

# **Application of MASSCOTE Approach on Modernization of Irrigation System - A Case Study for Tanjung Karang Rice Irrigation Scheme Malaysia**

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## **Abstract**

Tanjung Karang Rice Irrigation Scheme (TAKRIS) located in the state of Selangor is one of the eight Rice Granary Areas in Malaysia. With the total command area of 19 000 ha and current average yield of 5.0 tonnes per ha per season and cropping intensity of 200 percent, this scheme is considered as the most productive and progressive scheme in the country. To achieve the targeted rice yield of 10 tonnes per ha per season, this scheme needs to be modernized in terms of irrigation infrastructures and production management. The scheme is facing several constraints to increase the rice production due to the defective infrastructures and the failure of the irrigation system to comply with the need for planting of high yielding rice variety for the targeted yield, due to the faulty irrigation infrastructures and poor water distribution. The Rapid Appraisal Procedure (RAP) was used as a diagnostic and evaluation tool for all large irrigation schemes in Malaysia, including this scheme. The RAP evaluation of this scheme was conducted in 2007. The outcomes of the RAP evaluation of the scheme conducted in 2007 and Mapping system and Services for Canal Operation Techniques (MASSCOTE) approach guidelines were used in guiding development, operation and management of the scheme. This has enabled decision makers to ensure that diagnosis and solutions are investigated properly before engaging in the investment plans to suggest some specific strategies on how one should make the best use of the modernization investment of the irrigation project. This paper discusses how the RAP evaluation and MASSCOTE approach was used in the planning and execution of the modernization of the scheme considering the financial availability, the technical requirement, capacity building and institutional set up for the management of the scheme. The modernization plan for the scheme has been laid down and scheduled for implementation depending on the allocation provided by the Federal Government starting from the Ninth Development Plan (2006-2010) and will be continued in the next Tenth and Eleventh Development Plan (2011-2020). The adaptation of MASSCOTE has provided clear direction to guide the irrigation agency in the planning and execution of the modernization plans.

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## Summary and Conclusion

The Tanjung Karang Rice Irrigation Scheme (TAKRIS) with the total command area of 19 000 ha is considered as the most productive and developed scheme in Malaysia. The modernization is critically required to support double cropping of rice cultivation with high yielding variety, and mechanized production, increase water use efficiency for economical and environmental sustainability of the scheme. The Irrigation and Agricultural Drainage Division, Ministry of Agriculture and Agro-based Industry, envisage reforms in the scheme management and infrastructure development to modernize the rice production system and water resources, irrigation and drainage systems. MASSCOTE approach has been used to generate practical options and solutions for service and operation of the scheme. TAKRIS had been selected as a pilot project for the irrigation and farm management modernization program which will then be replicated in the other rice granary areas. The investigation, analysis and findings on options for TAKRIS was based on eleven MASSCOTE steps conducted by Technical Committee for Irrigation Modernization that came up with the recommendations for irrigation modernization for the scheme.

RAP external indicator indicated the comparatively good output per unit area, but indicators relating water use, such as output per unit irrigation supply, relative water supply, relative irrigation supply, main canal delivery capacity and irrigation efficiency are all far below expectation. RAP internal indicators point out to the problems of high fluctuation in water level, long travel time, lack of appropriate flow measurement, lack of maintenance, lack of remote spill monitoring, absence of regulating reservoir and large gap between what manager thinks and actual estimation on ground for all canal levels. There are also a lot of leakages and uncontrolled field off-takes flow, ineffectiveness of ordering and water delivery procedures, and low flow rate capacity of off-takes at tertiary canals. Water delivery service quality to individual farmers is low. There is also lack of proper road communication along main and tertiary canals. There are also lack of farmers' participation and contribution in management, operation and maintenance of the scheme. Many other problems encountered in the scheme have also been realized during the site visit for RAP evaluation exercise.

The iterative process based on the other 10 steps of MASSCOTE has produced a list of recommendations on modernization options for the scheme. The propose programs for implementation have been arranged according to priorities and the implementation schedule is laid down based on the impact to water delivery service and other advantages as recommended in MASSCOTE analysis, considering the allocation provided, practicality and time frame for implementation. Several management and infrastructure improvement works have been implemented and completed; some are in progress and others on the feasibility and design stages. One of the completed projects, the construction of a new cross regulator in the main canal at the end part of Compartment 2 has successfully solve the previous water control problem and ensured supply to the two problematic compartments.

Other projects are progressing well, and several projects are expected to be completed by the end of this year, the final year of the Ninth Malaysian Plan implementation. As for monitoring and evaluation of the irrigation modernization programs, the relevant and appropriate data has been planned for proper collection, analysis and making effective use for operation and benchmarking. Benchmarking of the scheme is planned to be conducted annually, while new RAP is planned to be carried out in April next year to evaluate the effects of the modernization to overall scheme performance. The application of MASSCOTE for irrigation modernization of TAKRIS has successfully provided the stakeholders a clear picture on the type and method of modernization, aspect and areas to be given priorities, planning and scheduling of modernization plans and finally the required continuous monitoring and evaluation of the modernization programs. With the clear insight of the modernization related factors, the appropriate management intervention and financial investments and physical development can be properly scheduled, implemented and monitored. As modernization is a long term and continuous process, the implementation of the plans, continuous monitoring and evaluation, continuous improvement through corrective actions will ensure the achievement of its vision. TAKRIS is an example of the application of this approach in irrigation modernization with clear vision on the future agriculture and water management.

## **1. INTRODUCTION**

The Tanjung Karang Rice Irrigation Scheme (TAKRIS) located in the state of Selangor is one of eight Rice Granary Areas in Malaysia. With the total command area of 19 000 ha and average yield of 5.0 tonnes per ha each season and cropping intensity of 200 percent annually, this scheme is considered as the most productive and progressive scheme in Malaysia. To achieve a new target of average rice yield of 10 tonnes per ha per season, this scheme needs to be modernized in terms of irrigation infrastructures and rice production management. The modernization is critically required to ensure the scheme's ability to support double cropping rice cultivation with high yielding variety, and fully mechanized production, increase water use efficiency for economical and environmental sustainability. The Irrigation and Agricultural Drainage Division Ministry of Agriculture and Agro-based Industry Malaysia envisage reforms in the scheme management and infrastructure development to modernize the production system and water resources, irrigation and drainage systems. The MASSCOTE approach has been used to generate practical options and solutions for service and operation of the scheme. TAKRIS has been selected as a pilot project for the irrigation and farm management modernization program which will then be replicated in other rice granary areas in Malaysia.

## 2. DESCRIPTION OF THE PROJECT AREA

The Bernam River water is diverted to the scheme via 39 km feeder canal and Tenggi River to the main canal. The main canal consists of 38 km of earth canal. There are 6 secondary canals, 33 km long in which 10 km are concrete lined and the remaining 23 km is still earthen canal. The total length of tertiary canal is 493 km, all are concrete lined. The design head discharge capacity of the canal is  $35\text{m}^3 \text{ s}^{-1}$  and is designed to run on a full supply level (FSL) of 9.6m head. The required FSL at the main canal is 4.50m. A portion of the downstream part of the scheme receives the irrigation supply from the BaganTerap Pumping Station.

The salient features of the Tanjung Karang Rice Irrigation Scheme are given in Table 1 and a pictorial view is shown in Figure 1.

**Table 1: Salient features of the Tanjung Karang Rice Irrigation Scheme (TAKRIS)**

1	Gross command area (ha)	<b>19,000</b>
2	Net command area (ha)	<b>18,800</b>
3	Secondary Canals (no./length in km)	<b>6/33</b>
4	Tertiary canals (no./length in km)	<b>113/493</b>
5	Main canal Off-takes to secondary canal (no.)	<b>5</b>
6	Main canal and Secondary canal Off-takes to tertiary canal (no.)	<b>113</b>
8	Direct field off-takes on tertiary canal (no.)	<b>16,000</b>
9	Drainage system (length in km)	<b>800</b>
10	Diversion and intake structures (Headworks)	<b>1</b>
11	Main Pumping Station(no of pumps)	<b>3</b>

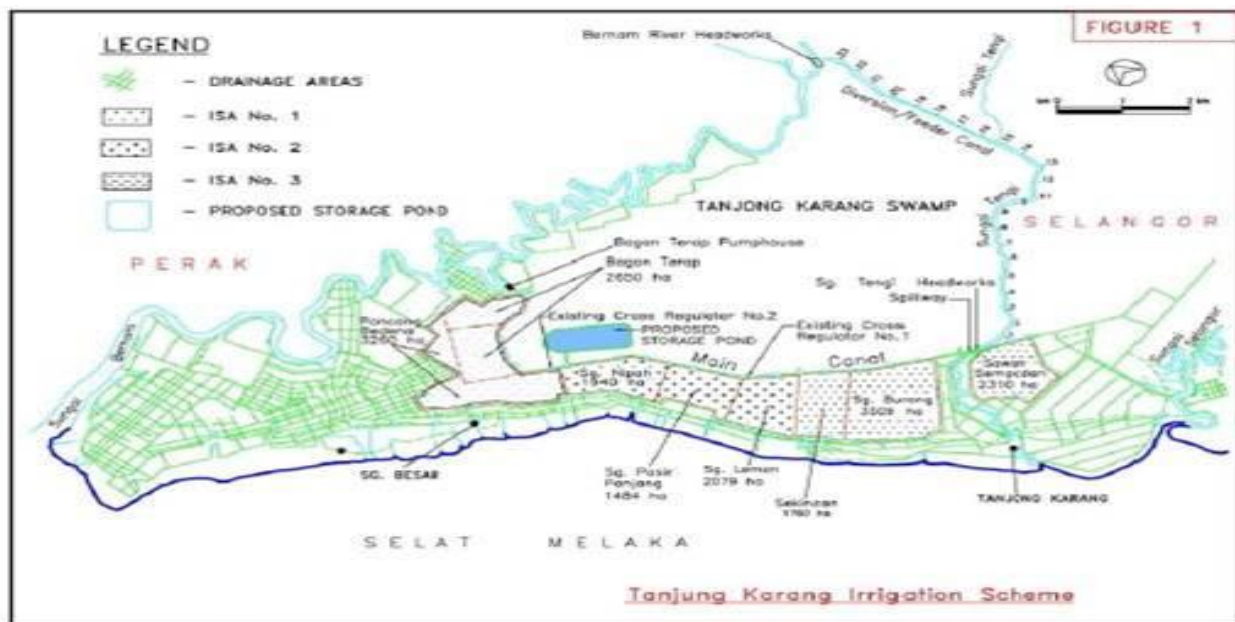


Figure 1: Tanjung Karang Rice Irrigation Scheme, Selangor Malaysia

### **3. METHODOLOGY**

Rapid Appraisal Procedure (RAP) evaluation of TAKRIS was conducted in September 2007 to evaluate the performance of the scheme and utilize the outcome of the evaluation for making the recommendation for the modernization plans for the project. In the same year, FAO produced Irrigation and Drainage Paper No 63 on Modernization Irrigation Management – the MASSCOTE approach. As to ensure appropriate investment of the allocated fund and anticipated future allocation, Irrigation and Agricultural Drainage Division, Ministry of Agriculture and Agro-based Industry took the proactive action to provide appropriate irrigation modernization programs for current and future 5 years development plans. MASSCOTE approach for irrigation modernization has been utilized to plan the irrigation modernization programs of the scheme.

### **4. APPLICATION OF MASSCOTE IN IRRIGATION MODERNIZATION**

MASSCOTE is an iterative process based on 11 successive steps (Renault et al., 2007).

#### **4.1 Rapid Appraisal Procedure (RAP) in TAKRIS**

RAP external indicator indicated the comparatively good output per unit area, but indicators relating water use, such as output per unit irrigation supply, relative water supply, relative irrigation supply, main canal delivery capacity and irrigation efficiency are all far below expectation. Thus, apart from improving crop yield, water use efficiency should be given emphasis. The farmers' contribution to operation and management is also very small. RAP internal indicators are related to operational procedures, management and institutional set-up, hardware, water delivery service and other processes in the scheme provide insight into what to be done to improve water delivery service and overall performance. These indicators point out to the problems of high fluctuation in water level, long travel time, lack of appropriate flow measurement, lack of maintenance, lack of remote spill monitoring, absence of regulating reservoir and large gap between what manager thinks and actual estimation on ground for all canal levels. There are also a lot of leakages and uncontrolled field off-takes flow, ineffectiveness of ordering and water delivery procedures, and low flow rate capacity of off-takes at tertiary canals.

Water delivery service quality to individual farmers is lower compared to water delivery service from main canal to secondary and tertiary canals. There is also lack of proper road communication along the main and tertiary canals, while there is good radio and voice communication within the whole command area. There are also lack of farmers' participation and contribution in management, operation and maintenance of the scheme. Table below shows external indicators of the six rice granaries of Malaysia. TAKRIS is also known as Northwest Selangor Scheme (Barat Laut Selangor -BLS)

## External Indicators of Granary Areas in Malaysia

### External Indicators

INDICATORS	MADA	KADA	PNG	KRN	SGM	BLS
Output Per Cropped Area (USD/ha)	1471	651	792	847	478	1032
Output Per Unit Irrigation Supply (USD/m <sup>3</sup> )	0.120	0.069	0.055	0.035	0.017	0.016
Relative Water Supply	6.4	4.2	4.85	6.14	6.9	6.9
Relative Irrigation Supply	2.4	1.7	2.1	2.1	4.7	4.6
Main Canal Water Delivery Capacity (%)	123	131	134	66	59	52
O and M fees collected (%)	0.6	0.0	0.0	0.0	0.0	0.0
Irrigation Efficiency (%)	42	45	39	48	17	19

#### 4.2 System capacity and sensitivity

##### Conveyance capacity of the main system

The hydraulic analysis showed that the canals sections with the existing bed gradient is unable to convey the design discharge due to siltation, inadequate width of some sections especially under the bridges and at the cross regulators. The absence of continuous bunds along those canals also caused the outflow of water from the canals to the surrounding swampy areas and inflows of water from the swampy areas into the canals. The excess water is then conveyed by this canal and diverted through the spillways. Other factors are heavy sediment of the Bernam River, flat topography, and vegetation and weed growth increasing the roughness coefficient of the canals consequently reducing the hydraulic efficiency of the canals.

##### Canal conveyance and structures capacity of secondary and tertiary canal system

Conveyance capacity of the secondary canal and tertiary canal structures are generally sufficient to provide the design discharges. However as these canals and structures are designed for 30 days pre-saturation period, they are unable to provide the new requirement for faster pre-saturation to suit current needs for high yielding variety and farm mechanization. Several structures such as tertiary canal off-take pipes provided to release water to farms are too small to provide timely water supply especially for faster land preparation water requirement and without

a proper flow control mechanism. This has caused most of the farmers to find other means to tap water from the tertiary canals by making use of plastic pipe siphon.

#### **Sensitivity of the main canal individual structures and sub-system**

There are 2 cross-regulators along the main canal designed as automated Amil gate which should function as downstream control cross regulator structure, but failed to function as intended. They are currently operated manually with the help of mechanical system installed. There are around 80 off-take structures for the tertiary canals and 5 off-takes for the secondary canals tapping water from the main canal. As most of the structures are designed as orifice off-takes, they are not so sensitive to water level fluctuations in the parent canal.

#### **Sensitivity of secondary and tertiary canal structures and sub-system**

There are 6 secondary canals in the scheme with a total length of 33 km and maximum length of 8.8 km. All cross regulators in the secondary canals are undershot structure with short side weirs and thus have high sensitivity. To reduce the sensitivity of these regulators, modification by lengthening the side weirs is suggested. There are 113 tertiary canals with a total length of 493 km. The length of tertiary canal is from 0.2 km to 6.0 km. All field off-takes to the individual lots are tapping directly from the tertiary canals. The original design of field off-takes is fixed 50 mm pipe. However, these have been abandoned by the farmers in favor of plastic siphons to meet the need of new field requirement for faster pre-saturation and larger discharge. The use of plastic siphon without proper control of flow results in chaotic management in tertiary canal and caused inequity of water delivery. Siphon is sensitive to water level fluctuation in tertiary canals.

### **4.3 Perturbations**

#### **Perturbation along the Feeder and Main canal**

Perturbation in the Main canal system is mainly due to discharge and water level variations as a result of operation of main intake and inflows from the Tengi River catchment and surrounding swamp areas to the main canal system. The supply is stable during the rainy season from the diversion, but local rainfall causes large increases in the main canal system due to inflows from the swampy areas. This perturbation is currently handled by two gated spillway structures through the operation of the gates.

#### **Perturbation along Secondary canal**

Discharge and water level perturbations in the secondary canals are mainly due to improper flow control and inaccurate flow measurement and illegal tapping. These can be controlled through the provision of proper flow measurement equipment and proper control of flow by the operators. One option is to absorb the positive perturbations in the secondary canal itself by raising the canal banks and storing the water temporarily.



### **Perturbation along Tertiary canal**

Water level and discharge fluctuations along the tertiary canal are due to illegal off-takes or the failure of the farmers to tap water according to their respective water allocation. The problems are related to the utilization of plastic siphons for field off-take. Water level fluctuation is also due to temporary weirs built by farmers to raise the water level in the absence of a proper water control device, causing extremely high perturbations for downstream users.

## **4.4 Mapping water networks and water balance/accounting**

### **Water resources**

The main source of irrigation supply is from the Bernam River. The Bernam River Headworks divert irrigation supplies to the upstream part of the scheme. The Bagan Terap Pumping Station supplies a portion of the downstream part. The design capacity of the main conveyance canal is 35 m<sup>2</sup>/s. Other sources of water are from rainfall, Tengi river and the swamp areas. During irrigation supply, the controlled drainage water is another source available. As the scheme is a run-of-river system without reservoir, the irrigation supply during low flows is insufficient to meet crop water demand. To meet the demand, reuse and recycling by pumping from the drainage system is practiced.

Within the sub-units, the main sources of water are from the canal, rainfall and recycled from the drainage system. All the sub-units have the potential of recycled water. Recycling requires the installation of pumping stations within each tertiary canal but will incur investment in initial cost and annual operational cost. Selected areas where the supply from the main canal is less assured should be given priority.

## **4.5 Mapping the cost of operation and maintenance**

The overall operation and maintenance costs for the scheme are estimated at MR 500 per year per ha or about MR 10 million annually. The irrigation tax charged to the farmers is merely MR 20 per ha, less than 5 % of the annual cost incurred. Upgrading of secondary canals to concrete line will reduce maintenance costs, but require high initial cost. Transfer of management of tertiary canal to WUG will reduce staff requirement currently overseeing secondary and tertiary canals. Good water delivery service from irrigation canal and optimization of “effective rainfall” will reduce the burden of recycling pumping cost to the government and the farmers. Enhancing farmers’ organization financially and technically will enable the transfer of management especially third level canals.



## **4.6 Service to users**

### **Water delivery service to the farmers at tertiary canal system**

Water delivery service within the scheme consists of several levels as indicated in RAP evaluation results. In this scheme and other main granary areas in Malaysia, the responsibility of operation and maintenance of irrigation schemes is still under the Irrigation Department. The outcome of the scheme RAP evaluation indicates the service quality at tertiary level canal to the individual farmers in term flow measurement, equity, reliability and flexibility as compared to the delivery service from the main canal to secondary canals. As the operation and maintenance of tertiary canal system involving small canals that are close to individual farmers, it was decided that this canal level should be managed by farmers through WUG. Nevertheless, in the long run these WUG should be strengthened and guided to group together to form a federation to have sufficient financial resources and means for operating the system and organizing the development of the association.

### **4.7 Mapping the management units – a subunit approach**

TAKRIS covers a command area of 19,000 hectares, and divided into 8 compartments of 1600 ha to 3200 ha. Each compartment has a management office for irrigation operation and extension staff and communication with farmers. For the purpose of farmers farming and irrigation management, field blocks are established covering a portion of the combination of two of tertiary canals with the area of about 80 ha. Farmers' leaders are selected by state government for each block, with modest monthly allowances. Operation of the main canal, secondary canals and tertiary canals off-takes are carried out by paid employees of state office. The current irrigation scheduling is based on the division of the scheme into three irrigation service areas (ISAs) with one month lag. Due to water level control problem during low flows, the ISA 1 is further divided into two phases of irrigation scheduling, with one month lag time. Consequently the compartment has to start one month earlier.

While the division of management units based on eight compartments is suitable for irrigation scheduling, homogeneity of grouping and flexibility in providing service to users, managerial efficiency, responsibility and professional in the definition of management levels, the current management of tertiary canal system based on blocks is not efficient and appropriate for those considerations. For more efficient irrigation and farm management, the division of sub-units for tertiary canal management is proposed to be based on each tertiary canal or combination of two canals for the shorter canals.

## **4.8 Mapping the demand for canal operation**

### **The level of service**

The demand for operation will depend on the definition of service agreed upon at main system level as well as at subunit levels. Within the command area, with the formation of WUG the demand for canal operation is for main canal and secondary canal to provide the required discharge to the tertiary canal as requested by the group as agreed upon. Water will be supplied according to agreed schedule, with the flexibility to change flows subjected to individual farmers' request through respective WUG, with three days' advance notice.

### **The perturbations**

The main perturbation along the main canal and secondary canal is related to the runoff during low flows as this affects the entire system with a similar intensity. During the high flows, the perturbations are managed through the proper operation of main intake structures, gated spillways and main canal regulators. The perturbations in secondary and tertiary canals are mainly caused by the operation of off-takes. The longer the secondary canal, the more the number of off-takes, then more effort is required to properly manage the water flows and ensure in particular that the tail-enders is receiving a fair share. Thus, the length of the secondary and tertiary networks would have to be taken as a criterion of differentiation of the demand for operation. Provision of good flow control and measurement for off-takes and water level control structures in secondary and tertiary canal will reduce the demand for canal operation related to perturbations. To reduce perturbations in the main canal, it was proposed to redesign the main canal system and regulator structures, additional regulator, provision real-time flow measurement and water level monitoring with SCADA system in the main canal system. The timely and synchronized operation of a series of cross-regulators with real-time data of flow rate and water levels monitoring will enable managers to deal with the perturbations. Reducing the operation time of the cross-regulators by mechanizing and automating the operation is another option.

### **The sensitivity**

The main sensitive part of the irrigation system is the main canal system, starting from headwork, the spillways and two cross regulators. The headworks, inclusive of weir and intake structure are very sensitive to changes in the river flow and obstruction of floating debris that requires regular operation and cleaning, and then demands for higher operation. Spillways and regulators in the main canal are also very sensitive to the changes of discharge and water level, and then require high demand for service. In the secondary and tertiary canals, the sensitive structures are mainly cross regulators as most of them are designed for undershot, instead of the preferred overshoot type for water level control. In this case, it is recommended to replace all those structures to overshoot type to reduce sensitivity, and consequently reduce the demand for canal operation in those canals.

## **Recycling**

Recycling is needed in some sub-command areas, especially at tertiary canal level. This criterion is therefore a critical one in allocating efforts for operating the tertiary system. Wherever there is supply from recycling, fewer efforts are needed for operation and while, in the areas without recycling facilities, extra efforts are required to control water deliveries on the upstream side.

### **4.9 Mapping options for canal operation improvements and sub unit improvement**

#### **Proposed improvements for TAKRIS**

##### **a) Water management improvement strategy to increase water productivity**

Water management strategy for the main canal system requires the improvement of the feeder canal and Tengi River conveyance and the main canal conveyance and structures. The water management strategy is to increase water productivity and efficiency through minimizing water losses, managing perturbations and consolidation of flow control throughout the scheme. The existing regulator, located at the end of the ISA 1 is unable to provide the required water control to meet the requirement of these two compartments. Additional regulator is required to improve water management for the two compartments.

At the unit level, the existing practice deferred with the original design where the tertiary canal supply based on rotational supply between head and tail-end users. The pre-saturation period is reduced to less than 14 days to suit the new farm operation and crop water requirements. The larger plastic siphons have been widely used to tap water from the tertiary concrete canals. The indiscriminate use of siphons has caused the low equity along tertiary canals and waste of water through runoff flows from the field to drains. The new strategies are required for water management at the scheme and tertiary canal level.

##### **b) Improvement in water control**

Based on internal indicators of RAP, these improvements are proposed to improve water control:

- 1) Provision of flow measurement and water level measurement along the main canal and at the pumping station;
- 2) construction of one new regulator and replacement of two existing regulators with modern design with the provision of long crested weirs;
- 3) modification from existing undershot to overshoot type and increase the number of cross regulators along the secondary and tertiary canals structure;
- 4) redesign of field off-takes;
- 5) determining new water level and discharge targets for each structure and setting proper operational procedures to meet the targets;
- 6) provision of water ordering and delivery procedures.

### **c) Improvement for cost effectiveness**

Operation accounts for a major cost of irrigation management. Options as to improve cost effectiveness are through reducing frequency of adjustments of new design of regulator and off-take structures, automate or mechanize the gate operation of main gated structures and utilize an effective information management system

### **d) Conjunctive use of water**

The proposed conjunctive use of irrigation water, rainfall and recycling of water from drainage canals or regulating reservoir for the scheme through the construction of regulating reservoirs and storages, recycling water from drainage system and separation of irrigation canal and drainage system to prevent the inflow of acidic water from the swamp area

### **e) Improving sub unit operation**

Water management for tertiary system requires extra attention due to its important role to provide excellent water delivery service to support new high yielding rice cultivation and associated farm management. Tertiary canal water management is closely related to on-farm water use and management, hence should be considered together. For this purpose, a research through a pilot project was proposed to identify most appropriate design of the structures and management system at this level. Conjunctive use of water from drainage system through the provision of recycling pumping stations at the tertiary canal system is proposed to increase water productivity and fast response to crop water needs.

## **4.10 Integrating service oriented management options**

### **a) Aggregating the rationale of sub units at upper level**

The rationale of water management, service, and operation at the compartment and tertiary canal level is subjected to the current and future needs for cultivation of high yielding rice cultivation, application of precision farming and irrigation, utilization of modern farm machineries to increase farm efficiency, increase water use efficiency at tertiary and on farm level, optimization of “effective rainfall” and control of chemical flow to the drainage system through surface runoff and seepage. This will require equitable, reliable and flexible supply from the main canal and secondary canal systems. The water management and service delivery from the main canal to secondary and tertiary canals need to be improved through various physical and managerial interventions.

## **b) Reaching a compromise between costs and service**

Reaching a compromise between technical opportunities and constraints, farmers' desires influenced by the agricultural system, and cost of operation incurred are very difficult to achieve within the limited time frame. This will require extensive negotiation between farmers and the government, represented by the Irrigation and Agricultural Drainage Division, Ministry of Agriculture and Agro-based Industry. As to encourage farmers to increase rice production, various incentives have been introduced by the government, including provision of better irrigation and drainage infrastructures to support the drive. Taking this opportunity, the plan for modernization through government allocation is targeted to increase water delivery service quality to make it convenient for the farmers to accept the responsibility and obligations after benefiting from the better service provided.

## **c) Service agreements**

To date, there is no proper service agreement in the scheme between the users and service provider. This will take some times as the WUG that will represent the users is still in the formation process. Negotiation will only possible when the farmers are appropriately represented in the process.

## **5. MODERNIZATION PLANS FOR TAKRIS (2008 to 2020)**

For TAKRIS, the vision of the scheme and irrigation modernization covering the agriculture and water management domains has been decided by the management as:

*“Tanjung Karang Rice Irrigation Scheme to become national and world leader in RICE producing industry through the application of latest technology for high yielding rice, creation of progressive, united and commercial farmers, efficient and effective water management and project economic and environmental sustainability by the year 2020”*

Modernization Plan for TAKRIS is divided into three phases: Phase 1 Ninth Malaysia Plan (2006 to 2010); and Phase 2 and phase 3 (Tenth and Eleventh Malaysia Plan (2011 to 2020).

The irrigation modernization programs chosen from the recommended options have been scheduled according to the three phases as follows:

### **a) Phase 1 - Ninth Malaysia Plan (2006 to 2010) – allocation MR100 million (about USD25 million)**

- i. Redesign and construction of feeder canal and Tenggi River with the provision of appropriate canal section, continuous bunds and drains

- ii. Desilting of main canal system and provision of farm road and continuous bund along the main canal
- iii. Design and construction of a new cross regulator at Sungai Burung Irrigation Compartment. New modernized design should include features such as mechanized gate lifting and long crested side weirs
- iv. Construction of a regulating reservoir.
- v. Construction of electrical submersible pumping stations for drainage water recycling
- vi. Pilot project on improvement of tertiary canal and on farm infrastructures and water management for high land and water productivity and good control of chemical and rainfall optimization
- vii. Provision of real time SCADA system for water management of main canal system with the installation ADFM for flow measurement and water level monitoring equipment, rainfall stations and other ancillary facilities
- viii. Feasibility study for the construction of main reservoir close to the scheme area.
- ix. Planning and design of storage system for Bagan Terap Pumping Station
- x. Rehabilitation and upgrading of existing concrete lined secondary canals
- xi. Training for managers, operators and farmers

**b) Phase 2 and phase 3 - Tenth and Eleventh Malaysia Plan (2011 to 2020)**

- i. Constructions of the two cross regulators along main canal.
- ii. Construction of the main reservoir.
- iii. Construction of storage system for Bagan Terap Pumping Station
- iv. Improvement of tertiary canal and on farm infrastructures as recommended by the pilot study
- v. Extension of real time SCADA system for water management to the secondary canal systems with the installation of ADFM for flow measurement and water level monitoring equipment, rainfall stations and other ancillary facilities
- vi. Design and construction of secondary canal upgrading to tertiary canal to improve water delivery service and reduce losses
- vii. Training for managers, operators and farmers

**6. MONITORING AND EVALUATION**

For the purpose of monitoring and evaluation of TAKRIS, three activities have been planned:

- a) Conducting RAP three months after the end of each Development Plan and Mid Term Review of the plans
- b) Benchmarking of the scheme every year
- c) Continuous monitoring for all aspects of irrigation management.

## 7. CONCLUSIONS

Application of MASSCOTE for irrigation modernization of TAKRIS has successfully provided the stakeholders a clear picture on the type and method of irrigation modernization, aspect and areas to be given priorities, planning and scheduling of modernization plans and finally the required continuous monitoring and evaluation of the modernization programs. With the clear insight of the modernization related factors, the appropriate management intervention and financial investments and physical development can be properly scheduled, implemented and monitored. TAKRIS is an example of the application of this approach in irrigation modernization with clear vision on the future agriculture and water management of the scheme. As modernization is a long term and continuous process, the implementation plans, continuous monitoring and evaluation, continuous improvement through corrective actions will ensure the achievement of the scheme's vision.

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