as well as constant evaluation of present approaches and practices.

It is necessary and timely to promote integrated water resources management at the basin or national level to ensure that water resources, in terms of quantity or quality will not become a constraint to the sustainability of future socio-economic development activities. This would required assessment and evaluation of the water resources potential of a river basin at an early stage and the formulation of a rational water resources allocation policy and a long term development and management master plan, to ensure the optimum use of resources and the sustainability of all existing and planned future development. The country must also devote suitable and appropriate human and financial resources to implement the required water resources development and management master plan. In the light of the privatisation policy of the Government, there is a need to establish integrated and multi-disciplinary institutions to carry out the functions of planning and regulatory control of water resources and land use changes at basin, state and national level.

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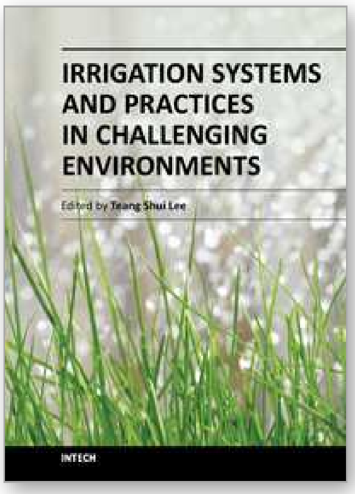

Irrigation Systems and Practices in Challenging Environments
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The book Irrigation Systems and Practices in Challenging Environments is divided into two interesting sections, with the first section titled Agricultural Water Productivity in Stressed Environments, which consists of nine chapters technically crafted by experts in their own right in their fields of expertise. Topics range from effects of irrigation on the physiology of plants, deficit irrigation practices and the genetic manipulation, to creating drought tolerant variety and a host of interesting topics to cater for the those interested in the plant water soil atmosphere relationships and agronomic practices relevant in many challenging environments, more so with the onslaught of global warming, climate change and the accompanying agro-meteorological impacts. The second section, with eight chapters, deals with systems of irrigation practices around the world, covering different climate zones apart from showing casing practices for sustainable irrigation practices and more efficient ways of conveying irrigation waters - the life blood of agriculture, undoubtedly the most important sector in the world.