

Kingdom of Cambodia

Ex-Post Evaluation of Japanese ODA Grant Aid Project  
“The Project for the Rehabilitation of the Kandal Stung Irrigation System”

External Evaluator: Machi KANEKO, Earth and Human Corporation

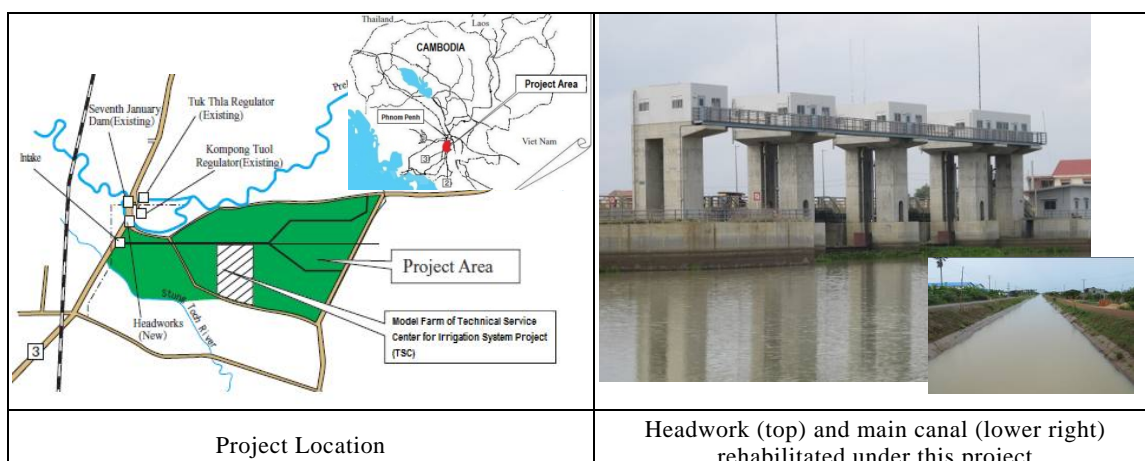
**0. Summary**

This project is intended to rehabilitate existing irrigation facilities in the Kandal Stung irrigated area and provide stable supply of irrigation water in the rainy season. The objective of the project is relevant with the development plan of Cambodia “community livelihood improvement through agriculture production” and its development needs. Therefore, the relevance of the project is high. The rehabilitated irrigation facilities caused the discharge of the main canal to increase, which has promoted conversion to the irrigated agriculture in the area concerned. The cropping area, yield per hectare, and farm income have almost achieved their targets to be aimed for in four years after completion, and farmers are fully satisfied with agricultural water supply.

Since the rehabilitation of secondary and tertiary canals borne by the Cambodian side was delayed, however, the efficiency of the project is low. As for maintenance of facilities, a framework of farmer’s group for operation and maintenance has been organized, but further reinforcement is required for developing into an independently functioning organization. Therefore, the sustainability of the project is fair.

In light of the above, this project is evaluated to be partially satisfactory.

**1. Project Description**



**1.1 Background**

Now that peace is being built and people are returning to a peaceful life in the Kingdom of

Cambodia (hereinafter referred to as “Cambodia”), the government of Cambodia has promoted agricultural development, thinking that development of agriculture, a key industry of the country, is required to increase national economy and reduce poverty. Especially as a part of agricultural development, Cambodia focuses on the conversion from rainfed agriculture to irrigated agriculture to improve farm income and the standard of living for accomplishment of the above goals. When the project was planned, however, 70% of existing irrigation facilities were damaged due to civil war, flood etc. and hardly fulfilled their functions.

Since the Kandal Stung irrigated area (hereinafter referred to as the “Project Area”), about 20 km southwest of Phnom Penh, has fertile soil and offers good access because of its location along National Roads No.2 and No.3, it is expected to play a role as the food supply base for Phnom Penh. The Project Area, however, has not fulfilled its function properly because of the unsatisfactory condition of the existing irrigation facilities.

Under such a situation, the Cambodian government requested the Japanese government to provide technical assistance on integrated agricultural development focused on rehabilitation of the existing irrigation facilities in the suburbs of Phnom Penh including the Project Area. In reply to this request, the Japanese government undertook the “Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh” from 1994 to 1995. As a result, the Kandal Stung irrigated area, the Project Area, of 1,950 ha was selected as the first priority area for development. At that time, the Project Area had the existing irrigation facilities constructed under the “Pol Pot Regime” (such as regulating gate and Pol Pot canals<sup>1</sup>), but they were severely deteriorated. Especially, the main canal was silted with its slopes seriously eroded. Furthermore, improper design of both gradients of canal and facilities prevented distributed irrigation water from reaching the end of fields.

Consequently the Cambodian government requested grant aid from the Japanese government for rehabilitation of regulating gates and main canal aiming at stable supply of irrigation water.

In the Project Area, a technical cooperation project, the Project for Technical Service Center for Irrigation System (TSC1) was implemented from 2001 to 2005 to develop the skill of irrigation engineers of the Ministry of Water Resources and Meteorology (MOWRAM), with a part of the irrigated area (260 ha) selected as an OJT (On-the-Job Training) model site. After that, the phase 2 of the above project (TSC2) was implemented in three provinces from 2006 to 2009. Further following TSC1 and TSC2, the Improvement Agricultural River Basin Management & Development Project (TSC3) started in six provinces in 2009 and will last

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<sup>1</sup> Those main canal and related structures constructed under the Pol Pot Regime (in the 1970’s) are called “Pol Pot canals.” Since Pol Pot canals were arranged on a grid along latitudes and longitudes regardless of land gradient, they often function improperly; water does not reach fields with an inverse gradient.

until 2014.

## 1.2 Project Outline

The project is intended to rehabilitate the existing irrigation facilities (intake facilities, irrigation canals, and maintenance roads) for stable irrigation water supply in the rainy season.

Grant Limit / Actual Grant Amount	1,740 million yen / 1,709 million yen
Exchange of Notes Date	January 2005
Implementing Agency	Ministry of Water Resources and Meteorology
Project Completion Date	August 2007
Main Contractor	Konoike Construction Co., Ltd.
Main Consultant	Nippon Koei Co., Ltd.
Basic Design	December 2004
Related Projects (if any)	- Development study, "Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh" (1994 - 1995) - Technical cooperation project, "Project for Technical Service Center for Irrigation System" (Phase 1: 2001 - 2005, TSC1), (Phase 2: 2006 - 2009, TSC2) - Technical cooperation project, "Improvement Agricultural River Basin Management & Development Project" (2009 - 2014, TSC3)

## 2. Outline of the Evaluation Study

### 2.1 External Evaluator

Machi KANEKO, Earth and Human Corporation

### 2.2 Duration of Evaluation Study

The External Evaluator performed an evaluation study as follows in the course of this ex-post evaluation:

Duration of the Study: October 2011 – August 2012

Duration of the Field Study: March 26 – April 14, 2012 and May 26 – June 9, 2012

### 2.3 Constraints during the Evaluation Study (if any)

None.

### **3. Results of the Evaluation (Overall Rating: C<sup>2</sup>)**

#### **3.1 Relevance (Rating: ③<sup>3</sup>)**

##### 3.1.1 Relevance with the Development Plan of Cambodia

When the project was planned, agriculture is the main industry in Cambodia accounting for 36% of the GDP and 70% of employment. In Cambodia's national policy of second Socio-economic Development Plan (2001-2005), "sustainable national resources management in consideration of environment" was proposed as one of the basic policies. To improve agricultural productivity, Cambodia thought it is indispensable to develop irrigation for effective use of water resources. Especially to increase productivity of rice cropping that is a key product in Cambodia, great emphasis was placed on improvement of irrigation and drainage infrastructure and development of human resources. Further the Cambodian government identified rehabilitation of old irrigation facilities and enhancement of their maintenance as a short-term policy.

As of the ex-post evaluation, the Cambodian government recognized management of water resources and irrigation as well as increase of agricultural productivity as top priority in the Rectangular Strategy announced as framework for Cambodia's national development in 2004. The measures for increased agricultural productivity and diversified production include increase of yield from existing farmlands, installation of irrigation facilities, and improvement of water management as key elements.

In the National Strategic Development Plan (2009-2013) enacted to realize the Rectangular Strategy, emphasis was still placed on development of the agriculture sector and increase of agricultural productivity. Then actual targets for expansion of irrigation area and increase of rice yield per hectare were set (irrigation area: expansion by 25,000 ha/year, rice yield per hectare: 3.83 ton/ha).

As a result, the project aiming at expansion of irrigation area and increase of rice yield per hectare by rehabilitation of irrigation facilities was relevant with the policies of the Cambodian government when it was planned. Also the project is still relevant with them as of the ex-post evaluation, judging from the fact that expansion of irrigation area and increase of rice yield per hectare remain key policies.

##### 3.1.2 Relevance with the Development Needs of Cambodia

In Cambodia, the civil war lasting 20 years caused agricultural infrastructure such as irrigation facilities to be seriously damaged and many irrigation engineers to be lost. In consequence of this, irrigation has been developed improperly. The Project Area, Kandal

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<sup>2</sup> A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

<sup>3</sup> ③: High, ②: Fair, ①: Low

Stung irrigated area, was in the similar condition. Since facilities were designed and constructed in disregard of basic technical information such as topographic map and design standards, irrigation facilities suitable for this area were not provided. In most of the area, gravity irrigation was not available even in the rainy season. For this reason, agriculture in the Project Area was subject to substantially the same cultivation conditions as those under the rainfed circumstances, and limited to single cropping (cropping once a year) of local rice varieties having resistance against unstable water utilization. Few farmers having their farmlands near canals, however, could use pump for irrigated agriculture. There was a gap in income between farmers with double cropping of rice by taking in irrigation water and farmers with single cropping of only local rice varieties. Further, since the Prek Thnot River shows a great difference in river discharge between the rainy season and dry season, the Project Area is often exposed to flood or drought risk. This fact had prevented conversion into cropping of high-yield rice varieties that require adequate water management.

Consequently, farmers in this irrigated area had no alternative to cropping of local rice varieties with low-yield (1.7 to 2.0 ton/ha), which had mainly caused low farm income.

As of the ex-post evaluation, implementation of the project had provided stable irrigation water supply necessary for the entire Kandal Stung area (1,950 ha) as well as foundation for promotion of irrigation development in the area. This allowed farmers to convert rainfed agriculture that depends only on local rice varieties (low-yield) to irrigated agriculture of IR varieties (high-yield). In this respect, the project is relevant with the development needs of Cambodia.

While the rice yield per hectare<sup>4</sup> (2010) has been increased to about 2.97 ton/ha due to recent rehabilitation or construction of irrigation facilities, it still remains lower than other neighbor countries such as Socialist Republic of Vietnam (about 5.32 ton/ha), Lao People's Democratic Republic (about 3.59 ton/ha), and Union of Myanmar (about 4.12 ton/ha). Reinforcement of irrigation facilities is still required.

### 3.1.3 Relevance with Japan's ODA Policy

In the Cambodia-specific aid plan, one of Japan's Cambodia aid policies, "realization of sustainable economic growth and stable society" is identified as an important field. This includes development of agriculture and rural communities as well as improvement of agricultural productivity. Further a policy to proactively promote grant aid for rehabilitation of irrigation facilities and improvement of water management systems is identified.

Through implementation of the project, irrigation facilities constructed under the Pol Pot Regime have been rehabilitated to provide the foundation for stable supply of irrigation water which farmers require for irrigated agriculture.

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<sup>4</sup> Source: Food and Agriculture Organization of the United Nations (FAO).

In light of the above, this project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy, therefore its relevance is high.

### 3.2 Effectiveness<sup>5</sup> (Rating: ③)

#### 3.2.1 Quantitative Effects (Operation and Effect Indicators)

##### (1) Intake volume

This project is intended to supply irrigation water enough to introduce double cropping in the rainy season in the entire Kandal Stung irrigated area (1,950 ha) through improvement and rehabilitation of existing irrigation facilities in that area. For this objective, the amount of water resources available for this project was reviewed based on the water balance of the Prek Thnot River (including obligatory discharge outflow), and the start discharge of the main canal was set at 2.73 m<sup>3</sup>/sec. Also since the river discharge of the Prek Thnot River is decreased during about a half month from the end of April to the beginning to May during which they prepare for early cropping, shortage of soil puddling water occurs, which is a difficult situation to introduce double cropping. To solve this situation, the storage function was improved by gate heightening the crest of the Seventh January Dam with a capability of holding an intake level as well as that of the existing regulating gates to ensure stable supply of irrigation water in the rainy season including the above half-month period.

At the ex-post evaluation, the start discharge of the main canal was kept at 2.73 m<sup>3</sup>/sec as planned. Further the gate heightening of the Seventh January Dam and regulating gates improved the storage function as planned and produced effects that allow for steady intake when river discharge comes short during a period from the end of April to the beginning of May.

In this irrigated area, Pol Pot canals had operated as existing canals though their capability was low. Rehabilitation of the main canal caused discharge volume of those Pol Pot canals directly linked to the main canal to increase. In the interviews with farmers in this irrigated area, it was pointed that the discharge volume of existing canals was increased just after the rehabilitation of the main canal, which led to considerable increase of crop productivity.

##### (2) Irrigation area

At the planning stage of this project, an actual irrigation area was set as an indicator for quantitative effects, besides intake volume as described in (1). An actual irrigation area is an area of the land in which the proposed cropping pattern has been implemented, and the target area to be aimed at four years after the completion of the project is set to 800 ha. The proposed cropping pattern is based on the cropping pattern and cropping ratio (174%) both of which were proposed at the development study conducted prior to this project. In the

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<sup>5</sup> Effectiveness should be judged in consideration of impact to determine a rating.

proposed cropping pattern, the objective is to single crop in the rainy season at 1950 ha, double crop in the rainy season at 975 ha and crop in the dry season at 468 ha in the entire irrigated area eight to ten years after the completion of the project. On the other hand, MOWRAM has collected data on cropping area in each season in the entire irrigated area, but has not identified the proposed cropping pattern as an indicator of the project objective. Thus MOWRAM was not able to determine the total area of the farmlands in which the proposed cropping pattern was implemented.

Some farmlands are not included in an actual irrigation area, though irrigated agriculture is already implemented there. Since cropping area expands in such farmlands, an actual irrigation area is not an adequate indicator for the ex-post evaluation to be conducted about three years after the completion of the project. MOWRAM has data about actual cropping area in each season (single cropping in the rainy season, double cropping in the rainy season, and cropping in the dry season), as shown in Table 2 below. The latest cropping areas are 1,593 ha for single cropping in the rainy season, 339 ha for double cropping in the rainy season and 294 ha for cropping in the dry season, and a total cropping area is 2,226 ha. This indicates the irrigation facilities constructed under this project operate as planned to allow for stable intake and supply of irrigation water, which has increased the cropping area in each season to the current level.

Further, some farmers triple crop rice (cropping three times a year), though the number of such farmers is still small. The trial of triple cropping is being made in farmlands in which access to water is available in the dry season with attention to the water volume of the main canal. The following <Reference Information> and Table 5 (page 12) show the features of each season. Now farmers in the Project Area can decide the number of cropping, cropping season and rice variety for themselves considering conditions of water supply to their farmlands and manpower and crop based on their decision. For example, a farmer who mainly depends on farm income for living selects a high-yield rice variety of early growing type to double crop while a farmer who earns wage income other than farm income selects a rice variety with a high unit sale price to single crop. Such diversified livelihoods of farmers are attributed to expansion of the irrigation area where irrigation water is stability supplied. This also contributes to the stabilization of farmer income throughout the year.


Table 2: Cropping state by season in each commune (May 2011 – April 2012)

(Unit: ha)

Commune name	Possible irrigation area based on secondary and tertiary canals	Single cropping in the rainy season		Double cropping in the rainy season	Cropping in the dry season	Total cropping area
		Mid-growing varieties (high-yield)	Local varieties	IR varieties (high-yield)		
1) Preah Putth	390	100	290	65	52	507
2) Tien	208	110	98	87	78	373
3) Rolous	153	70	83	40	70	263
4) Barku	380	150	230	50	-	430
5) Kong Noy	224	80	144	50	70	344
6) Anlong Romiet	22	12	10	2	-	24
7) Kork Trab	168	120	48	30	14	212
8) Siem Reap	48	30	18	15	10	73
Total	1,593	672	921	339	294	2,226

Source: Information provided by MOWRAM

(Reference Information)

Type	Period	Cropping state	Remarks
Single cropping in the rainy season	Jun to Nov	In this season, there are much rainfall and river discharge and the canal water level rises to the maximum. Water management is easy because the period with less rainfall corresponds to the harvest time.	 <p>This photo was taken in May 2012. From the front, you can see paddy fields just after soil puddling, paddy fields after the first time of the double cropping in the rainy season, and paddy fields before the harvest of the cropping in the dry season. In this season, the project is very effective, because river discharge is decreasing while more irrigation water is required. The data also show each farmer has come to be able to select a desired cropping timing, number of cropping, and rice variety based on his/her life style pattern.</p>
Double cropping in the rainy season	Apr to Jul Aug to Dec	To double crop in the rainy season, cropping has to start around April. At this time, however, soil puddling can be done only in lands for which water is secured from canals.	
Cropping in the dry season	Jan to Apr	In the dry season, cropping is available only in lands for which water is secured with pump from the main canal and/or secondary canals. Vegetable farming is also done.	

Under this project, the rehabilitation of secondary and tertiary canals was originally planned at the Cambodia side in parallel with the rehabilitation work by the Japanese side, but its completion was delayed until 2011. This caused the expansion of the irrigation area based on the rehabilitated secondary and tertiary canals to 1,593 ha as shown in Table 2 to be delayed to 2011<sup>6</sup>. As described above, however, the existing canals called Pol Pot canals in the Project Area distributed water from the main



Tertiary canal rehabilitated by Cambodia side

<sup>6</sup> According to MOWRAM, further rehabilitation of canals and aids for farmers are planned to achieve expansion of the irrigation area to 1,700 ha (in 2012), 1,800 ha (in 2013), 1,900 ha (in 2014), and 1,950 ha (in 2015).



canal to farmlands to the right or left of the main canal. Then farmers utilized such water for pump irrigation. Besides, an NGO implemented minor rehabilitation of existing canals in some places. As a result, the condition of existing canals had become better compared to that when the project was planned, which partially contributed to prompt supply of irrigation water.

The area for double cropping in the rainy season is rather slowly expanded due to the delay of the rehabilitation work at the Cambodia side, but this does not become a major obstacle because the area for single cropping in the rainy season has been largely expanded. Though neither the executing agency nor the District Agriculture Office has collected data about the cropping area before 2011, the change of rice production amounts as shown in Table 3 supports the effectiveness of this project. When compared between the original planning time (2001 to 2002) and the completion time of the main canal under this project (2008), rice cropping amount grew by 150%. After that it continued to grow and almost doubled in 2011. Since anxiety about unsteady water condition was alleviated, more farmers have chosen cropping of high-yield rice varieties that require adequate water management and productivity has been considerably increased.

Consequently, the irrigation area for which irrigation water is stability supplied has been expanded as planned since the completion of the project, and this clearly resulted in increase of productivity.

Table 3: Change of the rice cropping amounts in the Project Area (Unit: ton)

Commune name	2001-2002	2008	2009	2010	2011
1) Preah Putth	628	1350	1565	1593	1593
2) Tien	475	624	910	1015	1033
3) Rolous	420	459	544	513	676
4) Barku	530	1376	1505	1720	1720
5) Kong Noy	227	672	750	838	959
6) Anlong Romiet	366	72	77	84	84
7) Kork Trab	834	678	791	693	693
8) Siem Reap	-	189	202	221	221
Total	3480	5420	6344	6676	6977
(Increase ratio compared to 2001-02)	-	(156%)	(182%)	(192%)	(200%)

Source: Information provided by MOWRAM

### 3.2.2 Qualitative Effects

As qualitative effects of the project, it is assumed that stable supply of irrigation water is secured through rehabilitation of major irrigation facilities and 40% or more of the farmers in the Project Area convert from rainfed agriculture to irrigated agriculture.

At the planning stage of the project, most farmers in the Kandal Stung irrigated area farmed depending on rain water. To introduce double cropping in this irrigated area, a problem is that irrigation water has to be secured during the period from the end of April to the beginning of May. Figure 1 shown right illustrates the months in which irrigation water shortage occurred in 2011 based on the results of the beneficiary survey<sup>7</sup>. According to this figure, almost half of the respondents answered “shortage occurred” in February and March (the dry season), but its ratio decreases in April and May, the months in question. This implies conversion from rainfed agriculture to irrigated agriculture progresses smoothly.

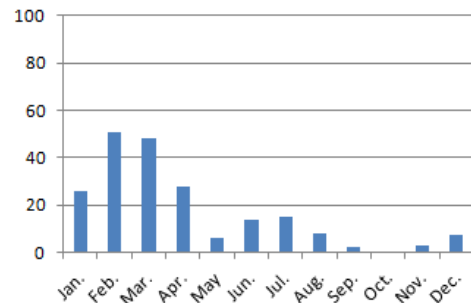
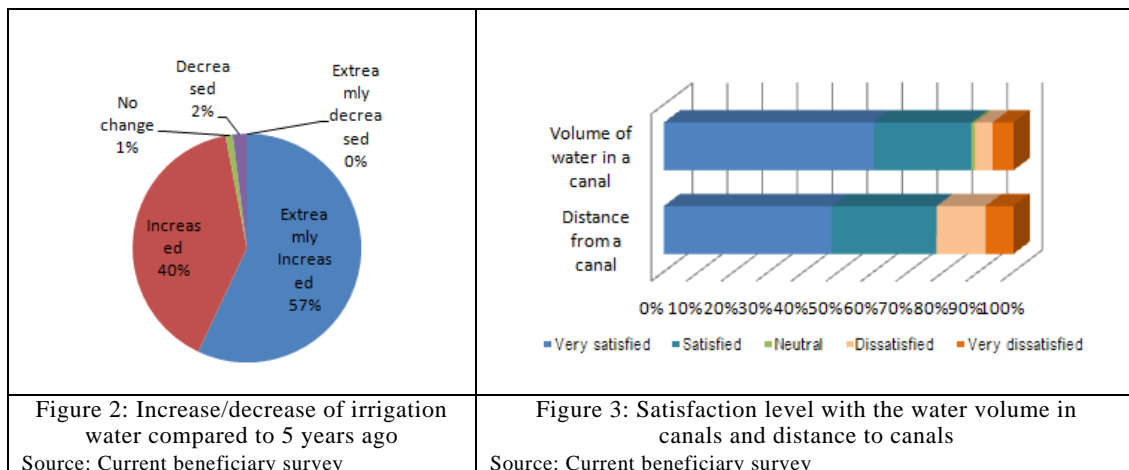


Figure 1: Months when irrigation water shortage occurred (in 2011)  
Source: Current beneficiary survey

Also through the implementation of this project, as described in the section 3.2.1, the increased discharge of the main canal allows for irrigated agriculture in about 80% of the entire Project Area (1,593 ha). This can be confirmed from the results of the beneficiary survey. As shown in Figure 2, 97% of the respondents answered irrigation water has “increased” compared to five years ago. Also Figure 3 shows 88% of the respondents are satisfied with water level in canals and 78% are satisfied with the distance to canals.



<sup>7</sup> The beneficiary survey was conducted in the Kandal Stung irrigated area in May 2012. In consideration of farmer population scale and distance to the main canal, Tien commune, Barku commune, Kong Noy commune, and Kork Trab commune (separated into inside TSC model site and outside TSC model site) were identified as survey target. On condition that each household questioned has farmed for eight years or longer (since 2004), 20 households in each of the five communes, a total of 100 households were selected. The number of samples was set to 100 according to the ex-post evaluation guide line.

### 3.3 Impact

#### 3.3.1 Intended Impacts

Table 4 below lists expected indirect effects of this project.

(1) Realization of irrigated agriculture in the Project Area (1,950 ha): As of April 2012, four years after completion of the construction, the area for single cropping in the rainy season was 1,593 ha, meaning achievement rate of 82% compared to the target value to be aimed at eight to ten years after completion of the construction (1,950 ha), and has been favorably increased. (2) Realization of double cropping in the rainy season: Though the area for double cropping in the rainy season was 100 ha to 200 ha before the start of the project, it has almost doubled and currently reaches 339 ha. (3) Increase of productivity (yield per ha): Both IR varieties and local varieties almost satisfy their targets, which means cropping based on the water conditions of farmlands and advantageous features of each rice variety has been achieved.

Expansion of the cropping area and increase of yield per hectare also contribute to (4) increase of farm income, as shown in Tables 4 and 5. In either cropping pattern, the yield per hectare exceeded the target value of 418US\$/ha. Further according to the results of the beneficiary survey as shown in Table 4, as a reason for increased income many households mentioned “duration of water availability increased”, “increase in rice crop yield per ha”, and “practice double cropping” and have actually felt the effects of the project.

Table 4: Indirect Effect Indicators of This Project

Expected indirect effects	Target Value	Actual value (May 2011 to April 2012)
(1) Realization of irrigated agriculture (double cropping in the rainy season, single cropping of local mid-/late-growing varieties, farming irrigation) in the Project Area (1,950 ha)	(8 to 10 years after completion of the construction) Single cropping in the rainy season: 1,950 ha (local mid-/late-growing varieties) Double cropping in the rainy season: 975 ha  Cropping in the dry season: 468 ha	(4 years after completion of the construction) Single cropping in the rainy season: 1,593 ha (mid-growing variety: 672 ha, local variety: 921 ha) Double cropping in the rainy season: 339 ha  Cropping in the dry season: 294 ha
(2) Realization of double rice cropping in the rainy season (April to the middle of December)	(8 to 10 years after completion of the construction) Crop intensity: 174% (where double cropping in the rainy season: 975 ha)	(4 years after completion of the construction) Crop intensity: - (where double cropping in the rainy season: 339 ha)
(3) Increase of productivity (yield per ha)  Local variety IR variety	(4 years after completion of the construction) 3 t/ha 4 t/ha	(4 years after completion of the construction) 3.5 t/ha 3.6 t/ha
(4) Implementation of cropping in the dry season and increase of farm income (net profit)	(4 years after completion of the construction) 418 US\$/ha	(4 years after completion of the construction) Double cropping in the rainy season: 762 US\$/ha Single cropping of middle-growing variety: 635 US\$/ha Single cropping of local variety: 529 US\$/ha

Table 5: Yield per hectare, and gross and net profits per ha in the Project Area

	Yield per ha (ton/ha)	Unit sale price (Riel/ton)	Gross profit (Riel/ha)	Net profit (Riel/ha)	Features of each variety
Double cropping in the rainy season (IR HYV)	3.60	700,000	2,520,000×2 = 5,040,000	3,276,000 (762 US\$)	IR variety HYV: Early-growing type, suitable for double cropping in the rainy season because of its short growing period (3 to 4 months). If sufficient water is not secured, however, yield will be considerably decreased.
Single cropping of middle-growing variety (HYV)	3.50	1,200,000	4,200,000	2,730,000 (635 US\$)	Middle-growing variety HYV: High-yield variety, a longer growing period (4 to 6 months), and a high sale price because of its good smell and taste.
Single cropping of local variety	3.50	1,000,000	3,500,000	2,275,000 (529 US\$)	Local rice variety: A longer growing period (4 to 6 months) and a high sale price because of its good smell and taste. Many farmers grow this rice variety for personal consumption.

Source: Yield per hectare and unit sale prices are based on the information provided by MOWRAM, and features of each variety are based on the information provided by MOWRAM and the hearing from farmers

Note: Net profits are calculated with the same method as in B/D (net profit = gross profit×65% (production cost)).

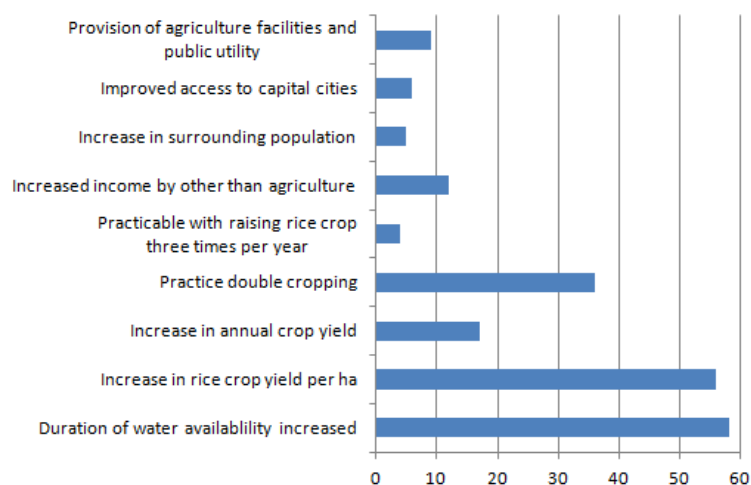


Figure 4: Reason for increase of income (multiple answers allowed)

Source: Current beneficiary survey

### 3.3.2 Other Impacts

#### 1. Impacts on the Natural Environment

According to the Law on Environmental Protection and Natural Resources Management and the Sub-decree on the Environmental Impact Assessment (EIA) Process in Cambodia, EIA should be carried out for any irrigation project with its developing area exceeding 5,000 ha. This project is not subject to EIA because its objective is rehabilitation of existing facilities and the irrigation area is limited to 1,950 ha. No special mitigation scheme is designed because the construction stage does not include any work affecting the environment.

On the other hand, the District Agriculture Office has provided farmers with instructions (including signs) on use of pesticide and manure after completion of the construction. When rehabilitating secondary and tertiary canals, the Cambodian government also rehabilitated drainage canals as an effort for environmental conservation in the Project Area.

## 2. Land Acquisition and Resettlement

The facilities rehabilitated by the Japanese side have not caused a land acquisition or resettlement problem.

For rehabilitation work by Cambodia, some lands were acquired though no resettlement was necessary. Specifically, when expanding the width of secondary and tertiary canals (total expansion of 39km) for their rehabilitation, farmlands necessary for the construction were provided by farmers. Based on the result of consultation with the commune, the lands were acquired with land cost in line with the standards established by the government. The total cost of land acquisition is 2,409,988 US\$ (about 196 million yen).

In light of the above, this project has largely achieved its objectives, therefore its effectiveness and impact is high.

### 3.4 Efficiency (Rating: ①)

#### 3.4.1 Project Outputs

As shown in Table 6 below, two changes have been made in the outputs at the Japanese side. However, there is no change in major facilities and the corporation scale remains unchanged.

As for outputs at the Cambodian side, the rehabilitation of secondary and tertiary canals was largely delayed. This is because the Ministry of Economic and Finance did not give priority to contribution of the counterpart fund to this project and it took a long time to obtain the budget approval. Further the establishment of the Farmer Water User Community was also delayed due to the delayed rehabilitation of secondary and tertiary canals.

Table 6: Outputs of This Project

Item	Basic Design (B/D)	Output
Japanese side: 1) Headwork (a) Weir type (b) Weir width (c) Weir height (d) Floodway gate (e) Sluiceway gate (f) Flow equalization gate (g) Road bridge (h) Other related facilities	1 site - Movable weir (all gates) - 50.0m - 4.8m - 3 gates, steel roller gate, motor-driven - 1 gate, steel slide gate, manual - 1 gate, steel slide gate, manual - Road bridge (National Road No. 3) x 1 (simple steel beam bridge, total effective span length 50m) - Control building, Electric generator building x 1	No change from B/D

Item	Basic Design (B/D)	Output
2) Rehabilitation of existing weirs and regulating gates 2)-1 Seventh January Dam (a) Weir width (b) Gate heightening height (c) Sheet pile  2)-2 Tuk Thla regulating gates (a) Gate heightening of the existing gates (b) Gate heightening height (c) Sheet pile  2)-3 Deum Russ regulating gates (a) Gate heightening of the existing gates (b) Gate heightening height  2)-4 Kompong Tuol regulating gates (a) Gate demolition (b) Road pavement	<ul style="list-style-type: none"> <li>- 213m</li> <li>- 0.55m, over-flow weir crest height: EL.11.80m</li> <li>- Continuous impermeable wall of steel sheet piles L=4.0m×610 sheets</li> <li>- 25 gates</li> <li>- 0.4m, gate crest height: EL.11.80m</li> <li>- Continuous impermeable wall of steel sheet piles L=4.0m×120 sheets</li> <li>- 3 gates</li> <li>- 0.2m, gate crest height: EL.11.80m</li> <li>- 1 site</li> <li>- 320m<sup>2</sup></li> </ul>	<p>No change from B/D</p> <p>No change from B/D</p> <p>No change from B/D</p> <p>No change from B/D</p>
3) Rehabilitation of irrigation facilities 3)-1 Irrigation canals (a) Planned length (b) Canal type  3)-2 Rehabilitation of intakes 3)-3 Turnout 3)-4 Water level regulating gate 3)-5 Canal crossing work 3)-6 outlet work 3)-7 Maintenance roads	<ul style="list-style-type: none"> <li>- 5.3km</li> <li>- Concrete block lining for both slopes with earth lining</li> <li>- 1 site</li> <li>- 26 sites</li> <li>- 2 sites</li> <li>- 8 sites</li> <li>- 6 sites</li> <li>- Rehabilitation of roads along the main canal of 5.3km (width: 5.5m) and roads along the secondary canals of 9.3km (width: 4.5m)</li> </ul>	<p>No change from B/D</p> <ul style="list-style-type: none"> <li>- No change</li> <li>- <b>26 sites→24 sites</b></li> <li>- No change</li> <li>- No change</li> <li>- <b>6 sites→7 sites</b></li> <li>- No change</li> </ul> <p>* The above two changes were made upon the request from the Cambodian side.</p>
<p>Cambodian side: Items to be undertaken for implementation of this Project at the Japanese side</p> <p>Rehabilitation of secondary and tertiary canals</p> <p>Establishment of Farmer Water User Community</p>	<ol style="list-style-type: none"> <li>1) Paperwork necessary for the grant aid project</li> <li>2) Land acquisition</li> <li>3) Investigation/disposal of bombs (including mines)</li> <li>4) Establishment and management of the MOWRAM maintenance office</li> <li>5) Formation of intake rule at the Roleang Chrey regulating gate</li> </ol> <p>Implementation of rehabilitation of secondary and tertiary canals (Detailed design, construction, and land acquisition were conducted in parallel with grant aid project)</p> <p>Establishment and training of Farmer Water User Community that is responsible for maintenance at related structures</p>	<p>The items shown left have been properly carried out.</p> <p>Secondary canals: 21,392m Tertiary canals: 17,749m Drainage canals: 12,100m</p> <p>The above works from design to construction were conducted by TSC trainees (irrigation engineers) at the Cambodian side and completed in 2011. The successful implementation of secondary and tertiary canal rehabilitation attributed to TSC Japanese specialists' efforts to the Cambodian side. Information about design and construction are shared with TSC3 Japanese specialists and technical support has been provided as necessary. Farmer Water User Community was established in April 2011 and registered in August 2011.</p>

### 3.4.2 Project Inputs

#### 3.4.2.1 Project Cost

As for the cost provided by the Japanese government for this project, the E/N limit was 1,740 million yen while the grand amounted to 1,709 million yen. Therefore, the cost at the Japanese side was lower than planned (98%).

As for the cost provided by the Cambodian government, on the other hand, it was estimated at 957,200US\$ (about 105.8 million yen) at the basic design study assuming that the counterpart fund would be utilized, but actually amounted to 6,295,171 US\$ (about 512 million yen). Therefore, the cost at the Cambodian side was significantly higher than planned (483%).

The increase of the project cost at the Cambodian side was mainly caused by rising prices<sup>8</sup> due to the delay of the project start; land price, cost associated with bombs and mine, labor cost, and construction cost were all largely increased. Especially as for land acquisition cost, the land price of the Project Area was sharply increased because Kandal Stung is in the suburbs of the capital of Cambodia, and the Cambodian government had to buy lands they had originally expected to be donated by farmers.

Further, the considerable increase of the project cost partially caused further delay of the budget approval for the counterpart fund at the Cambodian side, which, in turn, resulted in the elongated project period. It should be noted that the designed project cost at the Cambodian side is the cost estimated at the basic design study, but not that estimated at the detailed design study.

#### 3.4.2.2 Project Period

Though the project period at the Japanese side had been expected to be 33 months, it was actually 32 months (January 2005 to August 2007). Therefore, the project period at the Japanese side was shorter than planned (97%).

At the Cambodian side, the project period had been expected to be 33 months just like the Japanese side. However, the project did not start until 2010, which, in turn, delayed the completion of the project to December 2011. As a result, the period was increased to 84 months (January 2005 to December 2011). Therefore the project period at the Cambodian side was significantly longer than planned (255%). The reason for the delayed start of the project is late budget approval for counterpart fund at the Cambodian side, as described above.

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<sup>8</sup> According to World Economic Outlook Database (April 2012) provided by International Monetary Fund (IMF), the consumer price index (CPI) at the time of planning (2005) was 86.89 while the index at the time of project implementation (2011) was 145.03, which shows good economic growth during the period. Note that the calculation here is based on CPI in the period from October through December 2006 as 100.

Although the project cost/project period at Japan's side was within the plan, that at the Cambodia's side significantly exceeded the plan. Therefore the efficiency of the project is low.

### 3.5 Sustainability (Rating: ②)

#### 3.5.1 Structural Aspects of Operation and Maintenance

The irrigation facilities constructed under the project shall be operated and managed by the control of the Ministry of Water Resource and Meteorology (MOWRAM).

Actually engineers of MOWRAM as well as its Kandal Provincial Department of Water Resourced and Meteorology (PDA) are responsible for the operation and maintenance of these irrigation facilities. Through the technical cooperation projects (TSC2 and TSC3), these MOWRAM and PDA engineers have improved their technical abilities, which contributes to the establishment and reinforcement of the operation and maintenance scheme. Table 7 above shows the number of engineers receiving TSC training.

In PDA at Kandal Stung district, the Project Operation and Maintenance Office was established to which eight members are currently assigned. Though the original plan assumed that staff would be dispatched from the Ministry of Agriculture, Forestry and Fisheries to diffuse agriculture, no one has been assigned yet at the current point in time. Thus a current issue is that no system is available for giving agricultural training to farmers.

To solve such a situation, with collaboration between TSC3 and the technical cooperation project called "Agricultural Productivity Promotion Project in West Tonle Sap (APPP)" (from October 2010 to March 2015), a plan to bring Kandal PDA staff in APPP-conducted training<sup>9</sup> is in progress so as to diffuse farming technology APPP has to Kandal province. Since APPP designates the Ministry of Agriculture, Forestry and Fisheries as the counterpart, it is expected to take this opportunity to reinforce the collaboration with the ministry.

The establishment of the Farmer Water User Community (FWUC), which shall maintain secondary canals, tertiary canals and related structures, was behind schedule. In 2010, however, eight beneficiary Farmer Water User Groups (FWUG) were formed according to the 8-step procedure for FWUC organization stipulated in the Guideline for Participatory Irrigation Management Development (PIMD) in Cambodia (published in June 2000), as shown in Table 8. Then FWUC was established in April 2011, and registered as corporation in August 2011. And TSC2 and TSC3 were conducted to provide technical support for the

Table 7: Training conducted by TSC  
(total number of trainees)

Target	TSC2	TSC3	Total
Kandal province office	46	33	79
(where engineers in charge of daily inspection)	(18)	(12)	(30)

Source: Information provided by TSC3

<sup>9</sup> The training is scheduled from July to October 2012. Two PDA members will receive 5-week training (5 sessions) in total. After training, they will cooperate with diffusing members from the District Agriculture Office to diffuse farming technology in the Project Area.



establishment of FWUC and FWUG.

Trainings associated with water management and maintenance of canals have been conducted for FWUC according to the budget and activity plans designed by MOWRAM. At present, 57 key members from FWUC and FWUG are receiving training and instructions about the role of farmers using irrigation facilities. According to the beneficiary survey, 97% of the households know the existence of FWUC. This means the canal organization is becoming well-known.

Table 8 below shows the actual state of each commune (= FWUG) comprising FWUC. Reinforcement of the organization for committing maintenance activities of secondary and tertiary canals to farmers still stays at an early stage. According to the beneficiary survey, about 30% of farmers thought payment of irrigation service fee was “not so necessary.” To raise farmers’ awareness of irrigation service fee payment and grow FWUC into an independently functioning organization, MOWRAM should continue to take careful actions under the medium-term plan in the future. (Irrigation service fee payment is further described in the section 3.5.3 below.)

Table 8: Actual State of FWUCs established in the Kandal Stung Project Area

FWUG Number	Commune name	Number of households	Number of FWUG’s key members	Number of villages in the Project Area (number of villages in the commune)
1	Along Romiet	48	6	2 villages (6 villages)
2	Kork Trab	381	10	4 villages (9 villages)
3	Preah Putth	485	12	5 villages (5 villages)
4	Rolous	603	8	3 villages (4 villages)
5	Tien	284	6	2 villages (5 villages)
6	Kong Noy	351	10	5 villages (5 villages)
7	Barku	725	12	5 villages (7 villages) The first FWUC chairman was elected from FWUG7.
8	Siem Reap	86	4	1 village (7 villages)
Total		2963	68	27 villages (48 villages)

Source: Information provided by MOWRAM

\* FWUG7 is a commune where the TSC model site is located.

### 3.5.2 Technical Aspects of Operation and Maintenance

Through implementation of technical cooperation projects (TSC1, TSC2, and TSC3), support for establishment of Technical Service Centers for irrigation system (TSC), preparation of documents and manuals concerning the improvement of fields, training for irrigation engineers of MOWRAM and PDA in Kandal province, and support/instruction for construction of canals and related facilities within the model site (260 ha) located in the Project Area (1,950 ha) have been implemented. As a result, MOWRAM, TSC, and PDA engineers have acquired enough technical ability to maintain irrigation facilities constructed under the project including headwork, regulating gate, weir, and the main canal. During the

field study, the External Evaluator checked the records of daily inspection conducted at each facility as well as observation data including water level and discharge and concluded that data have been accumulated since the construction of irrigation facilities and adequate technique has been acquired.

At the field level, irrigation engineers at the Cambodian site have almost acquired necessary knowledge and technology about irrigation project. The design, estimation, and construction works of secondary and tertiary canals that Cambodian side was obliged to do have been implemented mainly by MOWRAM. Also through OJT at the TSC model site, MOWRAM irrigation engineers have acquired public participatory technique for rehabilitation of end canals directly irrigating farmlands.

Figure 5 shown right indicates the current state of access to irrigation water. According to the figure, only a limited number of farmers can obtain irrigation water directly from canals into their farmlands, and most farmers use

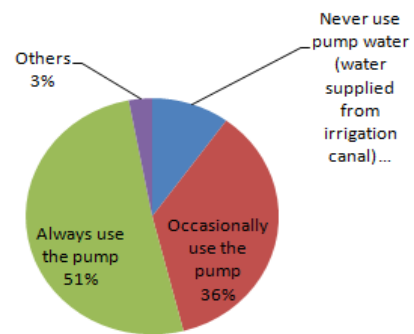


Figure 5: Current state of access to irrigation water  
Source: Current beneficiary survey

pumps for irrigation. Since a pump requires extra cost including fuel, its use should be preferably minimized to reduce rice production cost. An effective solution for this is rehabilitation of end canals. As described above, the technique required for rehabilitation of end canals has been already transferred to the Cambodian side. A current issue, however, is that such technique has not been diffused beyond the TSC model site because of limited budget. In the TSC model site, end canals have been already rehabilitated in cooperation of local residents. The prevalence rate of double cropping in the model site is around 60% to 70%, which corresponds to almost half of the area for double cropping in the rainy season (339 ha) described above. At the planning stage of the project, the TSC model site was expected to play a role as representing field of double cropping in the rainy season. As end canals outside the model site are being rehabilitated, an opportunity to present the actual procedure of double cropping in the rainy season is expected to increase.



End canals (delivery canals) in the irrigated area (this canals can deliver irrigation water directly into the paddy field.)

Under such a circumstance, MOWRAM and PDA engineers receiving training through TSC started rehabilitation of end canals with the aid of local farmers as a part of the TSC3 project in April 2012. Further rehabilitation will be carried out in an area near the model site in FY 2012 and continued in an area of up to 450 ha every

year. The rehabilitation in the entire Project Area will be completed in three years. Lending of heavy equipment necessary for construction, their fuel cost, and labor cost of farmers (3\$ per man per day) shall be borne by the project.

In the future, it is expected that promoted cooperation among farmers and transfer of technology will lead to the reinforcement of the organization for the entire Project Area.

### 3.5.3 Financial Aspects of Operation and Maintenance

The maintenance cost for main facilities constructed under the project as well as operation and maintenance cost for the project operation and maintenance office have been borne by NOWRAM as planned, and the budget has been properly arranged as shown in Table 9. During the field inspection, the External Evaluator checked each facility constructed under the project and found that repair work for which the Cambodian side was responsible had been properly conducted and no part was left damaged. Therefore the necessary maintenance budget is secured and used for the work at site.

The maintenance cost for the main, secondary, and tertiary canals are currently borne by MOWRAM and it is clearly decided that this cost will be borne by NOWRAM until FWUC becomes an independently functioning organization. MOWRAM has also budgeted

for reinforcement of FWUC and completed the establishment of FWUC, creation of draft community rules, and training of leaders so far. Figure 6 shows the result of the beneficiary survey concerning necessity of irrigation service fee payment. According to the survey, 66% of the respondents answered “necessary” while about 30% answered “not so necessary” or “not necessary at all”. Now, resident training including approach to such negative residents should be planned. Since the training budgets of the next and subsequent years are uncertain, a medium-term budget plan should be devised to secure adequate budget.

On the other hand, MOWRAM explains that it has collected irrigation service fee with great attention because people are liable to sensitively react to fee collection by the government due to influences of civil war and others. Thus the government should devise a scheme for collecting irrigation service fee while paying special attention so that people do not have any distrust. A successful example of irrigation service fee collection can be found in

Table 9: Annual maintenance cost borne by MOWRAM

	Operation and maintenance cost (US\$)			
	2008	2009	2010	2011
Labor cost	7,200	7,200	9,600	9,600
Maintenance cost	12,000	12,600	13,600	14,000
Total	19,200	19,200	23,200	23,600

Source: Information provided by MOWRAM

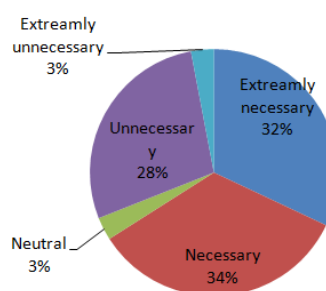


Figure 6: Necessity of irrigation service fee payment

Source: Current beneficiary survey

the irrigation project in Takeo province. In this province, MOWRAM, in cooperation with the local administration (village head), started to collect irrigation service fee three years after the establishment of the organization, and then devised a scheme with which FWUC mainly conducted the maintenance of irrigation facilities with the collected irrigation service fees five years after the establishment. Now they can successfully manage the scheme. Further they decided a unit price of the irrigation service fee, which they thought the most important in devising the scheme to collect irrigation service fee, as well as collection method (payment in kind or by cash) in consideration of opinions of local residents.

Draft unit prices of irrigation service fee for this project are proposed in the Farmer Water User Community Regulation<sup>10</sup>. As the organization is developing, however, proper prices are to be decided through full discussion with farmers.

#### 3.5.4 Current Status of Operation and Maintenance

The headwork, regulating gates, and weirs have been properly operated and maintained according to the operation manual, and no special trouble has occurred. The maintenance roads have been repaired as necessary, and properly maintained.

The main canal has a trouble; the concrete block lining of the slopes of the canal is uplifted and partially changed. (In the main canal, many cracks were discovered on the concrete block 3km upstream at the defect inspection, and repaired by the Japanese constructor.) It is thought this has been caused by the special soil texture behind the lining. Then, the field study by the Japanese and Cambodian sides has reached a conclusion that the main canal can function as irrigation canal even if the cement concrete lining panel is partially damaged and it is being considered that the executing agency will properly operate with the routine maintenance of the main canal in the future. Once the executing agency takes the responsibility for maintenance, MOWRAM will be technically prepared because MOWRAM has irrigation engineers who have received TSC trainings and been engaged in similar works. The External Evaluator also asked MOWRAM about the annual budget plan for the subsequent years and found the maintenance cost including the slope repair work was budgeted for 19,325US\$ in total (of which 4,900US\$ is for the main canal). Therefore MOWRAM will be financially prepared as long as damage scale is as same as before.

Though the Cambodian government intends farmers to play a main role in rehabilitation of secondary, tertiary, and end canals, MOWRAM is responsible for maintenance of secondary and tertiary canals at present. End canals have been properly maintained by farmers once these canals were rehabilitated in farmlands, as shown in the photo in page 18.

According to the beneficiary survey, only about 20% of farmers have been engaged in

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<sup>10</sup> According to the Farmer Water User Community Regulation, draft unit prices are (1) 40,000 Riel (9.3US\$)/ha per time for direct irrigation from end canals, (2) 20,000 Riel (4.7US\$)/ha per time for direct irrigation from end canals + pumping, and (3) 10,000 Riel (2.3US\$)/ha per time for pumping.

repair or clearing of canals. To help farmers operate and maintain secondary and tertiary canals rehabilitated by the Cambodian side as well as end canals to be rehabilitated with the aid of TSC3 in future, the Farmer Water User Community (FWUC) should be reinforced. For this reason, MOWRAM has already given FWUC leader trainings concerning water management and maintenance of canals as described above, and budgeted for the FWUC development cost for nine months in 2012. From the experience of the irrigation project conducted in the other province by MOWRAM, it is learned that an organization will start to function about three years after its establishment. Based on the experience of other projects, development of a resident organization with due care is expected.

Some problems have been observed in terms of the current structural/technical/financial aspects, therefore sustainability of the project effect is fair.

#### **4. Conclusion, Lessons Learned and Recommendations**

##### **4.1 Conclusion**

This project is intended to rehabilitate existing irrigation facilities in the Kandal Stung irrigated area and provide stable supply of irrigation water in the rainy season. The objective of the project is relevant with the development plan of Cambodia “community livelihood improvement through agriculture production” and its development needs. Therefore, the relevance of the project is high. The rehabilitated irrigation facilities caused the discharge of the main canal to increase, which has promoted conversion to the irrigated agriculture in the area concerned. The cropping area, yield per hectare, and farm income have almost achieved their targets to be aimed for in four years after completion, and farmers are fully satisfied with agricultural water supply.

Since the rehabilitation of secondary and tertiary canals borne by the Cambodian side was delayed, however, the efficiency of the project is low. As for maintenance of facilities, a framework of farmer’s group for operation and maintenance has been organized, but further reinforcement is required for developing into an independently functioning organization. Therefore, the sustainability of the project is fair.

In light of the above, this project is evaluated to be partially satisfactory.

##### **4.2 Recommendations**

###### **4.2.1 Recommendations to the Executing Agency**

- For promotion of double cropping in the irrigated area, training about farming technology should be properly given to farmers. Therefore, further cooperation between the Ministry of Water Resource and Meteorology and the Ministry of Agriculture, Forestry and Fisheries is required.

- To develop the current Farmer Water User Community (FWUC) and Farmer Water User Group (FWUG) into independently functioning agriculture organizations, continuous support and instruction should be given to farmers. Therefore, a medium-term budget/action plan should be created and carried out.
- In the irrigated area, some farmers have farmlands with good access to irrigation water and others have farmlands with poor access to it. An elaborate scheme to collect irrigation service fee should be devised so as not to grow inequality within the irrigated area.

#### 4.2.2 Recommendations to JICA

- The effect of the project will be maximized when reinforcement of the Farmer Water User Community by MOWRAM and rehabilitation of end canals by TSC3 are completed. Therefore, it is important for JICA to continuously monitor activities at the Cambodian side and provide support as necessary for the maximum effect of the project.

### 4.3 Lessons Learned

- Though the original plan assumed use of the counterpart fund as project cost to be borne by the Cambodian side, the project was largely behind the schedule from the start to the end of the construction due to delay of the budget approval by the Ministry of Economic and Finance. If a budget depending on the decision of the counterpart country such as counterpart fund is assumed as a project cost, the circumstances of the parties concerned including the Ministry of Economic and Finance should be thoroughly confirmed.
- In planning the project, an “actual irrigation area” was set as an indicator for quantitative effectiveness. An actual irrigation area represents a total area of lands in which the “proposed cropping system” is introduced, but its measurement involved great difficulty at the ex-post evaluation stage. This was partly because the proposed cropping system has not been shared with the Cambodian government, nor regarded as an indicator for the ex-post evaluation. Further, since the executing agency in charge of operation and maintenance of facilities was not required to record this data during normal daily operation, it was difficult to observe the data change over the past years and to grasp the current state. As for quantitative effectiveness, an agreement about an indicator monitoring plan should be made with the counterpart government, and further an indicator should be preferably selected among those data to be recorded during normal daily operation where appropriate so as to lessen the burdens imposed on the executing agency and related departments.