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Water Use Conflicts and Their Impact on Rice Yield in Takeo Province, Cambodia

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List of Abbreviations

ADB	Asian Development Bank
AusAID	Australian Agency for International Development
CC	Commune Council
CDRI	Cambodia Development Resource Institute
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FHS	Farmer Household Survey
FWUC	Farmer Water User Community
FWUCC	Farmer Water User Community Committee
IO	International Organizations
ISF	Irrigation Service Fee
KII	Key Informant Interview
KR	Khmer Rouge
MAFF	Ministry of Agriculture, Forestry and Fisheries
MOE	Ministry of Environment
MOWRAM	Ministry of Water Resources and Meteorology
O&M	Operation and Maintenance
PDOA	Provincial Department of Agriculture
PDOWRAM	Provincial Department of Water Resources and Meteorology
NGO	Nongovernment Organizations
RGC	Royal Government of Cambodia
UNDP	United Nations Development Programme

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Executive Summary

This paper aims to provide an overview of the irrigation sector in Cambodia. It attempts to document major problems and conflicts encountered in the irrigation sector in Takeo province and how these problems and conflicts are solved. It also analyzes the factors contributing to rice yield increase, particularly plot size, labor input, material input, and water adequacy.

The study reveals that many irrigation schemes in Cambodia are not able to function well due to two main reasons: (1) poor technical design and (2) lack of proper maintenance. Poor technical design results from limited resources provided for irrigation construction and from having multi-purposes for the facility including flood control, transportation, and agricultural activities. Insufficient maintenance, a result of the country's long civil war in combination with lack of both external financial and technical support to the FWUC, has yielded poorly maintained irrigation facilities.

In Takeo province, existing problems in irrigation are mainly about (1) financial constraints, resulting in lack of financial support for O&M; (2) low popular participation, resulting from a low sense of ownership due to poor extension, unfair practices in ISF collection due to poverty, abuse of power by the educated and powerful elite in the community, and poor law enforcement; and (3) poor technical design of irrigation schemes due to poor financial and technical support and multi-purposes of the dam construction. Moreover, there are two intangible problems: (1) inappropriate leader selection due to lack of flexibility to ensure selected leaders could earn the trust and respect of the community and (2) weak institution and lack of law enforcement due to limited capacity of leaders and cooperation from relevant authorities.

Water use conflicts occur more often among the same type of beneficiaries (e.g., rice farmers). Conflicts result from insignificant water supply for farming due to: (1) expansion of the cultivated area over years, (2) limited water supply due to the reservoir's limited holding capacity and low rain fall, and (3) improper timing of water release due to the farmland's geographical location and poorly performing operators due to lack of training and incentive. Conflict is also observed between rice farmers who want to keep water in the reservoir for dry rice farming and fishermen who want to flow water off to catch fish. Those benefiting from fishing are just a fraction of the irrigation community but they are relatively poor so it is difficult to enforce the law in the absence of other livelihood alternatives for them.

Conflicts are solved at different levels depending on their nature and size of the irrigation schemes. In small irrigation schemes, they are often solved at the community level by the FWUCC and/or CC, although sometimes complaints go up to the district, provincial and

national levels. In medium-scale irrigations where beneficiaries are from different communities, conflict resolution more often involves negotiations between the FWUCC and CC. High-level intervention (e.g., from provincial and national authorities) happens mostly to resolve conflicts in large irrigation schemes. External intervention is important in conflict resolution but the FWUC faces challenges with political interferences, especially before and during the local and national elections.

The study noted that the CC, in particular, which is a political body, influences the decision of the FWUC, including its financial management, to some extent. At its current stage of development, the FWUC needs more capacity building and strengthening in order to mobilize financial support for O&M of the irrigation scheme. More external technical and financial support is needed for at least several more years to place the FWUC on a track of sustainability and success in self-management.

The study found that the contributing factors affecting rice yield increase are plot size, farm material input, labor input, and water adequacy. The contributing factors affecting rice yield were identified through three regression models applied in upstream areas, downstream areas, and their combination in Takeo province. While these four factors have positive contributions to rice yield in general, plot size and water adequacy are the most significant ones, followed by either labor input or material input.

1 Introduction

Located in the Great Mekong Sub region, Cambodia has four major rivers: Upper Mekong, Tonle Sap, Bassac, and Lower Mekong. Moreover, it has a natural great lake, Tonle Sap Lake, situated at the center of the country. This lake is connected by Tonle Sap River to Mekong River, which crosses Cambodia for 486 km. In the wet season, heavy precipitation causes the water level and the surface of Tonle Sap Lake to rise by more than fourfold to 1.5 million ha. Along with many small lakes and rives, Tonle Sap Lake, Mekong River, and their tributaries provide abundant water to Cambodians.

The abundant water supply has enabled Cambodia to develop its agricultural economy; the agriculture sector accounts for approximately one-third of the country's gross domestic product (GDP) and employs about two-thirds of the total work force. Even though most Cambodians are engaged in agriculture, hunger and poverty remain to be critical problems encountered by rural Cambodians in different dimensions. Thirty-six percent of the population lives below the poverty line (approximately US$0.45 per person per day). To reduce this number by half by 2015, as targeted in the Millennium Development Goals, the Cambodian government has given priority to the agriculture sector (including crops, livestock, fisheries and forestry).

Since agriculture uses the largest share of water, there is a real need to monitor the water sector carefully. The Royal Government of Cambodia (RGC), therefore, has prioritized the water sector as the dynamic driving force for agricultural growth and poverty reduction as well as food security. However, according to the National Strategic Development Plan 2006, the total irrigated area is still limited; at about 588,687 ha in 2005, it is only about 20 percent of the total agricultural land. Meanwhile, the Cambodia Human Development Report 2007 indicates that only 7-8 percent of the sown area receives controlled irrigation (MOP and UNDP 2007).

1.1 Agriculture and irrigation

Generally, Cambodia has two cropping periods in a year: the wet season the dry season. Wet season farming produces approximately 80 percent of total crops in the country. During the wet season, farms rely on rainwater, making them vulnerable to the unpredictable patterns of rainfall. As such, wet season rice crops still need supplementary irrigation water. In the dry season, crops, rice in particular, are dependent overwhelmingly on irrigation water.

The Ministry of Agriculture, Forestry and Fisheries (MAFF) reports that in 2006 total rice yield was estimated at 6.3 million tons, an increase of 0.3 million tons from the previous year. The wet season rice yield was about 5.0 million tons; for the dry season, it was about 1.3 million tons. Apart from rice, Cambodia cultivates other crops including maize, cassava, bean, potato, peanut, sesame, sugar cane, vegetables, tobacco, and jute. The total yield of these crops increased from 1.4 million tons in 2005 to 3.2 million tons in 2006 (MAFF 2007). There are three main reasons of this increase: (1) expansion of irrigation facilities, (2) expansion of cultivated areas, and (3) good rainfall.

Population increase and demand for food by the domestic and export markets have put pressure on the agricultural sector to increase its output. To increase crop yields, irrigation plays a very critical role. Without a good irrigation system, two main problems may be

encountered: abundant water in wet season resulting in flooding of farmlands and little available water in dry season for late wet season and dry season rice farming.

Recognizing the importance of the irrigation sector, the RGC has formalized and established a new pattern of irrigation in 2000 through Government Regulation 306 (Prakas 306). This is aimed at enhancing irrigation management by improving the existing irrigation mechanism. Numerous efforts have been made to develop the sector in the past; however, the approaches may have been inappropriate to the physical, socioeconomic, and cultural conditions prevailing in the country.

1.2 Statement of the problem

Despite the important role that it plays in agriculture, irrigation still gets little investment from both the state and the private sector. The World Bank's 2006 Cambodia Poverty Assessment emphasizes the important role of improved irrigation infrastructure in increasing yield, and recommends more public investment to strengthen irrigation water management.

Generally speaking, water issues are becoming increasingly significant over time; the various challenges faced by the Cambodian agricultural sector now include competition for irrigation water among beneficiaries. Problems associated with water have constrained the country's development, not only as regards the agricultural sector but other sectors as well such as health care. Moreover, competing demands for water among farmers within community as well as among neighboring communities have resulted in conflicts.

After participating in the World Summit on Sustainable Development in Johannesburg in 2002, Cambodia has given more recognition to the important role of the water sector in the country's social, political, and economic development agenda. As a result, discussions have been conducted on issues of suitability, efficiency, and effectiveness of the differently sized schemes in terms of management and economic viability. Answers have varied, depending on a multiplicity of factors (agronomic, economic, technical, institutional, and social).

At present, the irrigated schemes in Cambodia are unable to contain the maximum amount of water that it potentially could, resulting in a lack of or limited irrigation water for farming. Besides the technical aspect, which is presumably related to poor technical design, the problem actually goes beyond limited water to issues related to water governance and conflicts.

Thun and Chem (2007) argue that answers to the existing problems generally depend on a package of governance, technical design, and popular participation. Moreover, they suggest that attention be given to small- and medium-scale systems operated by the local people or by the Water Farmer User Communities (FWUC) because they are important in terms of technical know-how transfer, water distribution, and system management which includes conflict resolution at the community level. Therefore, the development of small- and medium-scale systems would complement the RGC's decentralization and deconcentration program.

With regard to the organization of a small-scale irrigation system, the objectives of the group can often be achieved through interpersonal interactions. Cooperation among farmers and the emergence of water rights within the group are reflected through their social homogeneity, motivation to avoid social conflict, existence of a standard water allocation rule, a forum for interpersonal interaction, and the processes of a reciprocal situation.

Previous studies on irrigation in Cambodia did not provide any clear indications of the threats posed by water use conflicts to agricultural yield. Many irrigation related studies do not look in detail at the factors contributing to increased rice yield. In view of these observations, this study investigated conflicts and practical solutions in irrigation communities, and examined the key factors contributing to rice yield increase.

1.3 Objectives and scope

Recognizing the important role that irrigation plays in agricultural growth, the Cambodia Development Resource Institute (CDRI), with the support from the Economy and Environment Program for Southeast Asia (EEPSEA), conducted a research on water use conflicts and their impact on rice yield. This paper aims to present practical options that may be useful to a wide spectrum of potential readers, from policy-makers to extensions workers in the field.

This study focused on small- and medium-scale irrigation systems, with the main objective of understanding the problems confronting these systems in terms of water use conflicts and their impact on rice yield. The specific objectives are to:

- provide an overview of irrigation systems in Cambodia,
- study water use conflicts in small- and medium-scale irrigation systems in Takeo province, and
- determine key factors contributing to rice yield in small irrigation systems in Takeo.

1.4 Organization of the report

This report is divided into four sections. Section 1 provides an introduction to the study, which includes: link between agriculture and irrigation; statement of the problem; objectives of the study; and the structure of the report. Section 2 provides the methods used in the study. Section 3 presents the analysis of information and data from the survey and discusses the findings, which cover the following: overview of irrigation in Cambodia and irrigation systems in Takeo province, water use conflicts in Takeo, and impact on rice yield of the irrigation schemes in the study areas. Section 4 summarizes the key points and presents recommendations for improving the irrigation management in a manner that would contribute to increased rice yield.

2 Methodology

2.1 Timeframe and data collection

Cambodia's statistical systems for irrigation and related concerns have yet to be developed. To obtain the necessary data for this study, a field survey was conducted covering five irrigation schemes in Takeo in January 2007. The survey used the Participatory Rapid Appraisal method. The principal philosophy of this method is to listen to the target people

and involve them in a joint learning process. The authors were involved in the interview process from the beginning to the end. The study used both primary and secondary data.

- **Primary data collection**

  Three tools were used to collect primary data: focus group discussion (FGD), key informant interview (KII), and farm household survey (FHS). A checklist and a questionnaire were developed after a literature review, and then pre-tested.

  Both FGD and KII were used to collect data/information related to the history and management problems of selected irrigation schemes in the study areas. They enabled the collection and crosschecking of different data/information. During interviews, the researchers probed for ideas on how the irrigation systems' problems may be addressed or solved.

  The questionnaire was developed particularly to collect information on farm yield (e.g., rice yield, yield factors). Moreover, it collected information on yield related issues such as access to irrigation water, irrigation service fee (ISF) payment, and farmers' perception of the farmer water user community (FWUC). The questionnaire is presented as Appendix 1.

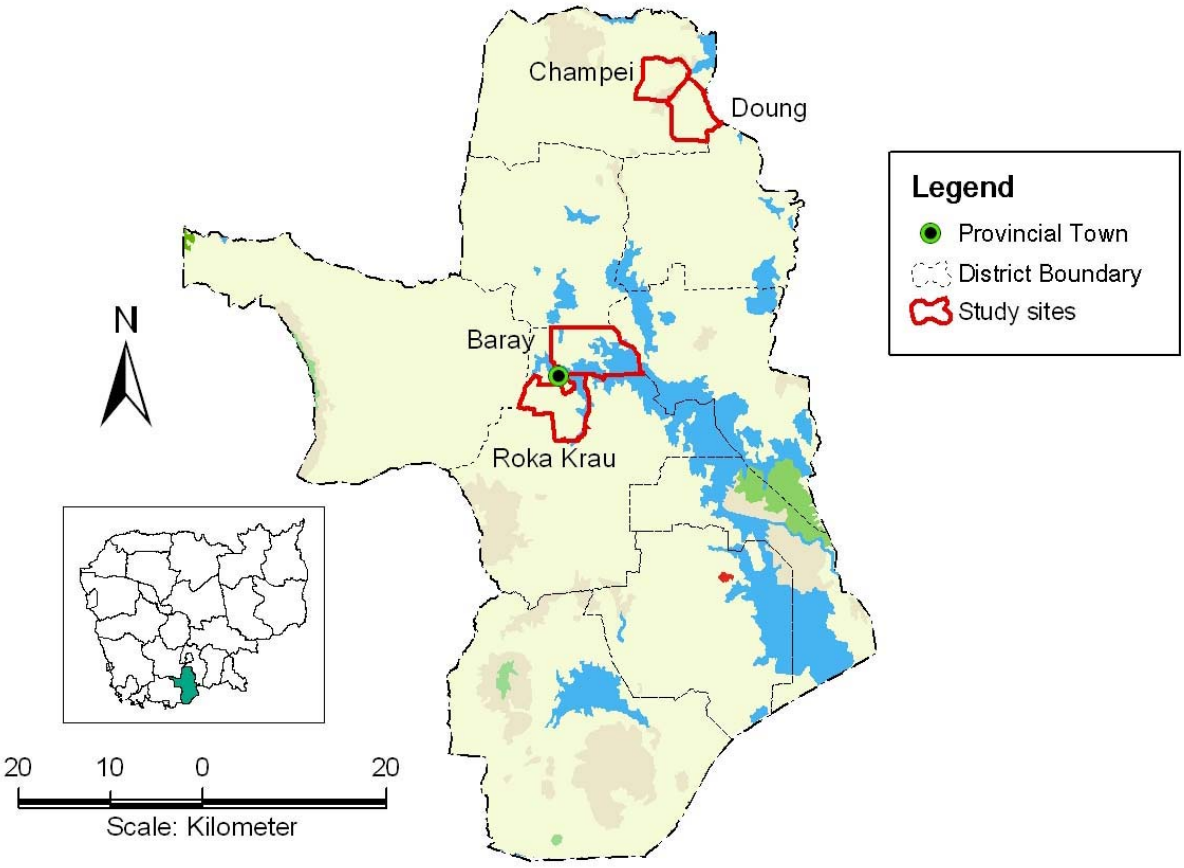
- **Secondary data collection**

  The research team collected and reviewed documents on irrigation water management including water laws, Prakas on the establishment of FWUC, etc. Data were collected from various government institutions and other agencies working in the irrigation sector.

  The research team worked closely with the Ministry of Water Resources and Meteorology (MOWRAM), particularly its provincial and district departments and office in Takeo, to gain access to important records and procedures. It also worked with the MAFF and its provincial department in Takeo.

2.2 Site and sample selection

In 2006-2007 rice cropping, five provinces of Cambodia produced more than half of the total yield (both dry and wet seasons) of the country. Takeo ranked second in terms of total yield and first in terms of dry season rice yield. The good performance of the province is partly due to the presence of various official aid organizations to rehabilitate the irrigation infrastructure, increase in the technical skills of provincial irrigation technicians, and support for the locally managed irrigation schemes. The major reason behind this support is because Takeo has been chosen by MAFF as a model province for agricultural development.



Map of the study areas

For the study, three small- and two medium-scale irrigation systems in Takeo Province were purposively selected. The province was selected for the study based on two criteria. Firstly, it is a major rice producer in both wet and dry seasons. Secondly, the irrigation projects in the province are known to have conflict issues related to water access for agriculture. The five selected irrigation projects are:

- Sampoch irrigation (small-scale), with irrigated areas of 757 ha in wet season and 214 ha in dry season, located in Champei commune, Bati district.
- Dang Kgnorm irrigation (small-scale), with irrigated areas of 600 ha in wet season and 150 ha in dry season, located in Roka Krau commune, Dounkeo district.
- Doeum Krolanh irrigation (small-scale), with irrigated areas of 200 ha in wet season and 150 ha in dry season, located in Doung commune, Samrong district.
- Chroy Samrong irrigation (medium-scale), with irrigated areas of 30 ha in wet season and 430 ha in dry season, located in Baray commune, Dounkeo district.
- Svay Khom irrigation (medium-scale), with irrigated areas of 185 ha in wet season and 857 ha in dry season, located in Doung commune, Bati district.

At least one representative each from the CC, FWUCC, and PDOWRAM was interviewed to obtain information on irrigation management in terms of contributing and influencing factors affecting water distribution, associated conflicts, and financial support for maintenance and operation (O&M), and their related impact on rice yield. Two representatives (one from the

PDOA and one from the Seila programme[1]) were also interviewed regarding agricultural yield.

For information on factors contributing to yield of rice farming, a farm household survey was conducted in two small irrigation schemes: one formal FWUC (Sampoch) and one non-formal FWUC (Dang Kgnorm). Researchers first identified the total number of farm households based on the list provided by each FWUC of the two selected schemes; the total number of beneficiaries was 103 households in Sampoch and 345 in Dang Kgnorm.

A randomized sampling technique was employed. Following Shao (1967), the standard normal deviate is written as follow:

$$z = \frac{\overline{X} - \mu}{\sigma / \sqrt{n}} \quad \Rightarrow \quad n = z^2 * \sigma^2 \Big/ \left(\overline{X} - \mu\right)^2$$

Where $n = sample\ size$

$z = standard\ \ Normal\ deviate$

$\sigma = population\ \ standard\ deviation$

$\overline{X} = sample\ \ mean$

$\mu = population\ \ mean$

The sample size was determined by applying the above formula. In the formula, the number of samples does not depend on population size but on the homogeneity of yield, that is, the range between the maximum and minimum yield per hectare. As such, fewer than 100 samples were needed. However, since time allowed, 110 farm households (55 from each irrigation scheme) were interviewed for this study.

2.3 Data analysis

The field study was divided into two phases. In phase I, researchers investigated the five irrigation sites on issues related to management and institutional arrangements. In phase II, they focused on the two small-scale irrigation projects for an in-depth study of factors contributing to rice yield.

All data gathered were processed using Microsoft Excel and SPSS. In the yield impact study, the yield function technique was used to explain the significance of selected independent variables (yield) on the dependent variable to obtain the factors affecting rice yield. The general model is presented in the following equation:

$$Y = f(X_1, X_2, X_3, X_4)$$

Where:

Y = RICE-OUTPUT = total rice yield, measured in ton (t) per plot.

[1] The Seila Programme is an aid mobilization and coordination framework in support of Cambodia's decentralization and deconcentration reforms.

X_1= PLOT-SIZE = area of planted land, measured in hectare (ha).

X_2 = INPUTS-KHR = all expenses associated with rice yield (e.g., seed, fertilizer, and pesticide), measured in thousand riels (‘000 riels).

X_3 = LABOR-KHR = labor value used from land preparation to harvesting, measured in thousand riels (‘000 riels).

X_4 = WATER-DUMMY = water supply variable. Depending on circumstances, each plot of planted land could receive different amounts of water, resulting in either adequacy or inadequacy of water for rice yield. Adequate supply has a value of 1 while inadequate supply is 0.

3 Results and discussions

3.1 Overview of irrigation in Cambodia

Irrigation schemes in Cambodia are classified according to scale (small, medium, or large) in three major agro-ecological areas (flooded, lowland, and highland). The scale of the irrigation schemes is defined as follows: up to 200 ha is considered small, 200-5,000 ha is medium, and above 5,000 ha is large[2].

Some small-scale irrigation systems and most medium- and large-scale irrigation systems have water reservoirs and irrigation distribution canal systems. Currently it is estimated that there are 2,403 irrigation schemes (1,415 small, 955 medium, and 33 large), and they can potentially irrigate more than one million hectares (MOWRAM 2004).

According to Perera (2006), “irrigations in Cambodia have been developed since the very ancient times of Cambodia. Those irrigation systems, however, have not had good designs and systems, as they were built for religious purposes and flood control rather than for agricultural purpose.” The same study divides the irrigation development in recent times into four periods: the French period (1930-1950), Sihanouk period (1950-1970), the Khmer Rouge (KR) period (1975-1979), and the current period (1980 to date).

Most irrigation schemes in the country were built during the Sihanouk and KR periods. When the KR regime came to power in 1975, it forced the populace to build a gridlock of canals and other types of hydraulic networks toward an agricultural arcadia, thus a great number of irrigation schemes were constructed. Perera (2006) found that about 69 percent of 841 existing irrigation systems were built during the KR regime. However, the majority of irrigation schemes was found ineffective due to poor planning and design, and often produced negative results on the environment, thus, did not enhance water management.

After the KR regime, many irrigation schemes became seriously deteriorated due to lack of maintenance because of the civil war and lack of financial and technical support. Lack of both technical and financial support also constrained irrigation infrastructure development, resulting in water insufficiency vis-à-vis the expansion of the agricultural sector to address the increasing needs of the growing population.

[2] There are also different kinds of smaller (household-level) irrigation, including manual pump and small household-water holders that can cover small plots of land of up to 20,000 m^2.

After 1985, the government has encouraged people's participation in irrigation development by providing farmers with diesel, oil, and construction materials. From the early 1990s, pilot projects were conducted, which involved farmers in the O&M of their irrigation schemes. Since 1994, the RGC has embarked on a program of transferring the responsibility for O&M of the irrigation systems from the government to the FWUC. In 1999, MOWRAM was established; in 2000, the idea of participatory irrigation management development was implemented through MOWRAM's Declaration 306 issued in June 2000. This gave the overall framework for the formation of the FWUC and the transfer of irrigation management to it.

The RGC has entrusted the MOWRAM to review and evaluate all irrigation systems, to standardize the statutes of the FWUC, and to carry out feasibility studies, as well as rehabilitate and reconstruct the irrigation systems. From 2000 to 2005, 328 FWUCs (approximately 151,120 families) were established throughout the country, although only 114 FWUCs have been registered. The FWUCs cover 184,578 ha of rain fed paddy fields and 67,916 ha of dry season paddy fields.

Until now Cambodia uses and rehabilitates those remaining irrigation systems for agricultural activities. Irrigation systems are used for two purposes: to store water and to recede it. The most common techniques of irrigation used in Cambodia nowadays include traditional lifting, mobile pumping station, gravity, or a combination of these methods. Treadle pumps have also been introduced by several nongovernment organizations (NGOs) (Yang Sangkoma, 1999). Irrigation dams, which are used for transportation, are deteriorating due to lack of sufficient maintenance.

3.2 Irrigation in Takeo

The Agricultural Statistics 2005-06 indicates that Takeo has a total area of 3,562.70 km^2 of which 251,737 ha is agricultural land (wet season rice fields = 175,153 ha, dry season rice fields = 76,584 ha) (MAFF 2006). Takeo has 114 irrigation systems; covering 121,295 ha (39,272 ha for dry season rice farming and 82,023 ha for rainy season rice fields).

Like in the other provinces in the country, most irrigation reservoirs in Takeo were built in the Sihanouk period. In the KR regime, a lot of canals were constructed to connect the existing reservoirs to the rice fields. This province is partly known as the Southwest Zone controlled by Chhit Choeun, called Ta Mok, whose forces are notorious for their brutality. They were ruthless in following the Khmer Rouge policy of using human labor to construct canals on a rectangular 1 km grid pattern, irrespective of the natural land forms.

In the 1980s, the local authority initiated villagers to establish local water solidarities to look after the irrigation systems and to manage irrigation water. Until 1996, with donors' support, some irrigation systems were rehabilitated while the initiative to establish FWUCs came up. The creation of FWUCs became more popular in 1999 after the Ministry of Water Resources and Meteorology (MOWRAM) was established and Prakas No. 306 was issued in 2000 to accept the FWUC.

Out of 92 schemes, 41 have already been rehabilitated with support from donors through the government, but not all rehabilitated schemes have a registered FWUC. Up to now, Takeo has 26 formal FWUCs composed of 44,987 families. Even after the schemes' rehabilitation, some overall problems are still evident in Takeo. For example, the irrigation infrastructure is

still physically poor and improper for water distribution due to lack of budget for and low popular participation in its O&M. The deputy director of Takeo's Department of Water Resource and Meteorology shared that "annually the department receives about US$30,000 (development budget) from the government, which is enough to build one or two medium canals only." Generally, without external support and intervention, the system would not last long due to lack of proper O&M. Individual politicians are also seen to be involved in the irrigation sector (e.g., providing financial support for rehabilitation and O&M).

Out of the five irrigation systems studied, one scheme was found to have cultivated areas larger than what the system could potentially supply; in others, the opposite case was true (Table 1). Rice yields in the five schemes ranged from 2.5 to 3.5 tons per hectare, which is higher than the national average. This is partly because the dry season rice field is flooded in wet season, resulting in the field being covered by fertile soil.

Except in Dang Kgnorm, all schemes receive technical and legal support from the PDOWRAM. With regards financial support, even though the government promised to contribute to O&M cost over five years, none of the schemes has received financial support. As a result, each scheme has to depend totally on contributions from FWUC members through ISF collection. However, the ISF collection could usually cover only about one-third of the estimated O&M cost. The constant fund insufficiency for O&M has become a serous threat for the sustainability and improvement of the schemes in the future.

Because it does not receive support from the PDOWRAM, Dang Kgnorm is still an informal FWUC run by a village chief; the other FWUCs are run by democratically elected leaders. No matter how each FWUC leader is chosen, FWUCs are formed in order to take care of the operation and maintenance of the irrigation schemes. Though Dang Kgnorm does not receive support from the PDOWRAM, it sometimes consults the district official of PDOWRAM.

Table 1 presents a summary of the profiles of the five irrigation schemes chosen for this study.

- **Sampoch scheme**

  Built during the Sihanouk period, this scheme has a capacity of 1.5 million cubic meters. It was expanded in 1972-73 and again during the KR's time. It gradually deteriorated due to the civil war and lack of proper maintenance. In 1992, it was rehabilitated by MAFF; labor was contributed by the villagers. It underwent a major repair from 2001 to 2002 with funding from ADB. It was repaired again in 2003 through a food-for-work program, in which farmers received approximately 4,000 riels per person per day[3]. This scheme benefited 103 farm households of two communes; Putsar and Champei. In 2003, the PDOWRAM established the Sampoch FWUC through an election in order to transfer the responsibility for the scheme's O&M to the community.

[3] Exchange rate: US$1=4,000 Riels.

Table 1: Irrigation schemes and command areas (potential and actual, dry season)

Scheme		Sampoch	Dang Kgnorm	Doeum Krolanh	Chroy Samrong	Svay Khom
Year built		1960s	1962	1976	1962	1973
Potential irrigation area (ha)		214	600	150	430	857
Actual irrigated area (ha)		143	525	92	748	580
Yield (t/ha)		3.0	3.5	2.5	2.0	2.5
No. of beneficiaries (HH)		103	345	351	851	1,000
Source of technical support		PDOWRM	PDOWRM	PDOWRM	PDOWRM	PDOWRM
Who runs		FWUC leader	Village Chief	FWUC leader	FWUC leader	FWUC leader
Services FWUC provides		O & M	O & M	O & M	O & M	O & M
Estimated O&M, '000 riels		2,700	3,500	2,000	2,500	5,000
Revenue, '000 riels	Last ISF collected	356	300	400	911	2,000
	Others	n/a	n/a	n/a	n/a	n/a

(1) This number excludes other farmers who receive a little water at the end of the harvesting season

Source: CDRI survey 2007 (* Data from PDOWRAM 2005)

- **Dang Kgnorm scheme**

This scheme was built in 1962 and slightly improved during the KR period. In 1996, it was rehabilitated with funding from the Australian government through AusAID. Again, it underwent rehabilitation in 2002 by MOWRAM with funding from ADB.

This scheme irrigates two communes; Srang and Roka Krau, benefiting 345 farm households. In 1985, the local authority initiated an informal solidarity group to be responsible for the irrigation's operation and maintenance; since then the group has been managed by the village chief. So far, there is no support to make this group formal. As an informal FWUC, this scheme has no formal water fee collection.

- **Doeum Krolanh scheme**

The irrigation was built from 1976 to 1977. The construction was not properly done; therefore, the irrigation could not store much water for farming. In 1991, it was seriously damaged by flood. In 1997, the government repaired one main water gate, two medium water gates, and one small water gate. After this repair, the villagers and commune councilors unofficially selected a leader to take responsibility for managing the irrigation with support from village chiefs. In 2004, the DOWRAM organized the election of a formal committee. However, the farmers have been experiencing water inadequacy during dry season rice cropping every year and thus have complained about inappropriate management by the committee (e.g., unclear schedule for water release, water loss, and improper interventions).

This scheme fully covers two villages (Key and Chouksar Tboung) and partly irrigates farmlands in three other villages in Soeung commune. In 2007, the entire commune

received land titling certificates, although some rice fields were exempted from the titling because they are situated in the reservoir.

- **Chroy Samrong scheme**

The scheme, constructed in 1962, can hold 4 million cubic meters of water and could potentially irrigate 600 ha of land. Its capacity and physical structures were upgraded by the KR regime; a few small rehabilitations were done thereafter. This scheme was seriously damaged due to flood in 2000. Later on, it was rehabilitated by the PDOWRAM with ADB funding but the low construction quality resulted in the dam having a lot of holes. Chroy Samrong scheme can benefit 851 farm households. Its FWUC was formally created with support from the DOWRAM in 2002; it started its operation in late 2002.

- **Svay Khom scheme**

The irrigation was constructed from 1973 to 1975. It had been rehabilitated twice -- first in 2000 by the DOWRAM with ADB funds to repair the water gates and strengthen the dams and second in 2003, with Japanese funds, in which the DOWRAM expanded the dams' width from 4 m to 6 m and constructed drain-off canals. This scheme covers three communes (Champei, Doung, and Krang Proteal) and benefits 1,000 farm households. Its FWUC was established in 2001 and formally registered in 2004.

3.3 Problems encountered and water use conflicts in Takeo

The RGC started to change the irrigation management system, from the vertical to horizontal approach, decentralization, and deconcentration, with the first commune election in 2002. This change is aimed at further empowering the local people engaged in the management and planning of their commune, which, in turn, is expected to also result in an improvement of natural resource planning and management.

A joint management period is used to establish, register, train, and strengthen the FWUC in the management of a scheme. Irrigation management is transferred to the FWUC only when its members are already capable of taking over the management. After the transfer, the FWUC faces various challenges in managing its scheme; it encounters different problems and conflicts over how water and water resources are used.

The three most common problems encountered by the FWUCs are financial, technical, and people participation. Different irrigation schemes have different degrees of difficulty. One scheme may face a high degree of financial difficulty, while another, a high degree of difficulty with people participation. Based on 18 FWUCC members' evaluations, financial issues rank first, followed by people participation problem and technical constraint (Table 2).

The study shows that financial limitation for rehabilitation and O&M of each scheme most concerns the FWUC. Due to the high cost of irrigation rehabilitation, community level efforts are not enough and there are consistent calls for external interventions. One farmers' focus group indicated that it is only when there are external interventions that the members are able to easily work together. Often outside interventions are usually late; interventions for small repairs and maintenance are usually neglected until the situation gets serious. However, the FWUC with social capital, especially when someone in the community knows important, rich and influential individuals, can speed up the intervention process. The problems encountered

in the irrigation sector do not end upon the completion of the irrigation system's rehabilitation.

Table 2: Degree of difficulty (1- least serious , 10- most serious)

Item	Min	Max	Mean	Std Deviation
Financial	5	10	8.15	1.345
Technical	2	9	5.08	2.060
Participation	3	10	6.92	1.935

Source: CDRI survey with FWUCC members (2007)

3.3.1 Problems encountered

In this section, the study discusses the financial issues together with the other key issues related to sustainability of irrigation scheme, which was raised by the FWUC during the field survey. All key issues are classified into five different groups: (1) financial constraints and lack of incentives, (2) low popular participation, (3) inappropriate technical design, (4) inappropriate leader selection, and (5) weak institutions and lack of law enforcement.

- **Financial constraints and lack of incentives**

Chapter 4 in the FWUC statute clearly states that the FWUC can receive revenues from four sources: (1) ISF collection, (2) assistance or credit from the government, IOs and NGOs, (3) profits from the business operation of the community, and (4) various levies and fines. The water fee is set based on five scenarios: in the first year, the government takes 80 percent of the responsibility and the members, 20 percent; in the second year, the government's share is reduced to 60 percent and the members account for 40 percent; in the third year, the government takes care of 40 percent, and the members, 60 percent; in the fourth year, the government, 20 percent, and the members, 80 percent, and in the fifth year, the members take on 100 percent of the responsibility.

The study showed that not all of the revenue sources mentioned in the statute exist in reality in all schemes, and the FWUC depends mainly on its members regarding the financing of O&M. All schemes experienced difficulty in generating sufficient funds from the communities for regular O&M activities. External financial support, however, comes in occasionally in an insecure manner. For this reason, O&M faces a serious problem when people do not pay the ISF.

Mobilizing local resources is partly difficult because farmers are not accustomed to the new system of water payment; they are used to accessing water publicly and free of charge, without any rules or regulations. According to anecdotes, even though the local people seem to support the formation of the FWUC, they vote "for the committee not for the water fees." Low ISF payment rates are also associated with time of collection. When the ISF collectors are busy with their own harvest and other activities, their ISF collection gets delayed. After the farmers have sold their products, then they become willing to pay the ISF collection.

Poverty and power abuse also contribute to low ISF collection. Poor farm households often have farmlands in disadvantaged areas. When investments in material inputs are low,

consequently, yield is low also, making the farmers reluctant to pay the ISF. Apart from poverty, power is another issue as some educated and influential water users use their power and knowledge to avoid paying the ISF, giving a bad example and giving rise to jealousy. That being said, in order to ensure fair practices in ISF payment and water allocation, there is a need to have a proper monitoring and evaluation mechanism in place. Financial management is a more issue raised as regards the interference by the CC. Also, due to lack of resources to understand well the land holding size, the FWUC depends on the estimation and report by land owners about land holdings, resulting in an inaccurate amount of ISF charged to each owner.

Since the FWUC operates within budget availability, a low rate of ISF payment affects the FWUC's ability to perform O&M as well as the sustainability of the irrigation infrastructure. "It is costly to rehabilitate or repair irrigation; we do maintenance activities according to the available budget... when there is no budget, there is no repair work either," said a member of Doeum Krolanh FWUCC. Low ISF collection translates into low pay for operators who take care of the water gate and do simple repairs.

For example, each operator in Chroy Samrong is supposed to receive 120,000 riels per year (about US$30) as agreed by the FWUC. However, each operator actually received only half of the amount, which is far below the opportunity cost of his labor. Insufficient pay for operators is common among irrigation schemes. The pay was higher at the beginning of the formation of the FWUC, but this has gradually decreased. A decrease in the ISF collection means less pay for the O&M persons, resulting in less incentive for O&M work. In Svay Khorm, each operator used to receive about 120,000 riels (approximately US$30) in 2005 but this had sharply declined to 30,000 riels (approximately US$7.50) in 2006. According to the study, the operators have become less interested in the O&M job; at least US$40 per person per year is needed to keep their services.

- **Low people participation**

Popular participation basically involves to two things: (1) financial contributions from water users to the FWUCC for use in O&M and (2) rehabilitation and O&M with labor contribution from the local people. However, financial contribution dominated most of the discussions in the five irrigation schemes in this study. The lack of popular participation and the lack of funds for O&M are some of the main problems hindering the effectiveness of the FWUC's management.

The farmers' ISF contributions are based on their yield, not on the quantity of water distribution and quality of service. By rule, the amount of ISF is supposed to be based on the size of the cultivated land and how water flows into the rice field. In Doeum Krolanh, where there is gravity flow of water, the ISF is charged at 100 kg of paddy rice per hectare, half drain and half pump at 70 kg/ha, and for fully pump at 50 kg/ha. The yield-based charge is problematic because yield is a function not only of water but also other factors such as land, labor, and material inputs.

Table 3: Annual ISF collection (in '000 riels) by the FWUCs, 2001-2006

	Formation year	2001	2002	2003	2004	2005	2006
Sampoch	2003	-	-	-	1,200	710	356
Dang Kgnorm	1998	-	-	-	-	1,200	300
Doeum Krolanh	2003	-	-	-	-	-	400
Chroy Samrong	2002	-	-	5,000	0	911	-
Svay Khom	2000	3,500	2,000	-	-	-	-

(1) This number excludes other farmers who receive a little water at the end of the harvesting season

Source: CDRI survey 2007

All FWUCs complain that water users do not pay the ISF regularly or in full. Generally speaking, the FWUC members enthusiastically pay ISF at the start of the FWUC formation but lose their enthusiasm and faithfulness in paying after sometime because there are no immediate outputs produced from their ISF payments and water delivery is still inefficient and unreliable. Due to lack of both financial and technical support, the FWUC cannot produce immediate visible outputs for the community, resulting in the perception that having the FWUC is not that useful.

Sampoch Irrigation is an example of reduced people participation. The interview with the FWUCs and CCs revealed that from 1.2 million riels (approx. US$300) collected in 2004, it decreased to 0.7 million riels in 2005, and down to 0.4 million riels in 2006 (Table 3) With this trend, the FWUC has become unable to stand on its own, especially if there is no external support and local resource mobilization.

One of the reasons for the low payment is low yield. For example, yield damaged by rats in 2006 in Sampoch and Svay Khom resulted in water users paying much less than the set fees while many refused to pay as they all claimed their harvest cannot cover the production cost, although they saw that the irrigation system's O&M was done well. This kind of refusal makes sense and seems to happen in different places beyond Cambodia's borders. Pasaribu and Routray (2005), in their study in East Java, Indonesia, showed that farmers do accept the set amount of ISF and are willing to pay for the improvement of their community's water supply, but in the reality, they are not able to pay due to their limited income.

> *"I am a member of Sampoch FWUC. Last year, I needed to pump lots of water from the canal to receive 3.2 tons from my one hectare of paddy field. I paid only 35,000 riels for water fees to the FWUC." (Interview on 06 January 2007).*
>
> *"I am a member of Sampoch irrigation. Last year, my 0.8 hectare of paddy land produced 1.5 tons of paddies. I pumped water from the canal. And I paid 18,000 riels to FWUC" (interviewed on 06 January 2007).*
>
> *"We know the importance of having the FWUC and want to contribute to O&M as we benefit from the scheme but low yield makes it difficult for us to pay water fees. From what we get from rice farming, we can hardly cover the expenses for yield and some of us are even in debt." (Farmers' focus group in Svay Khom)*

Irrigation is often a source of fish protein for the community and the FWUC often get permission from the local authority, PDA, and PDWORAM to manage not only the water but also the resources it carries, especially fish. Fishing fees used to be a major contribution to Svay Khom FWUC in 2001 and 2002 when fishing right was given to a private entity. When the fishing right was given back to the community, the FWUC could not collect fishing fees from any fishermen. The reason is that fishermen are mostly landless and among the poorest in the community. The FWUC, moreover, faces challenges with and cannot stop those who use illegal fishing gears.

Apart from giving financial contribution, the local people also do some repair work on the canals but only when the canals are located close to their land boundary or they use those canals. One of the main reasons is that they have a great sense of ownership and benefit from those canals. Lack of popular participation is also caused by the fact that the FWUC formation does not come from local initiatives (from people's heart and community interests); rather it is pushed by the PDWORAM. Therefore, it is hard to attract and retain the local people to join the work. With their sense of ownership, the local people may be more willing to participate in the O&M.

However, people participation may not rely only on the people's sense of ownership and immediate visible output. The interview with the CCs of Doung Commune showed that the local people are participate more in contributing money to the pagoda rather than to the FWUC. This implies that belief in getting a return in the future is crucial in terms of people participation. Belief also goes together with strong leadership, according to Acha (Buddhist priest). In some irrigation schemes, the selection of right and suitable leaders did not happen, leading to a limited participation by the FWUC members. Such sense of ownership and financial support could be harnessed by a strong leadership to mobilize local resources for O&M of the irrigation system.

> *"Villagers are more appreciative of contributing money to religion affairs than to the FWUC. They are willing to walk to the pagoda to bring money there; on the other hand, they refuse to pay for water fees to the FWUC though we try to go to meet them at home with some documents in hand." (Focus group discussion with Doung CC members)*

> *"If we put two boxes for cash contribution during any ceremonies -- box 1 for religious reasons and box 2 for FWUC management activities -- box 1 will be full before the ceremony finishes..." (Interview with FWUC of Chroy Samrong Irrigation, Takeo on 03 January 2006)*

In his study, Perera also emphasizes that in the areas considered to be relatively rich, the living standard of farmers and their income are better. While paddy cultivation is not the main livelihoods activities, the participation of such farmers are not active unless the FWUC can provide them incentive high enough to compensate for the cost of participation. On the other hand, this study found that some well-off families, including educated and high profile people do not contribute financially or via labor, leading to protests from the poor who contribute either ways.

- **Inappropriate technical design**

The physical conditions of most irrigation schemes are more or less the same as their condition during the KR regime due to lack of rehabilitation and maintenance afterward; thereby, the ability to store and provide irrigation water to farmers is still problematic. With

the absence of rehabilitation and O&M, most reservoirs have become shallow and dams have gradually weakened.

Weak reservoirs cannot hold as much water as potentially possible, resulting in limited available water for agricultural activities. While water supply has dwindled in recent years (due to drought), there has been an increase in cultivated areas over time, resulting in a greater need for water. As such, there is a need to increase the capacity of the reservoirs to ensure the availability of water for farming in the dry season.

However, the physical infrastructure of irrigation is one of the big issues hindering the FWUC's effective management of the irrigation system. The site visits and interview with the FWUCs of the five irrigation schemes revealed that all schemes are not able to store much water because irrigation dams have either collapsed or been broken by flood, wind, and erosion. Sluice gates are very old and a number of canals had been poorly designed, hence water cannot drain appropriately to the paddy fields. As a result, water users sometimes break the gates to get water. This has happened in Dang Kgnorm, Chroy Samrong, Doeum Krolanh, and Svay Khom.

Shallow canals, which are often a result of improper irrigation design and illegal use by farmers for rice farming, make it technically difficult to manage water distribution. The geographical condition is another problem; for example, some parts of the rice fields in Dang Kgnorm are located in the upper areas while canals are situated at lower areas, so that farmers have to pump the water, resulting in higher production cost, especially at these times of high gasoline prices. Farmers, however, do not have to pump the water during the wet season, except in some locations.

In Sampoch, the design of the scheme was still not appropriate even after its repair and rehabilitation. This is due to lack of consultation with the local people and now, there is a need to lower the water gate, which may cost about US$10,000. Also, the canals need to be deepened so minimize the need to pump water.

- **Inappropriate leader selection**

The law indicates that the FWUCC members are to be selected by the local people through a free and fair election. The local farmers are expected to be aware of the required leadership qualities of people they vote for; however, in some irrigation schemes, the PDOWRAM was observed to influence the nomination of candidates.

Personal qualities and high position in the community help a person earn credibility, respect, and trust. In the case of Svay Khom irrigation, the water users are not supportive of the first elected chairman because his qualities were not known to and accepted by the community. In the next election, the local people decided to choose a new person who they know well to be their leader. Though this person was very busy and involved in a lot of community work (regulation says that a person who stands as a candidate for the FWUC should not be involved in other groups), the people are happy to have him as their FWUC chairman. One of his advantages is that he lives closer to the reservoirs than the former chairman, making it easier for him to open and close the water gate in time. This situation suggests that the election and the selection criteria should be flexible in a way that produces a consensus among the local people. By doing so, they would view themselves as decision-makers rather than followers of the existing models.

On the other hand, education level seems to be closely linked with recognition by the local people. "My water users do not trust me and my technical capacity as they thought my

knowledge is not much better than theirs..." (Interview with the former Svay Khom FWUC chairman on 04 January 2006). It is important to note that people trust those with high education and want them to take control of the work. They also want those with high commitment, good attitude, good relationship with people in the community, and those who have produced good results so far. These criteria are important in enabling the local leaders to earn and build the trust of their people. Sedara 2007 said that community associations work well when their key members have good reputations and associate with other groups.

> *"I think people voted for me as an FWUC chairman because they trusted me. They believed that I can do the job. Another reason is I am more educated than many in this community and involved in many activities inside and outside the commune; for example, recently I am sitting in many positions such as pagoda association chairman, volunteer of commune health, chairman of village and communal development program, Svay village chief, chief of village bank, a member of CC evaluation committee, a member of planning committee for Seila Program..." (Interview with the FWUC chairman of Svay Khom Irrigation on 05 January 2007).*

- **Weak institution and lack of law enforcement**

The creation of the FWUC reflects the government's commitment to decentralization, especially as this group is expected to ensure effective irrigation management and development. However, there are a number of constraints relating to irrigation management by the FWUC. While the FWUC has been established very carefully, backed up by a legal framework, statement of purposes, etc., it is still weak inside.

Chapter 7 of the statute of FWUC indicates that both FWUCC members and water users may be sanctioned due to offenses such as absence from meetings, denial or irregular water fee payment, and refusal to contribute labor when asked for help by the FWUCC, illegal diversion of water from the canal, opening the sluice water gate without permission, damaging the canal systems or digging dikes, catching fish, wasteful use of irrigation water.

The sanctions may be in the form of warnings, fines, cutting off of water supply, and being sent to the communal authority for legal action. In practice, however, most of these sanctions are not applied. The study shows that the FWUC knows the abusers but they prefer to keep silence because often they cannot solve the problem without support from the CCs; also, they feel afraid of revenge from the offenders. In general, the CC is slow in taking action so that the people have become discouraged in reporting offenses.

Perera (2006) observed that institutional building in community irrigation management is not appropriate because it does not take into account all important aspects for effective institution building. There are some governance issues within the current FWUC management, including financial problems, lack of law enforcement, poor institutional capacity, and lack of incentives.

The FWUC formation process is weak in terms of strengthening, sustaining, and taking over the system management. The study found that the five irrigation schemes consistently need support in terms of capacity building and institutional strengthening. Currently, the links and affiliations of the FWUC with the local administrative institutions help strengthen it. The FWUC cannot work well without support from the Commune Councilors; however, such relationships affect the independence of the FWUC.

Though the FWUCC members have already received some training from the PDOWRAM they still need follow-up training in leadership development, participatory decision-making, conflict resolution, and proper conduct of meeting, record keeping, resource mobilization, communication, and coordination. In the absence of such training, the FWUC just learns by doing. They are especially confronted with the problems of low capacity in financial management, resource mobilization, leadership, and coordination. This issue has become the main reason for the CC to take control over the financial resources of one FWUC. A more serious concern is that one CC leader ordered an FWUC leader to give him money for no reason. This issue is known to some officials in the PDOWRAM but, regretfully, no action has been taken to address it.

Another aspect related to abuse of rules and regulations is the enlargement of farm land by occupying canals, resulting in narrower canals and secondary dams with thinner walls. “The rich and influential people including teachers are smart in grabbing public canals. That is why they are richer than us. We reported this issue to the commune council but there has been no solution so far,” reports a focus group in Chroy Samrong. This situation has led to smaller flow of water and high possibility of collapse of the secondary dams. Farmers cannot solve this problem among them and have been waiting for intervention from higher level authorities such as commune councils, PDOWRAM, and especially the Provincial Department of Land Management and Urbanization. Again, actions have been rarely taken or very slow.

3.3.2 Occurrence of conflicts

In many parts of Cambodia, the absence of water in rural communities is emerging as a major cause of conflicts in the farming sector. The availability of adequate supply of water minimizes conflicts related with water distribution and access among beneficiaries (e.g., rice farmers). The inefficiencies and inequities in water use are also a challenge. Rice farmers want to use water differently from fishermen, resulting in conflicts between them.

The common conflicts relate to the time for opening the sluice gates. These conflicts happen between the farmers and gate keepers. Conflicts also arise between farmers; for instance, one farmer would open the water gate and let water flow across the rice field of another farmer without prior notice or farmers who have pumping machines would pump large amounts of water from canals, leaving little water for use of farmers who do not have a pump.

Mutual understanding seems to be limited among water users, and the local people seem to be more individualistic, having little attention for collective action. Likewise, from the interviews with the FWUCs and CCs of the five schemes, conflicts regarding water distribution always occur every year due to misunderstanding. The problems become more serious in times of water shortage or lack of rain.

The scope of conflicts varies from community to community and is influenced by the irrigation scale and a multiplicity factors. Below are discussions on problems and conflicts faced by and among rice farmers who demand for water, and then followed by conflicts between rice farmers and fishermen over how this vital natural resource is used.

- **Conflicts among rice farmers**

According to Perera (2006), farmers complain that the existing irrigation systems lack access to water due to the lack of an adequate controlling system. Due to inadequate construction methods and materials, particularly during the Khmer Rouge regime, many irrigation structures are of little value or even harmful to water management (MOE 2005). This could be because these irrigation structures were constructed by people who were forced to do the job by the army, with limited involvement of competent technicians.

Conflicts in the irrigation sector happen both before and after rehabilitation of the scheme. In general, before the rehabilitation the main problem was lack of water due to low holding capacity and water wastage in the case of broken dams. After the rehabilitation, new problems and conflicts emerged over access to water and its efficient use. Water supply is still inadequate sometimes after the rehabilitation due to increase in cultivated areas as well as the lack of water in reservoirs due to low rain fall.

From the perspective of villagers, the problems with water are related to the distance between the water gate and where the operator lives. An operator from a different community would commonly try to protect the farmers from his own community, sometime at the cost of farmers in the other communities. "The operator did not want to open the gate for us as his commune wanted to keep the level of water high to avoid cost of pumping water to the rice field," shared by the farmer focus group in Svay Khom. The implementation of the agreement on water allocation timeframe is also a problem for the FWUC because farmers downstream are not patient and worry about possible delays in cultivation and about water run off. Downstream in this case refers to the lower part of the irrigation scheme located far from the reservoir; on the other hand, upstream means close to the reservoir. For downstream farms, their concern is that late cultivation often leads to a serious problem with rats.

It is often difficult for farmers from different communities to agree on a common schedule of water release and allocation, especially when water is insufficient. This issue results in tension between communities, which sometimes leads to violence. Tension and violence are harmful to water management, resulting in water wastage, insufficient water supply, and low yield of the cultivated land. "*Villagers come from far away to open the water for their rice field without permission from the gate operator and even though it is not yet their turn. And we cannot stop them as they need the water and threaten to fight us if we stop them. They open the water and do not take care if the amount of water flowing is beyond their need, which sometime leaves dry the reservoir. We cannot be strict with them as we do not want to die and leave our family behind*," said a focus group discussion of FWUC in Doeum Krolanh.

Conflict in water sharing is the most common issue in an FWUC, resulting in inefficient water use. People inside the reservoir need to release the water from the reservoir for farming in the dry season. Often, the water is not enough for farmlands outside the reservoir. This leads to conflicts to occur between farmers inside and outside the reservoir.

On one hand, inadequate water distribution is also very serious in this scheme as people mainly plant rice as their main livelihood and their choices for other jobs are so narrow. Conflicts often occur between farmers upstream and downstream regarding the schedule of water allocation.

Water conflicts in those areas are associated with water distribution. They include conflicts between farmers and water gate keepers due to timing of opening the water gate, flowing

water across the rice fields of another farmer without asking permission, farmers occupying canals, illegal opening or damaging of the water gate by farmers, etc.

When conflicts occur, people usually ask the FWUCC to intervene. However, if they cannot be solved, the people ask the intervention of the commune. Sometimes the commune faces lack of water, requiring negotiation with Bati district to allow water to flow down for farming. It is conjectured that conflict resolution and development in the community will be more effective if there is an intervention from the monk because people believe in Buddhism.

- **Conflicts between rice farmers and fishermen**

The FWUC is established to manage the daily activities associated with the irrigation system but its limited capacity appears to be a constraint in irrigation management. Before the FWUC formation, the community did not have a strong voice against the local authority who wanted to sell the reservoir to a fishing company. When the fishing company gained the rights over the reservoir, there were conflicts over the schedule of water release.

The establishment of the FWUC gave the community a voice to oppose the selling of fishing lots but the FWUC can hardly enforce the set rules and regulations. Now that the fishing lots belong to the community, conflicts have emerged between the FWUC and fishermen – i.e., the fishermen do not pay the fees for the use of water and they use illegal fishing gears.

3.3.3 Practical solutions

With regards the ISF, the payment rates would be higher if collectors could go and collect right after harvest. Thun and Chem (2007) see the need to: (1) set the ISF at a realistic level according to the locality and gradually increase it to a level that could sustain the irrigation's O&M, (2) help farmers understand the link between ISF and O&M, and (3) produce a simple cost and benefit analysis for farmers.

Moreover, the FWUC needs to have the financial, technical, and legal capacity to measure the land holding of each household so that it can accurately determine how much ISF to charge each water user. While the FWUC understands the members' difficulty in paying the ISF, it also needs funds to pay the irrigation's O&M. The solution of having the FWUC head encourage all members to participate seems not going to work well without external inputs.

Some villagers still want to work for the irrigation system even if they receive only a small incentive for doing so. This is because they use irrigation water and they also receive some intangible benefits. The intangible benefits might include being appreciated as well as obtaining a good reputation and respect from the local people. Doing a good deed is referred to as "tveu york bun." "I appreciate the FWUCC members because they carry out an unpaid job. I believe those people are the ones who truly care about people as they make their own sacrifices in terms of time and energy," said a commune councilor of Doung Commune.

However, in some irrigation schemes, the FWUC has become less motivated to work; some of the members are discouraged and no longer intend to stand as candidates in the next election due to lack of people participation and low benefit from the job they do. For example, a member of the FWUC in Chroy Samrong decided to give up his position in the FWUCC.

"I used to be enthusiastic with this job because I think I am so experienced and well-informed about the local situation and I wanted to serve my people. I didn't expect a good pay from this job but I did not get any small pay that I am supposed to get for three years. Now I am less interested in this work because of no incentive and lack of popular participation," (interview with FWUCC chairman of Doeum Krolanh irrigation on 04 January 2006).

"I will never stand as a candidate in the next election. I plan to quit this job, but have to wait until the end of this mandate," (interview with a sluice gate keeper in Doeum Krolanh Irrigation on 04 January 2007).

Before the formation of the FWUC, the villagers solved the irrigation problems individually, which sometimes benefited just one individual and damaging another. Moreover, farmers in a conflict used to take their complaints to high-level authorities (e.g., provincial governors and sometime even to the Senate Assembly in Phnom Penh) without trying to solve the problem at their level. The travel from the villages to meet different high-ranking officials e.g. in Phnom Penh is time consuming and an expensive way to solve a problem.

With the formation of the FWUC, the villagers must first try to solve problems collectively and through their representative in the FWUCC before they decide to go to the CC or other higher authorities. In some serious cases, the FWUCC works with higher authorities, especially the CC, to address problematic situations. If the CC still cannot solve the problem, they submit the complaints to the district level or even provincial level.

Conflicts in water use between farmers in an FWUC could be solved, to a certain extent, at the community level. For example, the CC in Doeum Krolanh got 7 complaints in 2005 from villagers; 4 were solved at the commune level while 3 were sent to the district level.

In cases of conflicts between two communities, it is often hard for the concerned parties to sit down together and solve their problem. They usually need to make a complaint to the PDOWRAM or ministerial level for intervention. Usually, all concerned parties accept the involvement of higher authorities and are satisfied with the solutions provided. However, the solutions are often temporary and short-term, especially when provided by politicians because politicians bear the cost of financial losses for all parties.

When higher authorities are involved, the social relationships between the FWUC and related institutions (e.g., CC and DOWRAM) and individuals (e.g., politicians and Excellencies) play an important role. As previously mentioned, farmers usually are satisfied with the solution provided by the influential outsiders, partly because they get compensated for their losses.

At the commune level, the study finds that the FWUC and local authority complement each other; for example, some village chiefs are selected by farmers as the leaders of water group; in other villages, the chiefs play a crucial role in helping to push water users to pay the ISF; and in some communes, the chiefs are the de facto advisers of the FWUC. These links are seen to make the FWUC functional because the village chiefs and CCs have been involved in such work even before the establishment of the FWUC; they are experienced, well-informed, and are used to the tasks.

The interview of the five irrigation schemes revealed that the CCs play critical roles for the FWUCs by providing spiritual support, helping address water conflicts, and linking the

FWUCs to outside institutions or people when external help is needed. For example, in the case of Doung commune, when the Doeum Krolanh scheme faced water scarcity for some years, the CCs went to meet the governors and the FWUC in Bati district to request the provision of water on behalf of the FWUC in Doung as their two schemes are similar with each other.

The CCs and village chiefs are important local leaders that are available in every commune and village; the other community organizations (e.g., Pagoda-associated Acha Committee and School Support Committee) exist according to geographical conditions. The link with the local leaders, along with support from the higher level of administration, is the most important factor that contributes to the functioning of all FWUCs. "The FWUC needs three qualities for good management: to be influential (to make decisions, to command, etc.), to make people believe and trust, and to enforce rules. The current FWUC apparently does not have those values, so they need to work closely with CCs who possess all those qualities" (interview with Mr. Phart, staff of PDOWRAM, Takeo).

A healthy relationship between the FWUC and CC is good to a certain extent, but often it is used as a political tool by CC members and politicians to collect votes for themselves and their party because the CC is a political body. This makes the situation difficult for the FWUC because it heavily depends on external support. In some cases, conflicts are managed using a political approach, which is not good in the long run. Hirsch and Wyatt (2004) illustrated that when the political approach is applied to conflict management, unequal power relations result in inequitable outcomes.

The CCs, however, do not serve as a strong backup, especially in dealing with sensitive conflicts because they want to maintain their popularity with the local villagers. "We asked the commune council to intervene in serious cases but they do not take action to solve the problems between groups of farmers for they are afraid of losing their popularity," said a focus group in Doeum Krolanh. In this regard, the links and affiliation with the local administration body may undermine the development of the FWUC as an independent water user organization.

Though it seems that the FWUC is able to deal with minor conflicts only, it is still viewed as a useful mechanism for the daily O&M of the irrigation scheme and also to solve problems between farmers in the community. Regarding O&M, for storage volume to increase, two important things should be considered: (1) grow trees and grasses along the dams to reduce the rate of erosion, and (2) pay a regular salary and give more authority to the FWUCC members so that they can spend more time to take better care of the dams.

Negotiations to allow only a certain amount of area to be cultivated according to the amount of water available have not been done; such negotiations may need external intervention. "We cannot negotiate on limited cultivated areas as everyone wants to farm because they don't have alternative livelihoods. They fight for water when the time for allocation of water comes. Villagers do not listen to us as we are not more educated than them. They will listen to higher level of people or most of the outsiders with high education," said the FWUC in Doeum Krolanh.

3.4 Yield impact on small scale irrigations in Takeo

3.4.1 Socioeconomic profile of households

In the study, the words "informal" and "formal" FWUC are used frequently. "Formal FWUC" refers to an FWUC that has been created, registered, and recognized by MOWRAM. "Informal FWUC" refers to a community of farmers that is not registered and recognized yet. Dang Kgnorm is informal and Sampoch is formal. As shown in Table 4, on the average, each household has 6 members; only 9.30 percent of the household heads are female. Most of the household heads were around 45 years old; 92.5 percent are married and 7.50 percent are separated. Slightly more than 50 percent of the household heads have not entered secondary school while less than 10 percent reached high school. The majority (95.30%) are employed in the agricultural sector. The rest (4.70%) engage in non-agricultural work for supplementary pay in/outside their villages; for example, they run a small business, drive a motor-taxi, and sell their labor (e.g., work as construction laborer). Sampoch, which is far from the provincial town, has no household head working in a non-agricultural sector while Dang Kgnorm, which is next to a provincial town, has 8.60 percent of the household heads working in a non-agricultural sector.

Table 4.- Household Profile

			Unit	Dang Kgnorm (informal)	Sampoch (formal)	Both
HH size (mean)			Persons	5.9	5.9	5.9
HH farming	Rice	Income	USD	429.0	348.0	392.0
		Expense		209.0	216.0	212.0
	Livestock	Income		226.0	213.0	174.9
		Expense		206.0	126.0	125.0
HH off-farm income				947.0	301.0	651.0
HH head	Schooling	No school	%	15.5	20.4	17.8
		Primary		38.0	28.5	33.6
		Secondary		43.1	38.8	41.1
		High School		3.4	12.2	7.5
	Gender	Male		86.2	95.9	90.7
		Female		13.8	4.1	9.3
	Status	Married		91.4	93.9	92.5
		Separated		8.6	6.1	7.5
	Occupation	Farming		91.4	100.0	95.3
		Others		8.6	0.0	4.7

Note: US$1 = 4,000 riels

Source: Calculated based on CDRI survey (2007)

There are farmers who raise cattle for use only in land cultivation; when possible, they raise pigs, fish, and chickens to earn extra cash. On the average, livestock provides US$175 per year to the family income. Rice farming contributes US$392 per household per year. The study calculated that the local farmers need to spend annually up toUS$125 on livestock production and US$212 on rice farming, of which about 70 percent is spent on farm inputs,

hired labor, and transportation. Animal production has become less active in recent years in the five irrigation schemes because of two main reasons: first, animal power has been replaced by machines, especially hand tractors, and second, there have been increased concerns over animal diseases including bird flu.

The greater availability of tractors has resulted in lower land preparation cost. It is observed that land preparation cost is about 5-10 percent cheaper using tractors than using animal power. As a result, the demand for animal power has declined. But the Northwest provinces are likely to shift back to animal power when there is less smuggling of fuel (resulting in higher fuel prices). The shift back to animal power is also expected to accompany an increase in the demand for beef in the future since farmers could raise these animals for dual purposes: for use in agricultural activities and for meat. Currently, farmers raise cattle mainly for rice farming and to fund urgent needs of the family.

A small number of people interviewed (6.5%) also get remittance money (average of US$120 per year) from their relatives who work in Phnom Penh. Apart from the remittance, household members also generate income from off- and non-farm activities within and across communities in the province. Overall, the off- and non-agricultural work contributes about US$651 per year to each household income.

The dry season rice fields become flooded during the rainy season and when water washes off, fertile soil is deposited downstream. As a result, generally the downstream area has higher land productivity, as indicated in Dang Kgnorm scheme. However, its rice farms also suffers more often than the upstream area from damage caused by rats due to late rice planting and rat multiplication when the water recedes. This is particularly true for Sampoch scheme, which faced a serious problem with rats in the year of the survey; thus the yield in the downstream areas was lower that that in the upstream area. Regarding number of plots, there are 29 plots in the upstream and 83 plots in downstream of Dang Kgnorm scheme. Meanwhile in Sampoch scheme, there are 35 plots upstream and 66 plots downstream (Table 5).

Table 5.- Household Land Holding

		Unit	Dang Kgnorm (informal)	Sampoch (formal)	Both
Size (mean)		ha	0.96	1.41	1.17
Yield	Upstream	t/ha	2.68	2.52	2.57
	Downstream		3.58	1.75	2.60
Ownership	Own	%	99.17	95.10	97.30
	Rent		0.83	4.90	2.70
Document	Yes		73.55	38.24	57.40
	No		26.45	61.76	42.60
No. of plots	One		22.40	28.60	25.20
	Two		55.20	44.90	50.50
	Three & more		22.40	26.50	24.30

Source: Calculated based on CDRI survey (2007)

Half of the people interviewed cultivate rice on two plots of farms. The majority of them (97.30%) said they owned the lands, but only half admitted having documents to prove their ownership (Table 5). Though two-thirds of farmers own more than one plot of farmland, the study shows that each plot has become smaller and smaller because the local people said they need to divide their lands for their children or sell some parts during emergencies (e.g., treatment of illness). On the average, a household owns 1.17 ha of paddy land.

3.4.2 FWUCC performance and satisfaction

This section presents the farmers' perception of the performance of the FWUCC. This study covered different components including issues of planning and budgeting; election and leadership; external relationships; ISF collection; financial transparency; educational capacity of FWUCC members; and water distribution.

Table 6 shows that 96.36 percent in Dang Kgnorm and 85.71 percent in Sampoch were satisfied with the performance of the FWUCC. This reflects the score received by each irrigation project in the evaluation of the FWUCC performance. On a scale from 1 to 10 (with 1 as lowest and 10 as highest), Dang Kgnorm got a score of 7.16, which is 0.53 higher than that obtained in Sampoch. The high score in Dang Kgnorm was due to high ratings given for financial transparency, planning and budgeting, and external relations. External relation is very much linked to financial issues, e.g., the ability to get financial support to rehabilitate and maintain the system.

Table 6: Satisfaction and FWUCC Performance (10 is highest)

FWUCC performance	**Difference**	**Dang Kgnorm**		**Sampoch**	
Planning and budgeting	0.88	6.86		5.98	
Election and leadership	0.48	7.52		7.04	
External relations	0.51	7.29		6.78	
ISF collection	0.19	7.54		7.35	
Financial transparency	1.04	6.41		5.37	
Educational capacity	0.37	7.35		6.98	
Water distribution	0.27	7.62		7.35	
Average	0.53	7.23		6.69	
Satisfaction	**Answer**	**No.**	**%**	**No.**	**%**
Technical design	Yes	41	74.55	46	93.88
	No	14	25.45	3	6.12
FWUCC performance	Yes	53	96.36	42	85.71
	No	5	9.09	7	14.29

Source: CDRI survey, 2007

Despite their satisfaction with the FWUCC, farmers in the two studied sites gave the lowest score to the item on financial transparency. Based on the results, it can be concluded that financial issues play an important aspect in the people's perception of the FWUCC

performance. These include ability to raise funds from other sources (e.g. collecting charitable contributions), transparency in the use of the money, and budgeting.

Water distribution is a very important function as the government expects that the water user community will decide internally how it will regulate and deliver the water according to the amount of water available. Water distribution is attributed to technical design of the system and the performance of the FWUCC. With regards the technical design of the irrigation system, the study shows that 74.55 percent in Dang Kgnorm and 93.88 percent in Sampoch are satisfied.

3.4.3 Yield impact

Takeo is a plain area that slopes eastwards toward the Tonle Bassac River. The floodplain soils have high organic mater due to annual flooding while high land soils have low organic matter. Most farmers in this province cultivate rice twice a year but not on the same plots. In general, the wet season paddy lands are located a little bit lower than the homestead lands but higher than the bottom of the reservoir; they are mainly rain-fed. The dry season farmlands are located lower than the bottom of the reservoir; hence, they could not be cultivated in the wet season due to flooding. They depend on irrigation water for dry season farming.

Rice yield relies on plot size and other factors including material inputs (seed, pesticides, and fertilizers), labor input, and water availability[4]. Theoretically, all variables contribute to rice yield. Table 7 shows the summary of the yield impact study, wherein the model is applied by location. Three sets of regression models were employed to see if the selected factors affect the performance of rice in different categories of analysis. The upstream and downstream areas of the irrigation system are expected to perform differently taking into account the application of inputs.

The results of the models for the three different categories indicate the fairly significant models, with R^2 of 0.548 to 0.585. This implies that the inputs in the model determine more than 50 percent (both upstream and downstream) of the variations in yields. The models suggest that in general labor has a positive impact on yield. Plot size has the most significant contribution, followed by water adequacy and either material input or labor input.

Irrespective of location (i.e., upstream or downstream), plot size positively contributes to rice production. This shows that productivity of farmland increases with farm size. Regardless of location, water supply also positively contributes to yield. The model shows that in general water adequacy increases production by about 350 kg; it contributes up to 800 kg in the upstream area. However, the coefficient of water adequacy variable is not significant in the downstream area where there is still a lot of water in paddy fields in the early dry season and competition for water from the upstream is experienced only in the late dry season.

[4] The productivity of irrigated land is approximately three times greater than that of rain-fed land (FAO 2005). This is due to increased number of cultivations per year and increased productivity per cultivation.

Table 7.- Summary of Regression Models

Model applied by location	Variable coefficient	R^2	t	P
Total (downstream and upstream)	$Y= -0.056 +1.025X_1 +0.002X_2 +0.002X_3 +0.349X_4$	0.548	$X_1 = 4.305$	0.000
			$X_2 = 2.688$	0.008
			$X_3 = 4.888$	0.000
			$X_4 = 2.927$	0.004
Downstream	$Y= -+0,072 +1.189X_1 +0.003X_2 +0.001X_3 +0.130X_4$	0.565	$X_1 = 4.013$	0.000
			$X_2 = 3.032$	0.003
			$X_3 = 2.898$	0.004
			$X_4 = 0.863$	0.390
Upstream	$Y= -0.392 +1.466X_1 -0.001X_2 +0.003X_3 +0.809X_4$	0.585	$X_1 = 3.089$	0.003
			$X_2 = -0.892$	0.376
			$X_3 = 2.566$	0.013
			$X_4 = 4.302$	0.000

Note: Y = RICE-OUTPUT (tonne); X_1 = PLOT-SIZE (ha); X_2 = LABOR-KHR ('000 riels); X_3 = INPUTS-KHR ('000 riels); X_4 = WATER-DUMMY

The contribution of material inputs to rice yield is also positive. The models indicate that rice production would increase by 3 kg in the upstream area and only 1 kg in the downstream area if material input cost increases by 1,000 riels. Since the price of one kilogram of rice is about 600 riels, it is not advisable to increase material inputs in the downstream area.

However, labor input has mixed signs in terms of its contribution to yield increase. In the downstream area, the coefficient is significant and positive at 0.003, which imply that production would increase by 3 kg if labor cost increases by 1,000 riels. So it is advisable to invest more in labor in the downstream area. In the upstream area, the variable coefficient is negative but not significant.

The upstream area would have more advantages in terms of water allocation due to its closeness to the water source and the village compared with the downstream area. Hence, the upstream farmlands have a lower labor cost per unit of output than the downstream area. On the other hand, the downstream area has a different advantage – that is, it has more fertile soils due to washing off of fertilizer from upstream when water recedes.

4 Conclusions and recommendations

4.1 Conclusions

The study reveals that many irrigation schemes in Cambodia have poor technical designs. This is because they were originally built for purposes other than agricultural production. Poor technical design and insufficient maintenance make these irrigation schemes hardly able

to function well. Insufficient maintenance is a result of the country's long civil war and the lack of financial and technical support to the FWUCs.

The following are the main conclusions of the study, although care should be exercised in making generalizations due to constraints on the study site coverage.

Field observations indicate that the downstream area gets too much water in the early dry season, making it impossible to do early land preparation activities. Due to its distance from the village, the downstream area gets fewer visits from relevant people and inadequate maintenance, resulting in a poor water delivery system in the area. On the contrary, the upstream area, which is closer to the village, gets more visits and better maintenance, resulting in a more systematic management of its irrigation system.

In Takeo province, the existing problems in irrigation are mainly related to: (1) financial limitation for O&M due to lack of external support and low contribution from the FWUC members; (2) low popular participation, which is the result of a low sense of ownership of the irrigation system due to poor explanation and extension by the FWUC members, poor performance in ISF collection due to poverty, poor law enforcement and abuse of power by the educated and powerful elite in the community; and (3) poor technical design of irrigation schemes due to a combination of poor financial and technical support and multi-purposes of the dam construction.

In addition to the three points above, the irrigation sector faces two other problems: (1) inappropriate leader selection due to lack of flexibility in the selection criteria and process and (2) weak institution and lack of law enforcement due to the leaders' limited capacity and lack of cooperation from relevant authorities. These two points are linked to each other, resulting in lack of work forces and strong leadership to mobilize resources for the irrigation structures' O&M.

Conflicts associated with the irrigation schemes result mostly from the above-mentioned problems. The study found that conflicts often happen among the same type of beneficiaries (e.g., rice farmers). They generally results from inadequate water supply and allocation to farms due to: (1) the continuing increase in cultivated areas, (2) limited amount of water in the reservoir due to its low holding capacity and low rain fall, and (3) improper timing of water release due to the geographical location of the farmlands and small incentive for operators.

Conflicts were also observed between rice farmers who want to keep water in the reservoir for use during the dry season and fishermen who want to release the water in support of fishing activities. Those benefiting from fishing are just a fraction of the total irrigation community but they are relatively poor so it is difficult to enforce the law because they have no alternative livelihood. The study also discovered political interferences in the decision-making process of the FWUC, especially before and during local and national elections.

Conflicts are solved at different levels, depending on their nature and the size of the affected irrigation schemes. Conflicts in small irrigation schemes are often solved at the community level by the FWUC, although sometimes complaints may go up to the provincial and national levels. In medium-scale irrigations where beneficiaries come from different communities, conflict resolution often involves the intervention of higher authorities (e.g., provincial and national authorities).

At their current stage of development, the FWUCs need more strengthening in order to increase their capacity in mobilizing financial support for O&M of the irrigation infrastructure. More external and financial support is very much needed for at least several years more to place the FWUCs on a track to sustainability.

The study reveals that the four factors affecting increase in rice yield are plot size, farm material input, labor input, and water adequacy. These factors were identified through three regression models applied in three situations: upstream area, downstream area, and their combination in Takeo province. In general, these factors positively contribute to rice yield, with plot size and water adequacy, being the most significant factors, followed by either labor input or material input.

4.2 Recommendations

- **Policy implications**

The efficiency and sustainability of the irrigation schemes require two critical factors: financial support for O&M and technical support to the FWUC in terms of management and resource mobilization. At the present time, the FWUCs just learn by doing. They need to be provided with technical and financial support so that they can help ensure a better and more regular O&M of the irrigation structures.

On the other hand, local resource mobilization is not easy to do because the water users are not familiar with the idea of paying the ISF and the services provided by the FWUC have so far fallen short of expectations. Moreover, some educated and powerful people are able to go around the regulations to avoid paying the ISF. To reduce the problem, a mechanism to monitor, evaluate, and penalize violators should be established to enforce the rules on ISF payment. In the future, when local resources are mobilized by the FWUC, the external financial support can then be decreased over time. The technical design of an irrigation scheme is often done by external experts without consultation with knowledgeable local community members.

There should be external financial support for the irrigation structure's O&M to help keep the responsible persons devoted to their job, but the amount of pay for regular involvement in O&M should be set by the local people based on the quality and amount of work. There is a need to strengthen the FWUC in terms of financial management and conflict solution.

Education and extension activities for the FWUC members are needed to increase their sense of ownership and awareness of the importance of O&M. Training activities, at least occasionally, are needed to strengthen the management and leadership of the FWUCC. Moreover, collaboration between the FWUCC and other relevant authorities is important in terms of institutional strengthening and law enforcement. However, the collaboration should be established in a way that minimizes political interference in order to avoid political and personal conflicts.

There is also a need to engender mutual understanding among farmers and between farmers and fishermen. This might be achieved by having strong and respected community leaders to explain and educate the community members on how to share resources according to the rules and regulations.

The study reveals that generally plot size, labor input, material input, and water adequacy, all positively contribute to rice yield. Plot size and water adequacy are the most important contributing factors, followed by either labor input or material input. However, since land is limited, it is advisable to invest more in labor, not in material input, in the downstream area. On the other hand, it is advisable to invest more in material input in the upstream area.

- **Future study**

Due to limited fund, the study could only compare the conflicts between small- and medium-scale irrigation schemes; large irrigation schemes could not be covered. Information and data from the household survey allowed the analysis of factors contributing to yield in small-scale irrigation schemes only. The measures introduced in this study could be refined, made more robust by comparing small-, medium-, and large-scale irrigations schemes. This could be the subject of later studies, which could cover the following:

(1) comparative analysis of water use conflicts by size of irrigation schemes (small, medium, and large),

(2) comparative study of potential factors contributing to yield in different sizes of schemes (small, medium, and large), and

(3) economic analysis of FWUC sustainability and minimum cost for O&M of the different sizes of schemes (small, medium, and large).

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