

Article

Assessment of Community Fish Refuge Management Practice in the Siem Reap Province of Cambodia

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Abstract: The Community Fish Refuge (CFR) is a fish conservation measure that is intended to improve the productivity of rice field fisheries and provide safe refuges for fish during the dry season. Cambodia's Fisheries Administration aims to develop one well-working CFR in every 1200 communes by 2019. This study assesses the current situation of the rice field fisheries in the Srey Snam district, Siem Reap province, examines community members' awareness of fish refuge management; and examines the socioeconomic impacts of the CFR among its beneficiaries. Data collected by interviewing 120 households reveal that 85 percent of respondents pursued rice field fishery as part-time work, catching on average 5.2 kg of fish daily during the ten-month harvest period. Most fish products were used for home consumption. Total household saving and income from fish production significantly increased after community members joined CFRs. Respondents' expenditures, savings and assets also increased after CFR intervention, indicating improvements in livelihood. Illegal fishing and budgetary constraint to implementing CFR interventions are the pressing problems facing the users. The paper ends by outlining measures that could help strengthen and sustain CFRs.

Keywords: community ponds; fisheries; community fish refuge; impact; Cambodia

1. Introduction

Fish is a major source of food and cash income for millions of the world's population. Increasing globalization, increased awareness of people from developing countries about fish products (e.g., rich in high quality proteins, contain many essential amino acids and vitamins) are helping to boost fish demand [1]. Fisheries are broadly classified into two systems. The marine fishery seems to be in decline but inland fishery (aquaculture) is growing, albeit its sustainability has been a concern [2]. Community Fish Refuge (CFR) is an enhanced inland capture fishery production system. Between 1970 and 2008 annual aquaculture production worldwide increased by an average of 8.4 percent; and by 2030, over 62 percent of fish for human consumption is projected to come from aquaculture [3]. Review of the literature shows variability in fish production systems by geography. The productivity is also associated with social subsystems such as access to natural resources, local culture and food choices. Thus, an assessment of an aquaculture system requires location specific studies and development strategies [4]. Some literature report that aquaculture has an increased threat of climate change. Also, there has been an increased competition for water resources which is essential for inland fish production [5]. Reports indicate a lack of infrastructures for aquaculture development and

stakeholders' knowledge about aquaculture management [2]. Furthermore, scholars agree that data on inland fisheries are either scanty or inconsistent [5,6].

Inland fish production by smallholder farmers are scattered and are not adequately reported. Given that overwhelmingly a higher number of inland fish growers are resource poor fishers who depend on fishery for their livelihoods, it has become more important to identify issues facing inland fishery and address these issues. This paper is about Community Fish Refuge (CFR), one of the inland fish production systems that has been gaining popularity in Southeast Asia, particularly in Cambodia in recent years.

In Cambodia, inland capture fisheries—notably those in the lowland agricultural cropping ecosystem—have gradually declined due to environmental degradation and the loss of fish habitats. But with the growth in population, demand for fish is ever increasing. Improving rice field fisheries is crucial to meet fish demand among local consumers. One possible option to improve fish production in the lowland agricultural ecosystem is the introduction of refuge and conservation areas for stock rehabilitation, which have been proven beneficial to the maintenance of fish stock diversity and yields [7]. The concept of community fish refuge was introduced by the Aquaculture Division of the Fisheries Administration of the Kingdom of Cambodia in 1995 in collaboration with the Asian Institute of Technology, Bangkok, through the Aquaculture and Aquatic Resources Management (AARM) Project [8]. The CFR system refers to a village/community protected pond established in seasonally inundated rice fields located far from natural permanent water bodies. The ponds are connected to rice fields through canals or fish pathways so that fish can reproduce and grow out naturally in the flooded rice fields during the rainy season [9]. Additionally, a CFR is a form of fish conservation measure that helps stabilize fish populations in rice fields, provides safe refuges for fish during the dry season and thereby improves the productivity of rice field fisheries. Rural households that depend on rice field fisheries can potentially benefit from CFRs.

Fisheries Administration Cambodia (FiA) with assistance from various donor-funded projects sought to scale up CFRs in Cambodia. In June 2006, a total of 52 CFRs had been established in 13 provinces, including Siem Reap. Starting in 2009, several new CFRs have been established and the four CFRs included in this study were set up in 2009 in Srey Snam district, Siem Reap.

Through an advocacy campaign called “One Commune, One Community Fish Refuge” and through the legal framework of Community Fisheries (CFi), the government of Cambodia has been promoting CFRs [10]. The authors [10] describe three steps in establishing a CFR, that is, site selection, institutional arrangements for CFR managements and local implementation of CFR activities. First, identification of appropriate sites is the paramount. The CFR site should be selected in consultation with local communities. Specifically, stakeholders such as Commune Chiefs, Commune Councillors, police officers and village heads who are knowledgeable about the local context should be consulted. The site selection should also consider hydrological, socioeconomic and governance factors for CFRs' sustainability. The site should have access to year-round water supply, infrastructures for water management and enough flood level to allow fish migration. CFRs are likely to be successful in areas where there are community-managed ponds and where community members and local authorities are committed to work in harmony.

The second step is the formation of CFR Committee and development of rules and regulations for managing the CFR. The third and final step includes the preparation of ponds and filling them with required volume and quality of water, securing fish pathways and plant cover. Then, brood stock and fingerlings are released. Common fish species for the CFR include snakehead (*Channa striata*), catfish (*Clarias batrachus*), climbing perch (*Anabas testudineus*) and the hatchery-raised silver barb fingerlings (*Barboides gonionotus*).

FiA plans to develop one well-functioning CFR in every 1200 communes by 2019 [11]. Despite these interventions ongoing for years, there have been no systematic studies on rice field fisheries, particularly about the socioeconomic status of CFR users and their participation in the CFR process. Joffre et al. [10] documented the outcomes of 11 CFRs supported by Aquaculture and Aquatic Resources

Management (AARM), Freshwater Aquaculture Improvement and Extension Project (FAIEX) projects or the FiA in Svay Rieng, Takeo, Prey Veng, Kampot and Kampong Speu provinces. These CFRs were implemented between 1998 and 2008. Viseth et al. [12] report that the CFRs are beneficial because they make fish catching easier, reduce the time needed for fishing, make fish available for family consumption and reduce illegal fishing practices. Brooks et al. [13] developed typologies of community fish refuges in the rice field fishery ecosystem.

This study seeks to assess the status of fish refuges and fish refuge farmers and document impacts of fish refuges on farmers' livelihoods. Specific study objectives are to:

- Describe the demographic-socioeconomic characteristics of CFR beneficiaries in Srey Snam district, Siem Reap province.
- Examine beneficiaries' awareness of and participation in CFR management.
- Assess socioeconomic impacts of CFRs among project beneficiaries.
- Suggest ways to improve the management of the CFR program and sustain its benefits.

The theoretical framework of this study builds on the premise that common-pool resources (CPRs) such as community fish refuges are complex systems that are often treated as public and open resources that everybody has access to and community members' knowledge of and participation in their management is paramount to sustain such resources. The major issue facing CPRs is its sustainable use through participatory management. Describing common property renewable resources through a stock and flow phenomenon, the author [14] argues that under open access, individuals tend to consume and/or withdraw resources at a higher rate than the resources are replenished. This gives rise to the so-called Tragedy of the Commons. So, CPRs are vulnerable to deterioration and they rarely recuperate. While a few members may benefit from using CPRs, overall the community keeps losing resources and such resources become unsustainable.

Scholars suggest several options to manage CPRs—communal management [15]; regulations [16,17], co-management and privatization [18,19], among others. "Regulation" refers to reallocation of rights and access to resources through government or private sector initiatives. In co-management, a resource user group and another organization, which is usually a government agency, share responsibilities of fisheries management. For example, the government agency provides fingerlings and technical advice while a user group carries out overall management. Another management approach, like co-management, is community-based management, in which community members are educated and/or informed to be able to independently manage CPRs. They are aware of the social, economic and environmental benefits of conserving and preserving CPRs. This participatory management process tends to be sustainable. Therefore, understanding what and how users perceive CPRs, how knowledgeable they are about CPRs (e.g., CFRs) and whether they have been benefitted from CPRs is paramount.

2. Methods

2.1. Study Site

The study was conducted in Siem Reap province in Cambodia. First, Srey Snam district was selected because of early introduction of CFR program in this district. Four communes with CFR programs and one village within each commune with CFR but with uniform agroclimatic conditions was selected purposively for household surveys (Table 1, Figure 1). The area under fish refuge in the selected villages ranged from 0.7 to 3 ha. They were established in the same year, that is, 2009. A proportionate sampling method was used to select a sample of 120 households from the selected villages. This resulted in a sample size at 8, 12, 36 and 64 households selected from Boeung Preah Kseit, Boeung Rong, Au Neang Leak and Trapian Thom, respectively (Table 1).

Table 1. Study sites in Srey Snam district and information about community fish refuge (CFR).

Name of CFR	Area (ha)	Location		Year Established	Households (N = 685)	Sample (n = 120)
		Village	Commune			
Boeung Rong	1.8	Sleng Chas	Kliang Hay	2009	70	12
Au Neang Leak	3	Prey Py	Prey	2009	208	36
Boeung Preah Kseit	2	Preah Kset	Sleng Spean	2009	43	8
Trapiang Thom	0.7	Chroy Neang Nguon	Chroy Neang goun	2009	364	64

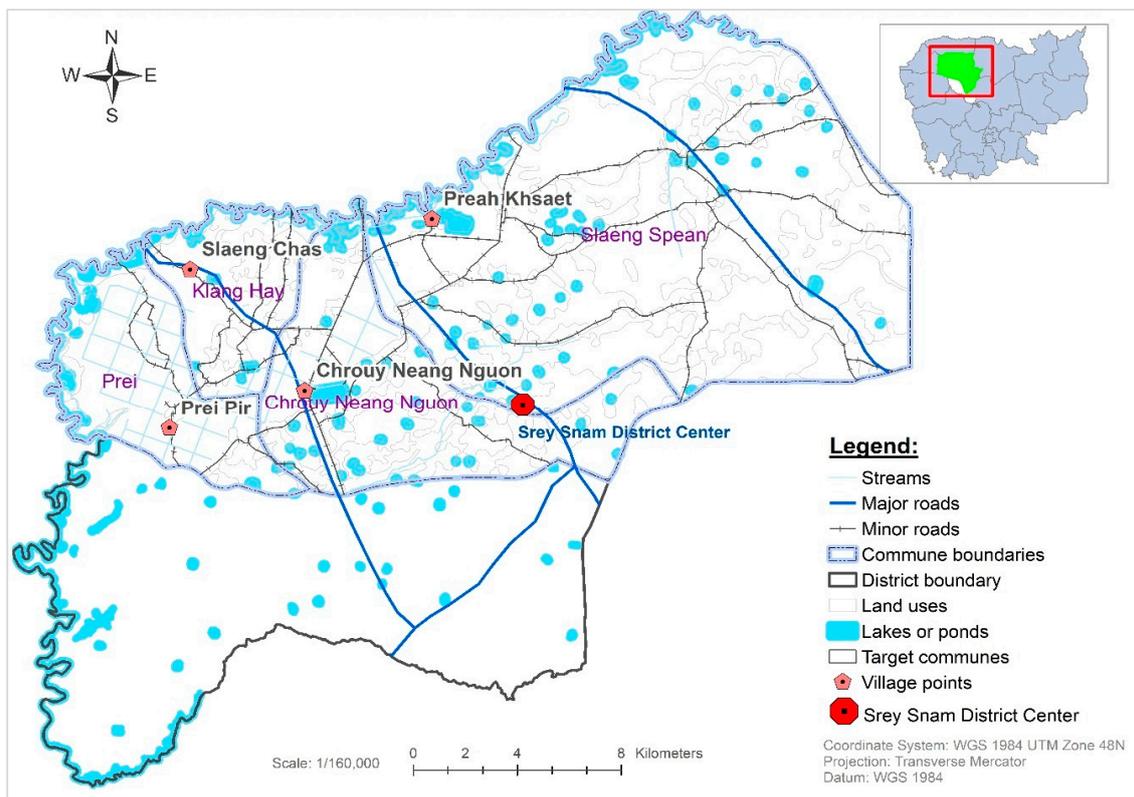


Figure 1. Map showing study sites.

2.2. Data Collection and Analysis

The study employed a combination of qualitative and quantitative methods to collect data. A household survey among CFR users was the primary method, supplemented by group discussion with CFR committee members. The researcher-designed and field-tested questionnaire was used to collect data through in-person interviews. Review of the relevant literature, a number of Cambodia-based reports on aquaculture along with lead authors’ experiences of working in aquaculture were the bases of initial draft of the questionnaire.

The survey consisted of questions soliciting CFR users’ demographic information; production, sale, consumption and income from fish; problems in CFR management; and suggestions to improve CFRs. Respondents were asked about their awareness of and participation in CFRs with “Yes,” “No,” and “Not sure” as the possible answers. Sample question included, “Have you heard about a fish refuge pond?” The first question on problems was a dichotomous, that is, “Yes,” “No,” then for those answering “Yes,” a question with multiple answer followed.

The question on “How would you improve the CFRs?” consisted of 11 options with “Yes,” “No,” and “Not sure” as the possible answers. Then followed an open-ended question asking respondents to provide additional suggestions, if any, to improve CFRs.

The questionnaire was field tested among farmer households who were not among those in the sample. Experts reviewed and validated the questionnaire. The final questionnaire was translated into the Khmer language.

The questionnaire was updated, integrating feedback from pretesting. Four enumerators were hired for field data collection. A one-day training for data collectors was conducted in Phnom Penh. The enumerators were divided into two teams and each team worked under the supervision of a Cambodian researcher. Data were collected during May 2015.

The researchers conducted one group meeting with CFR committee members in each CFR to gather their perspectives on CFRs. Group discussions were used to gather data on site selection for CFRs, access to water sources and market demand. The research also benefitted from the secondary data about CFRs obtained from Department of Aquaculture Development and the Provincial Cantonment Fisheries Administration.

Data were entered in Excel, exported to SPSS (IBM, New York, NY, USA) and cleaned as needed. Descriptive statistics were calculated during data analysis. Paired-sample *t*-test was calculated to compare before- and after-project scenarios. Qualitative data gathered from personal interviews were used to explain and interpret quantitative results.

3. Results and Discussion

Objective 1. Describe the demographic-socioeconomic characteristics of CFR beneficiaries in Srey Snam district, Siem Reap province.

3.1. Demographic-Socioeconomic Characteristics of CFR Beneficiaries

Table 2 shows respondents' demographics. Males and females were almost in equal proportion (male: 52%; female: 48%). They were on average 45 years old. The majority (83%) were married. A large percentage of respondents (63%) indicated that they had either primary or secondary schooling. Of the respondents, 10% and 9%, respectively, indicated they did not have any schooling and were illiterate. Findings in Table 2 reflect respondents' low levels of education.

Table 2. Respondents' demographics.

Particulars		N	% or Mean
Gender	Male	62	52
	Female	58	48
Age	Years	120	45.0 (13.2)
Marital status	Single	10	8.3
	Married	100	83.3
	Widow	8	6.7
	Separated	2	1.7
Schooling	Not attended school	12	10.0
	Illiterate	11	9.2
	Primary school	40	33.3
	Secondary school	36	30.0
	High school	21	17.5

3.2. Fishery as An Occupation, Fish Catch and Its Utilization

CFRs as fish farming systems have been a way of life for respondents and rice field fish are mainly destined for household consumption. A large percentage of respondents (85%) said fishing is their part-time job; the remainder (15%) said it is their full-time job (Table 3). The fact that they have been growing fish for about 17 years indicates their interest to pursue fish farming. Rice field fishery production increased after the introduction of CFRs. The *t*-test calculated to compare average fish production by households before and after the introduction of CFRs showed a significant increase

(142.9 kg versus 180.7 kg) at a 1 percent level of significance (Table 3). A high proportion (85%) of respondents were managing to catch on average of 5.2 kg daily during the fish harvest period. The harvest period spanned 10 months, that is, May through February and covers the rainy and mid-dry seasons. It should be noted that, under Cambodia's 2006 Law on Fisheries, the fishing is suspended every year from June 1 to September 30 for areas north of Phnom Penh and from July 1 to October 31 in the south. However, the law does not apply to the CFRs.

Table 3. Fish catch and fish utilization.

Detail		N	% or Mean (SD)	
Fishing as an occupation	Full-time	18	15%	
	Part-time	102	85%	
Have been in fish farming for (years)		120	17.7 (2.4)	
			Before CFR	After CFR
Average fish production (kg) ***		120	142.9 (116.8)	180.7 (189.9)
Fish catch (kg/day)		120	4.4 (3.1)	5.2 (1.0)
Fish utilization				
Consumption		66	55%	
Sale		6	5%	
Sale and consumption		48	40%	

*** Mean difference is significant at 0.001 level.

Findings in Table 3 show that the amount of fish caught each day increased by 0.8 kg after they participated in the CFR program and the variability of catch among households also became lesser (i.e., SD = 1.0 vs 3.1 kg) after the CFR. The findings also indicate that CFRs are contributing to equalize income among community members. More than half reported that the fish they grow is for their own family consumption, 5 percent said this is for sale and 40 percent said the fish is for both sale and family use. It is plausible to say that CFR contributed to improve household food security and livelihood of CFR members. So, CFR users are not only able to afford to get more fish (nutritious food) in their diet but are also earning cash to support their other daily necessities.

Objective 2. *Examine beneficiaries' knowledge of and participation in CFR management.*

3.3. Beneficiaries' Knowledge of and Participation in CFR Management

As the data in Table 4 show, overall, respondents seemed to be somewhat knowledgeable about CFR, what CFRs are about, how CFRs sites are selected and CFRs contribution to stabilize fish population in the rice field. The findings indicate that the CFRs are being managed in a local pond or water bodies agreed upon by village leaders or community heads and related authorities. Most beneficiaries had contributed labour or money to establish the CFRs and participated to release the brood fish and fingerlings into the CFR. Respondents seemed to be aware of roles of local leaders in CFR management. However, authors would like to caution readers that only a few statements were included about awareness of CFRs and their management. A highly positive response to these statements may not necessarily indicate a higher knowledge about CFR management. Further, it should be noted that not all respondents had actively participated in CFR activities. For example, about one-third of the respondents indicated that they were neither invited to a meeting to discuss CFR regulation and management nor they participated in making suggestions to improve CFRs.

Table 4. Beneficiaries' knowledge of and participation in CFR management ($N = 120$).

Statements	Yes	No	Not Sure
	%		
Awareness:			
Heard about a fish refuge pond	97.5	0.8	1.7
Knew that CFR is a form of stock enhancement or a fish conservation measure that is intended to improve the productivity of rice field fisheries	99.2	-	0.8
Knew CFR provides help to stabilize fish populations in rice field	95.0	2.5	2.5
There is a fish refuge pond in my village	98.3	1.7	-
Knew that fish refuge pond selection was agreed by village head and head of commune and authorities	90.0	3.3	6.7
Participation:			
Voted to select CFR committee(s)	79.2	13.3	7.5
Visited CFRs in other communes or villages	82.5	5.8	11.7
CFR had a banner with information display	83.3	4.2	12.5
Participated to release the brood fish and fingerlings into CFR	79.2	13.3	7.5
Invited to a meeting to discuss regulation and CFR management	56.7	27.5	15.8
Attended the meeting of CFR last year	34.2	20	45.8
Served in the CFR committee	30.8	57.5	11.7
Could make suggestions for CFR improvements	56.7	33.3	10
Contributed labour, materials or money to establish CFR	83.3	10	6.7

Objective 3. Assess socioeconomic impacts of CFR among project beneficiaries.

3.4. Socioeconomic Impact of CFRs

Rice field fishery production, sale, household saving and family expenditures significantly increased among beneficiaries after the introduction of CFRs (Table 5). A baseline data would have been very useful to determine the increase in fish catch. However, recall data indicate that on average, there was an increase in fish catch and household savings between 2009 and 2015. Even though only 10 farmers reported that they sold processed fish, their sales almost doubled the amount they sold before the introduction of CFRs.

Table 5. Fish sale and income before and after CFRs.

Particulars	N	Before	After	Mean Difference (SD)	t-Value
		Mean (SD)			
Income					
Overall saving (US\$)	120	211.9 (152.4)	604.3 (379.9)	392.4 (349.4)	12.302 ***
Fresh fish sale (kg)	120	142.9 (116.8)	180.7 (189.9)	37.8 (100.3)	4.128 ***
Fresh fish sale (US\$)	120	200.0 (150.4)	312.5 (292.9)	112.6 (184.7)	6.677 ***
Processed fish sale (kg)	10	27.0 (17.2)	45.5 (28.4)	18.5 (21.0)	2.774 **
Processed fish sale (US\$)	10	122.0 (68.0)	214.0 (124.1)	92.0 (78.7)	3.696 **
Expenditure					
Food and clothing (US\$)	120	157.2 (130.0)	291.0 (248.9)	133.8 (155.9)	9.403 **
Education (US\$)	117	61.8 (67.5)	141.1 (124.4)	79.3 (103.1)	8.321 ***
Health care (US\$)	119	31.4 (29.8)	60.3 (61.9)	29.0 (48.2)	6.539 ***
Fishing gears (US\$)	118	12.5 (8.0)	22.5 (21.4)	10.0 (17.3)	6.261 ***

*** At 0.001 level of significance. ** At 0.01 significance level. Income/saving data is not adjusted for inflation.

Respondents reported that their expenditures also increased over time. Expenditures on clothing and food, children's education, family health care and fishing gear went up after they participated in CFRs. The income generated from fishery activities could have supported household activities but it is hard to make precise estimates of the impact of CFRs on household expenditures and livelihoods of farming communities. Income from the CFR may also have helped beneficiaries to acquire physical assets such as bicycles, radios and TVs, among others.

Objective 4. *Suggest ways to manage CFR program and sustain its benefits.*

3.5. Constraints in CFR

Beneficiaries have been facing many constraints in their efforts to manage CFRs. As shown in Figure 2, illegal fishing is the most pressing problem (54% reporting), followed by lack of budgetary support reported by 40%. These findings are consistent with [10]. Illegal fishing using toxic chemicals is increasingly common in Cambodia. These chemicals not only destroy many aquatic species but also pose a health hazard to consumers of fish collected through such a process. Additionally, CFRs connect to rice fields and are interconnected through water systems, so any toxic chemicals used to kill fish easily spread to a large swath of field within no time and can adversely affect plant and animal species. Many fishers use electric current for fishing. This fishing technique kills many fish of varied ages and severely affects aquatic biodiversity. These practices threaten the entire CFR system. Other problems such as lack of participation, lack of natural fish fingerlings and natural hazards were mentioned by only 5.8% of respondents.

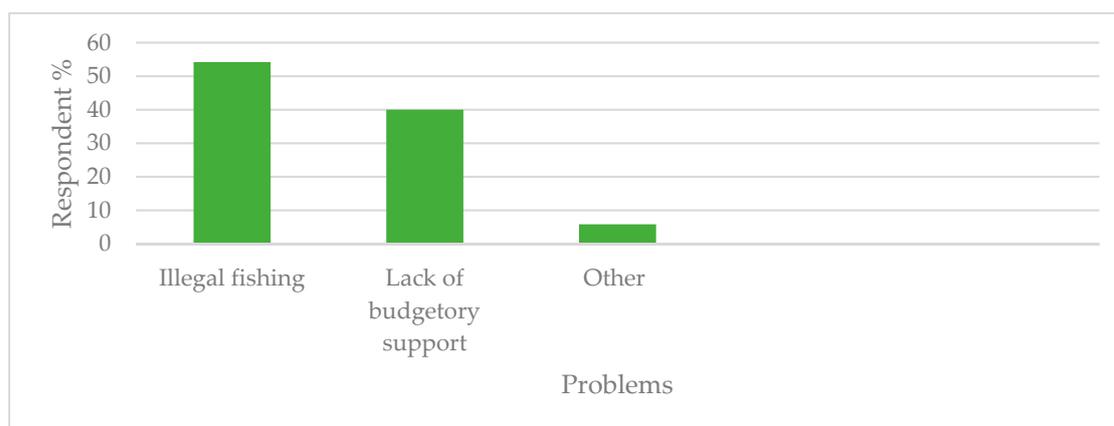


Figure 2. Major problems in community fish refuges (CFRs) management.

Similar to issues reported in inland fish farming in Barbados and Jamaica [20] and Bangladesh [21], the findings of this study indicate low level of participation of community members in resource conservation and management but actively seek benefits from this resource. These are the common problems encountered in the management of CPRs [14].

3.6. Suggestions to Improve CFRs

Table 6 shows respondents' suggestions to improve CFRs. A great majority of respondents (more than 80%) felt that raising the height of dikes, installing culverts and cleaning the pond were the most pressing technical issues requiring attention to improve CFRs. Following closely were establishing a channel connecting the pond with rice fields, capacity building of local authorities and communities and providing technical assistance. These suggestions on building capacity of local authorities and CFR beneficiaries and mobilizing extension educators and technicians to help with educating fishers are consistent with a previous study [22]. Contrary to earlier recommendations of more regulation and stricter enforcement of such regulations [19], a significant number of respondents

(41%) indicated that they were not sure whether additional rules and regulations would contribute to strengthening CFRs. About two-thirds of the respondents felt that networking and cooperation among key stakeholders need to be strengthened. As recommended by the Global Conference on Inland Fisheries 2015 and Tenure and Fishing Rights 2015: A Global Forum on Rights-based Approaches for Fisheries [1], the findings of this study suggest that systemic efforts are needed to integrate social, cultural, ecological and local context-based managements for CFR's sustainability.

Table 6. Suggestions to improve the CFR management in the future ($N = 120$).

Parameters	Yes	No	Not Sure
	%		
Building capacity for local authorities and communities	75.0	-	25.0
Providing technical assistance	70.8	0.8	28.3
Strong networking and cooperation with key stakeholders	64.2	0.8	35.0
Visit/tour to other communities where good practices of CFR	60.8	9.2	30.0
Time management	58.3	7.5	34.2
Strong participation of local authorities and communities	60.0	5.0	35.0
Rules and regulations	54.2	5.0	40.8
Establishing a channel connecting the pond with rice fields	77.5	10.0	12.5
Installing culverts	81.7	5.8	12.5
Raising dikes	84.2	11.7	4.2
Cleaning the pond as a habitat for fish	81.7	11.7	6.7

4. Conclusions

This study sought to assess the demographic and socioeconomic characteristics of CFR beneficiaries in Srey Snam district, Siem Reap province in Cambodia, examine their awareness of and participation in fish refuge management; assess socioeconomic impacts of CFR; and suggest measures to improve CFRs. It appeared that CFRs are becoming popular in Cambodia, especially among middle-aged, married rural farmers with primary and middle school education. CFRs have had positive impact on the communities by providing access to fish that they and their family members can consume or sell as a means of income. However, illegal fishing, low monetary support and low participation of beneficiaries appear to influence CFR outcomes. Respondents perceived that strengthening infrastructures such as installing culverts, raising dikes and cleaning the pond should be the priority of CFR's sustainable management. They also indicated that there is no need to enforce additional regulations into CFRs.

Sustainable use of common property resource warrants a combination of social, economic, technical and environmental measures. Support of local people and concerned stakeholders (e.g., extension workers, local leaders, etc.) is paramount to check illegal fishing and sustaining the benefits of CFRs. The beneficiaries need to understand the dynamics of CFRs, including water sources, local fish species, changes in fish population and production and productivity over the years, whether to introduce new fish species and tools used for fishing and so forth. Importantly, CFR users should be aware of the entire fish value chain and constantly evaluate the dynamics along the chain. They should recognize that CFRs are not designed for short-term benefits but they are designed as development strategies resulting in sustainable benefits to communities. Left out local people, if any, should be informed of the benefits of the CFR program and be included as beneficiaries. CFR management should encourage its members to share their perspectives and value their view points. Beneficiaries should actively participate in managing and sustaining CFRs. The Government should strive to educate local people and service providers for sustainability of CFRs. Illegal fishing

issues can be addressed locally. The Fisheries Administration should provide technical advice but let the local communities manage the CFRs. Imposing too many regulations may be detrimental to CFR sustainability.

In conclusion, sustainable management of common property resources like CFR in Cambodia should start with the conservation of the resource bases (e.g., water sources, fish and other aquatic species), use of technology appropriate to local contexts and empowerment of beneficiaries to manage these resources. Involving local communities in all aspects of CFRs, that is, assessing local needs, planning and implementing CFR activities, will benefit them in a sustainable manner.

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