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**GUIDELINES
FOR COMMUNITY
FISH REFUGE – RICE
FIELD FISHERIES SYSTEM
MANAGEMENT IN CAMBODIA**

FEBRUARY 2019



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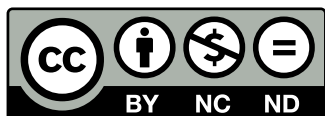
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In partnership with



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ACRONYMS

CBOs	Community-Based Organizations
CC	Commune Council
CFR	Community Fish Refuge
CSO	Civil Society Organization
FiA	Fisheries Administration
FiAC	Fisheries Administration Cantonment
FWUG	Farmers Water User Group
MAFF	Ministry of Agriculture, Forestry and Fisheries
M&E	Monitoring and Evaluation
OAA	Other Aquatic Animals
PDA	Provincial Department of Agriculture
PDWRM	Provincial Department of Water
RFF	Rice Field Fisheries
RFFEP	Rice Field Fisheries Enhancement Project
RFF II	Feed the Future Cambodia Rice Field Fisheries II project
USAID	United States Agency for International Development
VC	Village Chief
Zol	Zone of Influence

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
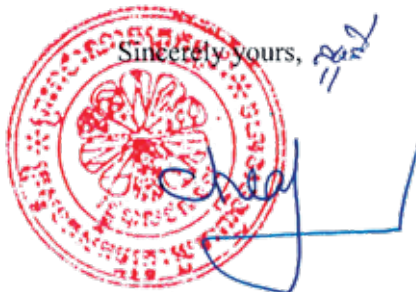
FOREWORD

Cambodia's rain-fed and flooded rice fields are important and productive sources of inland fish and other aquatic animals, including frogs and snails. These aquatic resources are important to millions of Cambodians, particularly those in rural areas. They make important contributions to rural livelihoods, contributing to food security, nutrition and income generation, particularly as rice field fisheries are an open access resource in Cambodia. Rice field fisheries act as a safety net for many rural families that are poor and vulnerable to factors such as the effects of climate change, agricultural failures and income insecurity. In addition, the more than 112 documented species of fish in Cambodia's rice field systems, together with other aquatic animals, are important to, and play specific roles in, local ecosystems, including contributing to biodiversity.

Through the Fisheries Administration, the Royal Government of Cambodia (RGC) prioritizes Community Fish Refuges (CFRs) to ensure the productivity of rice field fisheries and to enhance wild capture fisheries (Pillar 1 of the Strategic Planning Framework for Fisheries). CFRs also contribute to the RGC's support for the Voluntary Guidelines for Securing Small Scale Fisheries, including the development and implementation of ecosystem friendly and participatory policies, strategies and legal frameworks for the enhancement of responsible and sustainable small-scale fisheries. Effective and well-managed CFRs are considered very important in maintaining capture fisheries production in Cambodia. Through their roles in protecting wild fish during dry periods and providing good habitats for fish to breed, spawn and grow, CFRs maintain and increase fish numbers in the surrounding rice fields. FiA has supported the establishment of 884 CFRs across the country, which have increased the production of rice field fisheries.

This manual for the management of rice field fisheries systems in Cambodia, published in partnership with WorldFish Cambodia, is an important contribution to inland fisheries management in Cambodia. It provides evidence-based step-by-step guidance for selecting existing water bodies and the surrounding communities; conducting needs assessment and action planning with stakeholders, including FiA and other local government and community residents; and training and supporting communities to plan and conduct improvements to physical environments and sustainably manage these environments.

It is our strong hope that both governmental and non-governmental field practitioners, policymakers and planners who wish to provide facilitation to strengthen existing CFRs and RFFs in Cambodia will find this manual useful. It is relevant to the staff of provincial fisheries cantonment, local and international NGOs and development partners, as well as to local community members. However, others beyond Cambodia may also find this manual useful, and may adapt the manual for their particular context. We encourage all interested stakeholders to make effective use of this manual, and to ensure that they share the learning and experience from the application of this manual.

Sincerely yours, 


H.E ENG Cheasan
Delegate of the Royal Government of Cambodia
Director General of Fisheries Administration

INTRODUCTION

These guidelines are a summary of a full manual for Community Fish Refuge (CFR) – Rice Field Fisheries (RFF) system management in Cambodia. A copy of this manual is available from WorldFish Cambodia. The contents are based on findings from the implementation of the USAID-funded Rice Field Fisheries Enhancement Project (RFFEP) in four provinces of Cambodia (Kampong Thom, Siem Reap, Battambang and Pursat) between 2012 and 2016.

What these guidelines aim to achieve

CFR–RFF systems managed under the RFFE project have been shown to contribute to a 71% increase in annual average fish catch by households in the poorest quintile (RFFEP completion report, 2016). Well-managed CFR-RFF systems can contribute to enhancing the natural productivity of fisheries in floodplain environments – including fish and other aquatic animals (frogs, snails etc.) – to meet local consumption needs and nutritional requirements.

The aim of these guidelines is to document good practices in CFR-RFF system management, and thus act as a resource for organizational stakeholders wishing to support fish conservation, food security and nutrition in such environments.

Who can benefit from these guidelines

These guidelines are intended for field practitioners, planners and development partners from both government and non-government groups who wish to provide or support facilitation to strengthen existing CFRs and RFFs in Cambodia. In addition, fisheries policymakers may find these guidelines

useful as a resource which may inform specific the development and adaptation of specific fisheries policy.

How these guidelines can be used

The purpose of the guidelines is to provide guidance in how to approach:

1. the selection of a CFR;
2. the process of designing and implementing:
 - a. improvements to the CFR;
 - b. improvements to the structures and practices of a CFR management committee;
 - c. monitoring and evaluation.

Thus, these guidelines can be used to inform the design of specific interventions to contribute to enhancing the natural productivity of fisheries in floodplain environments. In addition, they may be useful for informing policy which is related to floodplain fisheries.

More detailed information about individual steps in CFR-RFF management is available in the full Manual. In addition, the Training Module on CFR-RFF Enhancement (FiA, WorldFish and FAO, 2016) sets out individual training modules on specific aspects of CFR-RFF management including biology and water chemistry, fish catch monitoring, etc.

How the guidelines are organized

These guidelines are organized into two sections:

1. **Section 1:** the Rice Field Fishery and Community Fish Refuge system. This section briefly describes

this context for the RFF-CFR system, and describes key individual components, including different categories of CFRs.

- Section 2:** The RFF-CFR development process. This section outlines three key phases in RFF-CFR development, and key activities for each phase. Specific and practical guidance is provided for each activity.

How to strengthen the learning process

Key ways in which stakeholders may strengthen the learning process for improved RFF-CFR system management are:

- Ensuring participatory consultation and planning with all relevant people at local level – including village and commune leadership as appropriate – at the site selection, needs assessment and action planning and interventions and management phases. This helps to ensure a common understanding from the outset.
- When introducing information which is somewhat technical and may be new to participants, particularly during the detailed planning and prioritization, it is helpful to show simple graphics and photos to build a common understanding of exactly what is being discussed.
- ‘External’ people with technical expertise in inland aquatic production systems and/or the identified ideal characteristics of RFF-CFR systems should provide inputs as needed to ensure that assessments and plans are technically sound.
- Annual provincial information-sharing workshops with CFR committees, local authorities and the Fisheries Administration are very important opportunities for participants to discuss progress against annual workplans and in terms of improvements to CFR committee capacity, reflect on and share challenges and lessons, plan ahead with future commitments, and – for committees with outstanding progress – to receive formal recognition.



Section 1

The Rice Field Fishery and Community Fish Refuge system

1.1. The Rice Field Fishery system

Figure 1 provides a simple illustration of how the RFF-CFR system works in seasonally-inundated rice fields in Cambodia.

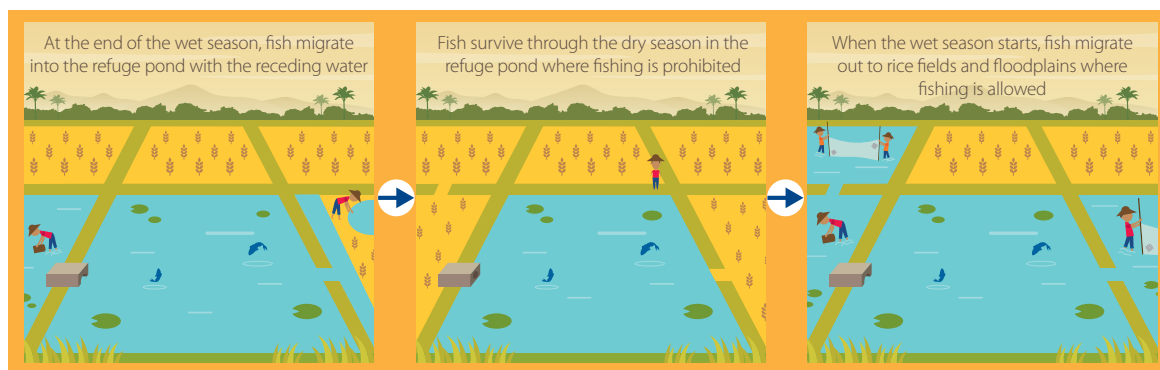


Figure 1: Simple representation of how the rice field fisheries system works

Over the past several decades, the easily accessible local rice field fisheries have faced increasing threats from a general increase in fishing pressure, but also from the expansion of, and changes in, agricultural practices. Fish have been known to use rice fields as breeding, spawning and feeding grounds and as growth habitats for thousands of years. As such, rice fields should be considered an integral part of fisheries management so that they can contribute significantly to overall fish production and local economies (De Silva et al. 2013a). However, agriculture intensification, usually involving the heavier application of chemical inputs (De Silva et al. 2013a) and modified ecosystems such as irrigation/road infrastructure development and the degradation of flooded forests, have created obstructions to fish movement. In such cases, there may not be enough fish retained in dry season water bodies, affecting reproduction and recruitment onto the floodplains and reducing the fish production from rice field ecosystems when the water returns.

1.2. Domains/Components of a RFF system

The major physical domains/components for a RFF/CFR system in Cambodia consist of: 1) a Community Fish Refuge, 2) a migration channel, and 3) the floodplain rice fields.

A Community Fish Refuge is a perennial water body in which fish and OAA can survive extended dry periods before returning to the floodplain when water levels rise.

A migration channel is a supporting structure in a variety of forms including a canal, stream, or another form of water body or facility to provide connections between a CFR and a flooded rice field agro-ecosystem. An adequate and unobstructed water flow through the channel network is required to ensure good connectivity between the CFR and rice field.

The floodplain rice fields refer to a flooded rice agro-ecosystem where fish can disperse during the flooding season to feed and breed, and where fish and other aquatic animals (OAAs) can be caught.

The *Zone of Influence* (Zol) of a CFR refers to the area that is influenced by the CFR. This is the radius that adult fish or juveniles from the CFR can reach in order to breed and grow. For this reason, it is important to consider the whole ZOI in the management of rice field fisheries. In this manual, rice fields are often

referred to as the Zone of Influence of a CFR. It may also be areas where some habitat improvements have been done. For example, ponds dug in rice fields themselves are considered secondary options for creating fish refuge habitats beside the CFRs. These improvements can help sustain fish and other aquatic animals during short droughts that often occur in Cambodia between July and August each year.

Figure 2 provides a 'bird's eye view' of the main physical components of the Rice Field Fisheries / Community Fish Refuge system.



Figure 2: The main physical components of the Rice Field Fisheries / Community Fish Refuge system

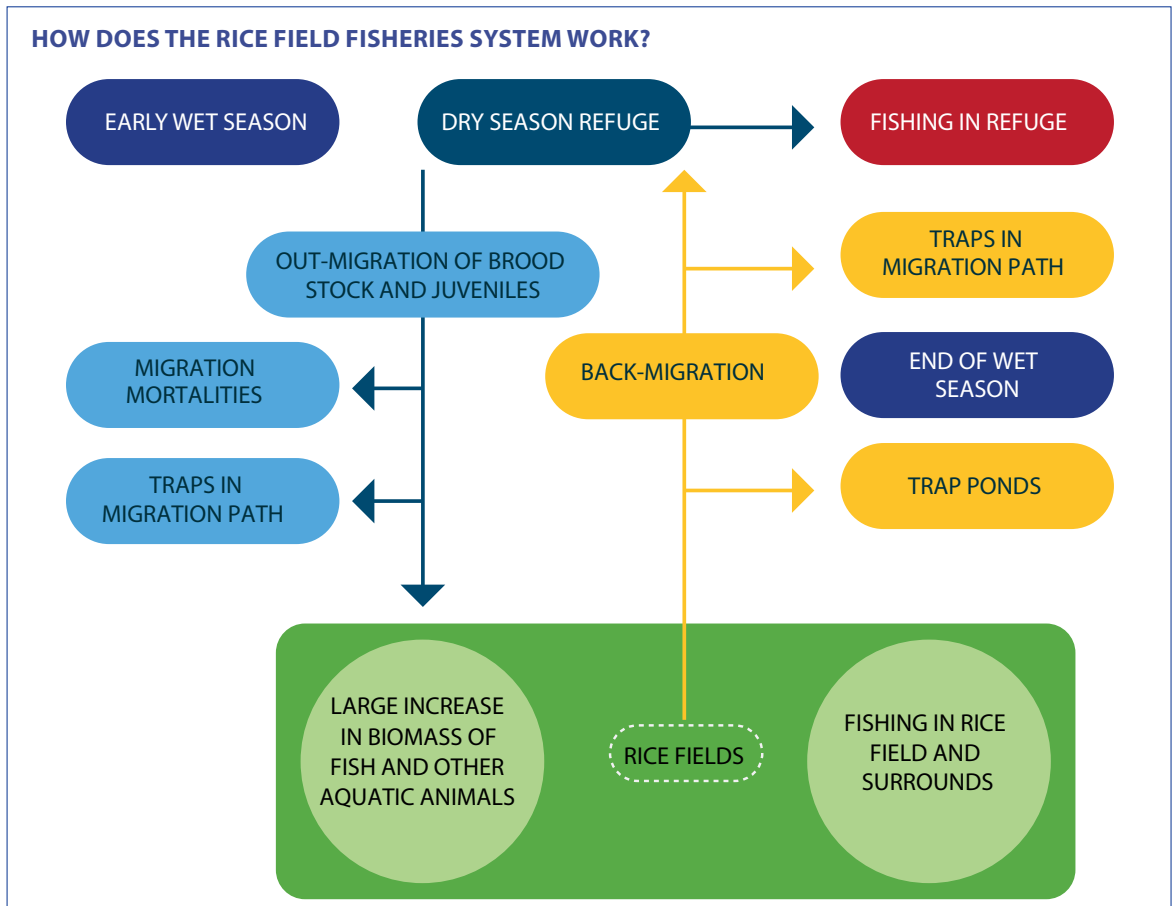


Figure 3: Diagram of the Rice Field Fishery system (source: Adapted from Guttman & Gregory (2002).)

In addition to physical components, a Community Fish Refuge Committee, comprised of a group of 5-11 local volunteers who are elected by the community living in the Zone of Influence of the CFR, is responsible for managing and improving the CFR and providing protection from illegal fishing. In the context of Cambodia, with support from the local authorities and Fisheries Administration Cantonment, the CFR Committee can receive official recognition of the CFR from the Provincial Department of Agriculture. To achieve this recognition, the committee must meet a number of requirements, including having developed appropriate CFR by-laws, having filled designated positions on the committee, and other requirements.

Structure and roles of the CFR committee

In general, CFR committees are structured as follows^{III}:

- Committee Chief: usually this is the candidate for the CFR committee who receives the highest number of votes. S/he oversees the committee.
- Deputy Chief: s/he supports the Committee Chief.
- Secretary: responsible for organizing meetings and maintaining records of meetings and other relevant documents.
- Cashier: responsible for maintaining records of funds raised for RFF-CFR system management.
- CFR patrolling team: these people are responsible

for patrolling the CFR and the wider Zone of Influence in coordination with the Fisheries Administration Cantonment to protect against illegal fishing. Members of the patrol team are allowed to stop illegal fishers and confiscate their fishing equipment. They must immediately report this to the local police or the Commune Council Chief, who will then report this to the FiA-C for further action according to the Law on Fisheries.

- Awareness-raising / information sharing: these people are responsible for sharing information about the purpose of the CFR and its committee, and activities planned and conducted by the committee.

By-laws of the CFR

Each CFR committee is responsible for establishing by-laws to:

- Define the roles and responsibilities of each CFR committee member;
- Define what actions are and are not allowed in the

CFR and the extended no-fishing area, including:

- What type of fishing gear is and is not allowed in the Zone Influence;
- How patrol team members are allowed to stop and detain illegal fishers and confiscate their fishing gear;
- Whether traditional/customary harvesting of fish from the CFR will be allowed.

These by-laws must be submitted to local authorities for approval before being submitted to the Fisheries Administration at Cantonment level. Acceptance of these by-laws is one of the requirements for the CFR receiving formal recognition from the Provincial Department of Agriculture.

CFR management and governance

Figure 4 below outlines the organizations at sub-national and national level that are involved with the governance and management of CFR-RFF systems in the context of Cambodia.

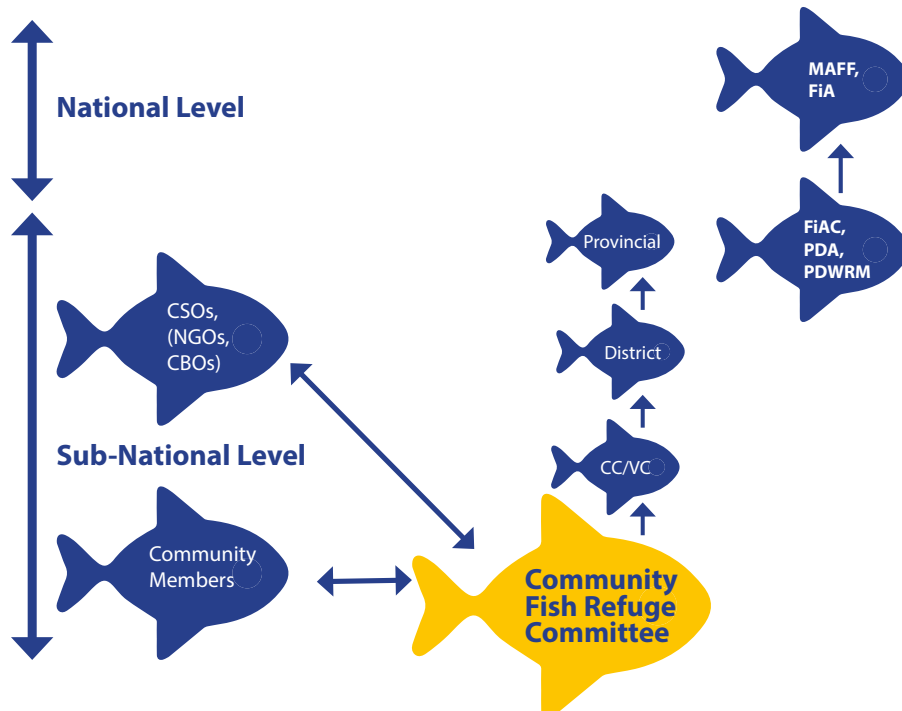


Figure 4: Organizations involved in management and governance of CFR-RFF systems

1.3. Categories of CFR

In Cambodia, CFRs can be characterized into four different categories (Brooks et al. 2015).

- Category 1 represents CFRs in upland reservoirs;
- Category 2 represents CFRs which are community ponds outside flood-prone areas (for the Tonle Sap Lake (TSL) floodplain, this area is roughly defined by highways 5 and 6);
- Category 3 represents CFRs which are community ponds prone to flooding (typically located inside highways 5 and 6);
- Category 4 represents CFRs within a large natural water body, particularly in the Tonle Sap floodplain.





Category 1. Irrigation Reservoir

(e.g. Kuch Noub-Pursat)

- Large water body, usually an upland reservoir, with a section managed as a CFR;
- Associated with irrigated dry season rice fields
- Equipped with water control structures;
- Long ditch(es) and/or channel(s) to rice fields;
- Water volumes fluctuating and rapidly changing;
- Water supply to rice fields is controlled;
- Where there is increasing use of pesticides due to agricultural intensification.



Category 2. Community Pond No Flooding

(e.g. Lbeuk Keteyuos–Siem Reap)

- Community pond with water control structures and is usually not flooded;
- Often a shallow CFR where some parts dry out; and
- Short channels connecting to rice fields.



Category 3. Community Pond Flooding

(e.g. Trapaing Thlok Meanchey–Kg Thom)

- Community pond with water control structures and frequently flooded;
- Often a shallow CFR and some parts dry out; and
- Short channels connecting to rice fields.



Category 4. Within Large Water Body

(e.g. Boeng Rolum–Kg Thom)

- Natural depression forming large water body, extensive flooding areas;
- Relatively small compared to total area of water body;
- Widespread and diffuse connections to the rice fields;
- Deep water rice with the fields vulnerable to flooding; and
- Some flood recession rice cultivation.

Section 2

The RFF-CFR development process

2.1. Key steps and activities in RFF-CFR system improvement

Based on experience implementing the RFFEP, the development of sustainable RFF management of CFRs can be divided into three phases:

1. site selection;
2. needs assessment and action planning; and
3. intervention and management.

The three phases are shown in Figure 5, and described in more detail in the following sections.

Figure 5: Key phases and activities in RFF-CFR system improvement



2.2. Site selection

Site selection represents the first important phase in establishing a successful CFR-RFF system, including ensuring that intended objectives will ultimately be met while delivering the highest value for money spent.

In the context of Cambodia, the process starts by looking at potential areas for intervention within the existing CFR-RFF system, and results in a set of existing CFR-RFFs being selected and agreed by all relevant stakeholders. Because selected sites will need to follow strict resource conservation practices to be successful, it is important to think about potential for conflict over water and fish resources between CFR committee and community members. Based on experience with the RFFEP, careful site selection and participatory consultation and planning according to this guideline will help to prevent such conflict (Miratori and Brooks 2015) in most years.

2.2.1. Desk review and field interviews

The purpose of desk review and field interviews is to gain a better understanding of the types of areas with CFRs-RFF that are available for selection.

- This involves reviewing the existing literature, including published and non-published reports and maps, as well as scoping the geographical

area for CFR-RFF sites where a project to strengthen existing CFR-RFFs could take place.

- Having identified a potential site, the project implementation team should visit a few individuals who have relevant knowledge and understanding of the local area, including of the physical CFR-RFF systems.

This allows the researcher/team to build a list of desirable characteristics and attributes as part of developing site selection criteria. A template for ideal scenarios is available in the Manual for CFR-RFF system management in Cambodia, 'Annex 1: Characteristics of CFR ideal scenarios.'

2.2.2. Development of CFR site selection criteria

The key output from this step is a set of criteria developed using information from the desk review and based on discussions within the implementation team. This exercise should take into account all aspects of CFR-RFF development and management needs, including the physical, biological, social, legal and institutional dimensions. Examples of potential criteria for site selection are provided in Box 1 below. More detailed information, including a site selection form template, is available in the CFR-RFF system management manual, 'Annex 5: Detailed site selection criteria for RFF/CFR intervention'.



Box 1. Examples of criteria with utility for RFF-CFR site selection

Physical aspects:

- The CFR has not dried out during the dry season over the past 5 years;
- The CFR has a connection, or potential for a connection, to surrounding rice fields;
- The CFR is large enough to sustain biological production. Etc.

Social and economic aspects

- The selected site offers potential benefits to poor members of the community;
- Practices that require water during droughts will not be prevented by designating the local water body as a CFR;
- The CFR site is accessible to all, not only the land owner;
- The local community has strong commitment, and makes contributions, to improving the CFR. Etc.

Legal

- No conflict over land ownership of the CFR or rice field areas nor over water/land usage;
- The CFR site is legally or locally recognised.

Institutional

- The authorities and FiA (Fisheries Administration of Cambodia) support the development of a CFR committee and the implementation of the intervention;
- A functional community organization (CFR committee) is already in place or there is potential for a local CFR committee to be established.



2.2.3. Preliminary field reconnaissance

The purpose of this reconnaissance is for the team and local stakeholders to visit and see potential sites for themselves in order to gain a clearer idea about whether the site can be selected for intervention. A quick assessment should be made at each CFR site by the implementation team together with relevant stakeholders, including the Village Chief, Commune Council (CC), existing CFR committee or Farmers' Water User Group (FWUG) committee (where applicable) and other community representatives. Prior arrangements should be made for local people to meet at the site for the assessment. The assessment should use the criteria developed and agreed upon in advance in step 2.2.2. above.

2.2.4. CFR-RFF assessment and selection

The information collected for each potential CFR-RFF in 2.2.1. – 2.2.3. should be assessed against the agreed criteria. This information about the sites should be presented in a table, with sites ranked according to how they meet the criteria. A short explanation should be provided on why individuals sites meet or do not meet the sets of criteria. It is useful to then circulate the matrix for comments and feedback from selected members of stakeholder groups who had been involved earlier, i.e. government fishery agencies, provincial line government agencies and the local authority. With this feedback the implementation team should produce a consolidated analysis of results, providing a justification for the ranking as relevant. Based on the ranking, the key output from this step is a tentative list of the selected sites in a presentable format. The final decision about which sites will be selected should be made in the action planning session (see below) with the participation of broader community representatives.

2.2.5. Selection results sharing

Selection results sharing event aims to provide understanding of how and why certain CFR-RFF sites were decided-upon, agreement on the final site selection, and mobilization and engagement for future local support (Hortle 2013). A site selection results-sharing workshop should be organized at a site accessible to the participants and with access to suitable facilities. Participants from no more than 20 different CFR sites should attend each event. It is also recommended that only the key members from each site participate. It is recommended that four participants attend from the sites that best meet the selection criteria and two participants from sites that do not meet the selection criteria. The workshop must also present results from the site assessment so that participants from the different sites can understand why their area was or was not selected.

The workshop/meetings can also serve as inception meetings for the project, and can be a useful opportunity to present background information about the project interventions and milestones, information about who might be involved, who the potential beneficiaries are, and how benefits will accrue to the communities.

Thus, the key output from this step is a workshop with representatives from a maximum of 20 CFRs to present site assessment results and serve as an inception meeting for the project.

2.3. Needs assessment and action planning

The main objectives of this component are to:

1. identify and prioritize the need for both physical improvements to the CFR-RFF system and improvements to people's (including the CFR committee's) capacity for sustainable

- management of the physical CFR-RFF system; and
2. to develop a detailed implementation plan for each site.

It is recommended that the activities involved in this component include:

2.3.1. Design of ideal scenarios

An 'ideal scenario' for the physical aspects of the CFR-RFF system should be developed for each selected CFR. In the scenario development, different sets of elements with corresponding characteristics should be clearly defined. This should be done for each of the three general domains (CFR, channels and rice fields) and their sub-components. This design of ideal scenarios should be done in accordance with the desired functions of domains and sub-components, and should cover both physical and biological attributes (see Table 1 below for example).

Ideal characteristics for each element can be determined for each CFR category by external 'experts', key stakeholders and the relevant CFR committee members, particularly those with knowledge and experience of inland aquatic production systems and/or the identified characteristics (Hortle 2013). Examples of ideal scenarios for a CFR Category 2 – No Flooding and for different CFR-RFF components for each CFR category are given in Annex 1.

2.3.2. Design CFR committee's capacity assessment tool

It is recommended that a tool is developed for assessing CFR committees' capacities for CFR-RFF management through a participatory assessment with community representatives, CFR committees and relevant stakeholder groups in the community. The capacity assessment tool should be developed simultaneously with the site information collection instrument and, along with the ideal scenarios, should be presented for consultation at a stakeholder workshop, preferably held at the provincial level. A scoring system can be used to give a rough

estimate of current management capacity, with '1' representing the lowest capacity and '3' representing the highest. This will lead to greater understanding of the capacity needs and required actions. The capacity assessment tool used in the RFFEP is provided in Annex 2 (see also Miratori and Brooks 2015).

2.3.3. Site information collection

Prior to field information collection, a Site Information Collection instrument should be developed. The development of this instrument should be informed by the ideal scenarios for the CFR-RFF system and the management capacity assessment tool.

With the information collection instruments in hand, it is useful for the implementation team to visit each of the identified CFR-RFF sites and organize a multi-stakeholder session, preferably held at the CFR location, with local authority representatives, community leaders, existing CFR committee members, community members, landowners and other relevant people. In addition, the team may choose to conduct Key Informant Interviews (KIIs) with selected individuals who did not attend the multi-stakeholder session. Data and information collected for each site should be recorded in a tabular form.

2.3.4. Assessing improvement needs

The profile for each CFR, with information collected during the field visit, can be used as a snapshot of the current state of the CFR-RFF system. When this information is combined with information on ideal scenarios developed above, it is useful as a basis for an assessment of CFR improvement needs. The differences between the desired (ideal) and the current states should be considered gaps in improvement needs. This assessment of improvement needs is conducted by contrasting the ideal scenario with the current status of the CFR, and should ideally be conducted by the same teams who developed the ideal scenarios. An example of a needs assessment for physical improvements is provided in Table 1 below.

Table 1: An example of an assessment of improvement needs (Annex 1 provides more information on how this matrix is developed)

(Sub-) Component	Key element	Characteristics under ideal scenario	Current situation	Assessment of required interventions
CFR - Environment	Dimensions - area, minimum in dry season	5% of large water body (LWB) size, 1 ha minimum	1 ha of protected area	
	Dimensions - depth, minimum dry season	1-2 m deep over 60% of area, 2-3 m deep over 40% of area	0.5-1 m deep over 100% of area during March to April	1) Expand conservation site to upstream 2) dialogue with water users 3) agree processes to manage pumping of water from CFR to dry season rice
	Percent of surface area cover by aquatic vegetation	25% in patches and some low density	Vegetation (cover area 20%, dominant species and others)	No improvement needed
	Density of brush parks / tree branches	10 brush parks x 40 m ² = 400 m ²	Zero brush park / snags	Install brush parks / snags and concrete ring
	Trees in and near CFR	Plant along CFR, upper drawdown zone and within 20 m of riparian zone	2000 m ²	Plant trees in riparian zone/bank - upstream
	Water quality – nutrients	Secchi disc 30-45 cm in April-May, green water	PH (8), PO ₄ (0.25), NO ₃ (0), Secchi disc (41-43 cm), clear water.	No improvement needed
	Water quality - turbidity	No clay in water column	No clay in water column	No improvement needed

2.3.5. Detailed planning and prioritization

It is recommended that this step is achieved through a number of 'mini-workshops' at the community level with a larger group of stakeholders. Recommended participants in the event include community leaders and key community members / existing CFR committee members, members of the local authority, landowners and other community interest groups. Key steps in these workshops include:

Step 1: Introduce the CFR-RFF system concepts

It is useful for participants to be introduced to CFR-RFF concepts in order to gain some background information and a basic understanding of key aspects of a CFR-RFF system. Graphic presentations using photos and/or other visual materials of different RFF domains and CFR types is desirable, as this helps to ensure a common understanding of exactly what is being discussed (Miratori and Brooks 2015).

Step 2: Build a realistic vision

The recommended activities for building a realistic vision are:

- Participants develop a resource map of the current state/status of their CFR/RFF system. It is useful for the facilitator to make suggestions to add any information from the CFR site profile into the map if/as needed;
- Participants build a vision of their RFF system over the next 4-5 years. It is useful for the facilitator to make suggestions to add any information from the ideal scenario to the vision if/as needed;
- Participants finalize their vision and present it back to the meeting for further discussion, approval and agreement.

Step 3: Facilitate problem tree analysis

Using the resource map and the agreed vision, the participants should then identify the main problems and barriers (in terms of the physical environment and management capacity) that will constrain efforts

to achieve their vision. Key constraints/problems should then be prioritized and analyzed with the participants using a problem tree analysis method. Plans for protecting water in the CFR should account for the fact that livelihood shocks may require poorer and vulnerable households to 'opt-out' of the agreed six-month CFR management action plans.

Step 4: Conduct a stakeholder analysis

The purpose of conducting a stakeholder analysis is to:

- identify existing stakeholders active in the area;
- assess the interests and resources accessible to support the implementation of priority actions (see Step 5 below), particularly local resources such as community rice banks, community savings and pagoda funds as well as in-kind contributions.

Step 5. Develop an action plan and prioritize actions for the next 6-month implementation

The activities in step 5 are as follows:

- based on the community stakeholders' vision, and using the action plan template as a monitoring tool, create an action plan to help the community achieve their vision;
- based on the stakeholder analysis in step 4, confirm the resources (people, finance, materials and network) to support the implementation of activities in the action plan.

2.3.6. Setting up an M&E framework

A core focus of any CFR-RFF intervention is to facilitate improvements in two aspects. Monitoring can be designed to capture improvements in five main areas across the two aspects:

Aspect 1: The performance of the CFR-RFF system:

1. CFR physical and biological components;
2. management capacity and effectiveness of CFR committees;

- engagement and support from other community members and stakeholders.

Aspect 2: The resulting benefits to local livelihoods and food security:

- catch within the CFR Zone of Influence by local communities;
- contribution to local fish consumption and income.

Specific indicators of change in these five areas are relevant for all CFR-RFF interventions (see examples in the tables below) and can be monitored during and after the intervention period to assess progress, results, and outcomes.

Design of a monitoring and evaluation (M&E) system includes selection of indicators and planning the implementation of the monitoring program. Answering the questions of how, how often and

by whom each indicator will be monitored is an important part of M&E design, and should take place prior to implementation.

Establishing baselines

Baselines should be established from the outset of the project / activities through initial (first iteration) monitoring, ideally as soon as a CFR-RFF is selected. As the intervention progresses, the monitoring program will continue to generate data at established intervals, allowing assessment of progress.

One important consideration in the development of an M&E framework is the availability of resources such as time and funding. In general, aspect 1 indicators require relatively few resources, while aspect 2 indicators require more resources and may need to be selected and scheduled carefully.

Monitoring and physical and biological components

Table 2: Example of a plan for monitoring physical and biological components of a CFR

What to measure	How	How often	By whom	Resource demand
CFR water levels	Using a colored water marker pole installed in the CFR	At least fortnightly; more frequently in the dry season	CFR management committee	Very low
Water quality in the CFR	Secchi disk (water clarity), thermometer (water temperature)	At least monthly; more frequently when water levels are low	CFR management committee	Low
Condition of the CFR vegetation	Visit the CFR and observe key components, including grass/ foliage cover around the CFR to prevent erosion, and aquatic plant cover of the water	At least every six months	CFR management committee	Low
Biomass in the CFR	Numbers, size and species of fish and OAA	2-4 times per year, in both dry and flooding / wet seasons	Project team and CFR-RFF committee	Moderate

Monitoring the management capacity and effectiveness of CFR committees

Table 3: Example of a plan for monitoring management capacity and effectiveness of CFR committees

What to measure	How	How often	By whom	Resource demand
Progress against the five indicators of CFR committees' effectiveness in making and implementing decisions to meet their CFR-RFF objectives: 1. Organization management; 2. Planning and implementing the plan; 3. Resource mobilization; 4. Linkages / networking; 5. Representation and participation	Scoring carried out through a participatory assessment with community representatives, CFR committees and relevant stakeholder groups in the community	At the start and near the end of the project; or every two years.	By the CFR management committee, led by the committee chief.	Low

Monitoring levels of engagement and support from other community members and stakeholders

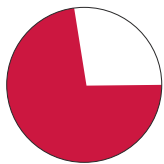
Table 4: Example of plans for monitoring levels of engagement and support from the community

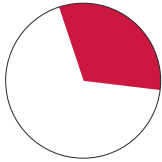
What to measure	How	How often	By whom	Resource demand
Community members' and wider stakeholders' (e.g. Commune Council's) contributions in cash, labor and other in-kind contributions	A simple logbook as a record of contributions	Record contributions as they are made	CFR management committee secretary	Low
Community members engagement in patrolling	A logbook recording the names of CFR patrol members	Record as names are added and removed	CFR management committee secretary	Low

Monitoring at the activity level

It is recommended that each CFR-RFF has its own set of activity indicators.

Table 5: An example of activity monitoring conducted by community members

Activity	How to ensure the activity is delivered?	Main responsible person(s)	Achievement
Draining water to avoid flooding of village and rice field	<ul style="list-style-type: none"> ➤ Study the need for canal expansion; ➤ Meeting to discuss canal expansion and planning; ➤ Mobilize resources to implement the canal expansion plan 	<ul style="list-style-type: none"> ➤ Village development community; ➤ Village and commune authorities 	

Activity	How to ensure the activity is delivered?	Main responsible person(s)	Achievement
Store water for irrigation and enhancing fisheries resources	<ul style="list-style-type: none"> ➤ Meeting to raise awareness on repair of a dike; ➤ Generate income from fishing in reservoir 78; ➤ Select contractor for dike repair; ➤ Conduct M&E on dike repair 	<ul style="list-style-type: none"> ➤ Village-commune authorities; ➤ CFR management committee members; ➤ Local villagers; ➤ Water committee 	

Monitoring potential for sustainability

Key indicators that will support sustainability include:

- Increased fish catches;
- Regular participation in CFR committees by different stakeholders including the Commune Council;
- Successful fundraising and financial commitments to CFR action plans;
- CFR action plans are incorporated into Commune Investment Plans (CIPs).

2.4. Interventions and management

Whilst this section is separated into four parts (development of CFR management capacity; improving bio-physical attributes; improving management of the CFR and rice fields; monitoring the impacts of the intervention and benefits to livelihoods and food security), it is preferable that these actions are carried out in parallel, as in practice they are interlinked.

2.4.1. Development of CFR management capacity and awareness

Where the intervention focuses on an existing CFR-RFF site, a management committee may already be in place but may not be functioning effectively, or it may not be functioning at all. The purpose is thus to reinvigorate the management committee and equip it with necessary knowledge and capacity for effective

CFR-RFF management. Where no management committee is in place, a new committee will need to be established.

It is recommended that the CFR committee be made up of local volunteers, elected by community members living in the CFR's ZOI. A CFR committee should be made up of 5 - 11 members depending on the population size and number of villages in the ZOI. The main duties of the committee should be: to ensure effective CFR management, including developing CFR bylaws and a management action plan; encouraging fundraising activities, targeting commune councils, NGOs, community members and other local sources; defining the CFR's boundary, managing fish migration routes and other domains of the RFF systems; and reviewing progress with the support of local communities, authorities and the Fisheries Administration (FIA).

Stakeholder awareness and empowerment

The following steps may be taken to improve awareness and enhance stakeholder involvement:

Meet with local authorities (commune councilors and village chiefs) to:

- Motivate them by appreciating their work;
- Tell success stories of development activities that have been planned and implemented by communities and local authorities without external funding support;
- Ask questions related to RFF systems in their target areas;

- Explore their visions to improve this system.

Organize with commune councilors and village chiefs for a village meeting to be held with CFR committees, community representatives and other CSOs working in the target villages/communes to ensure participation by villagers from across the village.

Other awareness-raising and training

Capacity building in this section refers to formal and informal training courses, workshops, field visits, coaching and mentoring. The relevant topics for training include:

- the technical aspects of a CFR, including general CFR concepts such as refuge ponds, cement rings, and biological monitoring processes;
- management characteristics, including fisheries law, presentation skills, rice field system governance, book keeping and how to develop and integrate the CFR management plan activities into Commune Investment Plans;
- the advantages of micro-nutrient rich fish species and how fish can be cooked to maintain nutrition and vitamins.

Capacity building for multiple stakeholders

The stakeholders to whom capacity building may be provided are: partner NGO staff, CFR committees, commune councils, fishery agency staff, police officers, teachers and students from secondary schools who will be involved in implementing the intervention.

Capacity building for local partner NGOs

Three major steps are recommended to strengthen local NGO partner capacities:

1. Engagement of NGO partner staff including senior management and field staff in field monitoring to allow them to get involved, build ownership, including of project outcomes and sustainability;
2. Assessment of NGO partners' staff capacity needs on governance, skills in facilitating community

visioning, problem tree analysis, stakeholder analysis and community action planning;

3. The provision of capacity building should be divided into two stages:
 - i. The formal training process should focus on good facilitation skills and use of participatory analytical tools e.g. community visioning, problem tree analysis, stakeholder analysis and community-led action plan development;
 - ii. Field practice with coaching by project staff should provide hands-on practice by trainees in selected villages with follow-on coaching and trouble-shooting by project staff.

Building sustainability of the interventions

It is recommended that four stepwise activities be implemented for the formation of a sustainable (including financially sustainable), well-connected and motivated CFR committee.

Step 1. A series of follow-up visits to be organized over the length of the CFR management committee's action (i.e. a period of 6 months or other chosen period) to support committees with their action plans, provide coaching and build important networks with other institutions within the village and commune.

Step 2. A stakeholder workshop with the CFR management committee and other relevant stakeholders should be held to focus on five main activities:

1. Reviewing and reflection of key successes and challenges;
2. Role-plays by skilled facilitators to enact the characteristics of good governance and management using the five types of characteristics defined (see Annex 2);
3. Participatory assessment using a simple descriptive assessment tool which describes the current status for each of the five characteristics of management/governance;
4. An exposure visit to other CFR sites; and
5. A draft of the next 6-month plan.

Step 3. Second-level engagement should follow during the second 6 month action plan. In this engagement, more emphasis should be placed on improving governance, identifying opportunities for integrating some elements of the plan into the Commune Investment Plan and fund-raising via private sector support and the committee's innovative approaches. Ideally, there should be about 2–3 visits over the 6-month period for each CFR committee.

Step 4. Six months after the first-level engagement (as described above) a stakeholder workshop should be arranged with a similar agenda similar to that of the first. However, since external support will have to end eventually, the focus should be on identifying and agreeing on opportunities for institutional sustainability of the committee and finding further support from local funding sources.

2.4.2. Improvement of the biophysical systems

This section describes ways that CFR and RFF environments can be improved to maximize their biodiversity and productivity.

Ensuring an adequate CFR surface area and water depth

A CFR may be used as a source of community water supply, usually for rice irrigation during dry spells in the wet season, but also for irrigating nearby vegetable gardens. Whilst this is a good use of the resource (and sometimes it may be the most important function of the water body), it is recommended that at least 5% of the total water surface area, above a depth of 1.5m, be retained for a CFR pond (Hortle 2013). For a large CFR water body, a minimum of 1 ha of surface area should be retained.

The objective of the CFR should be an improved habitat that will increase overall abundance and diversity of species, especially the smaller planktivorous species. In principle, the more varied the CFR environment created, the better it will be

able to support different fish species (Roni et al. 2005). If possible, a CFR should have a range of different depths to provide for different fish species and age class needs. The shape of the CFR should also be varied to create more heterogenic environments. Increasing the perimeter length of a water body will allow for the planting of trees at strategic locations for substrate and shading effects.

To help communities manage water levels in the CFR, a depth marker pole can be installed. The pole can be painted in different colors to show when water levels have risen high enough to inundate the surrounding rice fields (blue) and when no further water should be extracted (red). Once the water level has dropped to the red color on the pole, committees and community members (who may pressure the committee members to allow more water extraction) will know that further extraction will affect the fish populations. A further advantage of the marker pole arrangement is that it can encourage communities to maximize the amount of available stored water for other uses such as topping up small-scale fish farm ponds or irrigating vegetable gardens.

Ensuring adequate provision of vegetation in and around the CFR

Aquatic vegetation (macrophytes) such as water hyacinth can choke the water body, reducing its biological productivity and accelerating siltation. For CFR categories 2 and 3, vegetation cover should not exceed 25% of the surface area, especially around the perimeter of a CFR. Given that vegetation grows quickly in these environments, care must be taken to ensure vegetation cover is present but kept in check. Vegetation cover provides safe refuge areas for juvenile fish and also for nesting substrates for some species (e.g. Snakeskin Gouramis) (Hortle 2013), and some aquatic plants can reduce water turbidity and help provide oxygen through photosynthesis.

High turbidity, characterized by brown water, results in a loss of productivity of the water body as primary production of plankton (green water) is reduced,

mainly due to lack of sunlight penetration in the water column (Hortle 2013). To help stabilize slopes and reduce erosion, grass should be planted on the embankment and the slope surrounding the water body. If CFR water levels fluctuate by several meters in a year, larger plants or shrubs should be used to retain the soil and protect from erosion.

On the top of CFR banks, trees provide the additional benefit of providing shade in some areas, producing leaf fall and fruits which can increase fish production, and attracting birds contributing to increased biodiversity of the area (FiA pers. comm.). A guideline developed by Conservation International (Dong and Heng n.d.) may be useful in this regard. Information is needed at community level about suitable tree species and where and when to plant seedlings. Where flooding of the refuge pond embankment is unlikely, hardy crops such pineapples or lemongrass may be cultivated.

Brush parks and other substrates

Many fish species feed on plants, microbes, detritus and algae growing on substrates such as tree branches, grasses and rocks. Brush parks of tree branches offer the best surface area for encouraging the growth of these small microbes collectively known as periphyton. They also provide attractive resting areas for predatory species as well as shelter for juvenile fish to hide from predators. Brush parks can be removed from CFRs when water levels drop significantly.

In conservation areas and CFRs in Cambodia, where fishing is not permitted, brush parks are permissible if they are not used to assist in the harvesting of fish (FiA pers. comm.).

The use of tree branches may not be environmentally sustainable if harvested from standing trees. Samrahs should only be built from dead wood. Based on experience, a tree harvesting area of about 200 m² is recommended per CFR, but there is no known research to provide more guiding information.

Ensuring provision of adequate supporting infrastructure

Building meeting halls or guarding facilities may be required, depending upon the size and value of the CFR. Guardhouses should not be too small but large enough for multiple purposes. It is recommended that guardhouses are built so that a guard can live there permanently, so that the incremental cost for a larger guard house will be justifiable. Experience from RFFEP has showed that, once a guard is in residence and keeps dogs, the incidences of poaching are significantly reduced if not completely abolished.

Fencing may be required to prevent cattle and water buffalo from excessive wallowing in the CFR or destabilizing the slopes due to their frequent access. If the CFR is also used for animal bathing and cooling then a section in the CFR should be assigned for this purpose.

Improvements of channels

Channels are essential in linking the CFR to floodplain rice growing areas, so that fish can migrate freely. Investments can include:

- cleaning the channels;
- dredging to a depth of at least 0.5m during the wet season; and
- ensuring that a well-functioning water gate or sluice is provided.

It is advisable that a no fishing zone be established 50 - 100 meters from the CFR and migration channel. Culverts and spillways are alternatives when ideal channels are not possible (for example, if there is a road between the CFR and the floodplain). Two channels from each side of the CFR should be provided as the minimum water connection. More channels which are in good condition would of course provide better connectivity and assist fish migrations more.

Improvements of the rice field system

The main way of improving fish productivity in the rice fields is to retain water as long as possible, maintaining a depth of about 25cm in the fields throughout the rice growing period. During the early monsoon, many Cambodian rice fields may dry out. One way to mitigate the loss of fish during such times is to adapt the field by creating a deeper area of the field that does not dry out. One method that has been used is to install cement rings into a corner of the field for fish to take refuge in when water recedes from the field (Taylor and Sengvilaykham 2010). Alternatively, small ricefield ponds may be a more practical solution to this problem.

For areas inside the Tonle Sap flood zone, in order to prevent farmers with rice fields close to the CFR from catching most of the fish in ricefield trap ponds, a 'no-fishing within 100m zone', sign should be erected using concrete poles. For areas outside the Tonle Sap Lake flood zone, refuge ponds or trap ponds may be constructed within rice field areas as long as they are small, (<100 m²) in size. The ponds may be as deep as 3 meters to ensure water retention during the dry season. Farmers should be encouraged to retain some fish through to the dry season so that these trap ponds contribute to the CFR effect.

2.4.3. Management of the CFR-RFF system

Once community capacity has been enhanced and the bio-physical aspects of the CFR / RFF have been improved, effective management must be put into place. Institutional capacity building should be done simultaneously with the development of the RFF system (Miratori and Brooks 2015). The aim of CFR-RFF management is to maximize sustainable productivity through good governance. In other words, the habitat must be managed in a way that ensures expected returns. This may not always be the maximum fish yield from the system but rather

an optimum level that satisfies the multi-purpose functions of the RFF ecosystem, of which of course rice production is usually treated as the main priority.

At this stage the ideal scenario for bio-physical systems should be close to being achieved. The RFF system should have:

- a CFR with deep refuge, good quality water which is not turbid, some aquatic vegetation but not more than 25% of area cover;
- operational sluice or water gates;
- brush parks installed for habitat enhancement;
- vegetated slopes to prevent erosion;
- clean migration channels of >1 meter wide and 50cm deep, connected to rice fields;
- rice fields which maintain a good depth of water and which may have small temporary refuge areas and no fishing zones, demarcated with concrete poles.

CFR water management

Water volume and depth

For CFRs to achieve their purpose, an absolute minimum water volume and water depth has to be maintained year round. High temperatures in the hot season have a strong effect on water evaporation and can quickly lead to lowering water level. CFRs should be sited in water bodies that have not dried out completely for at least twenty years. The extraction of water for irrigation can rapidly reduce the water volume after the rainy season. Even though physical improvements such as deepening may have been carried out, the physical condition of CFRs can change quite quickly; for example, high erosion/sedimentation can reduce water depth. CFR management committees should be aware of potential for such changes and prepare resources accordingly. Water can be retained in the CFR by closing water gates and allowing for water to be kept for a longer period.

Water quality

The management of water quality in the CFR should not be over-looked nor its importance underestimated. This relates to helping communities to anticipate and plan for shocks and changing priorities around CFR water use.

The fish stock may be confined to the CFR water for as much as nine months once the CFR is disconnected from the surrounding wetlands. Therefore, it is important that the conditions within the CFR are optimized to ensure that a multi-species fish assemblage can thrive. The basic biology within the CFR will be a mix of different feeding ecologies, mainly planktivorous and carnivorous. Maintaining good water quality is the basis of good management practices.

Ideally water in the CFR will be a green color with the human hand still visible when the arm is submerged roughly translating to a visibility of 30 centimeters (Rouse 1979). The water should not be a brown color, typically indicating heavy mineral turbidity, which reduces sunlight penetration and plankton growth. Key factors affecting plankton density most relevant to the CFR are the concentration of important nutrients such as carbon, phosphorous, nitrogen and potassium and mineral turbidity. The concentration of essential elements for plankton 'food' will be determined by assessing concentrations in the incoming channel water or run-off. Run-off from heavily fertilized agricultural land will be nutrient-dense, but may also contain pesticide residues. Often though, CFR water in Cambodia has low concentrations of these essential elements (Sieu et al. 2015). One remedy is to add them in the form of fertilizer; however, this is expensive and the returns are unknown and should only be done in newly excavated CFR which tend to be unproductive. The benefits have to be carefully calculated because as soon as connectivity with the rice fields is restored there will be a flushing out of nutrients from the CFR.

Probably the most important factor to note is the incidence of mineral turbidity, a common problem in Cambodia. The frequent heavy rainfall and flash

flooding in Cambodia cause rapid soil erosion leading to turbidity. The soil must therefore be stabilized by vegetation to reduce erosion. This means managing floodplain forest bushes planted where necessary at the time of the initial technical intervention. This also means taking care of these bushes and facilitating their natural propagation to cover as much soil area as possible. Every year the floodplain forest species of bushes and grasses may need to be replanted.

Aquatic plant management

Once any infesting aquatic plants such as water hyacinth have been removed during habitat restoration, steps must be taken to prevent any reoccurrence of the infestation. Infestation by water hyacinth in large water bodies may be prevented with the installation of a cable along the surface of the water. In some instances physical removal may be arranged in campaigns involving various community representatives.

Water hyacinth can be used for composting, handicrafts, and as material to keep gardens afloat (as practiced in some villages around Tonle Sap) and as a substrate for bacterial treatment (floating latrines). If labor is available, the water hyacinth can be chopped and returned to the water where it will be decomposed by bacteria and provide a substrate for periphyton growth which provides valuable additional food for some species of fish (Hortle 2013).

It is important the management committee ensures that a 2-3 meter border of aquatic plants around the littoral zone is maintained. This creates a zone of cooler water in the hot season. Smaller-leaved aquatic plants that do not propagate rapidly such as a hyacinth are preferred, e.g. water lily, morning glory and water mimosa. These plants provide cover for juvenile fish and may support some species requiring cover and substrate for breeding. Warmer water in the littoral zone will promote faster growth of small fish during the winter months of the dry season (December, January). Plants around the edge of the CFR may also help deter poaching.

Micro habitats / eco-shelter (brush parks)

Once the samrahs or 'eco-shelters' are installed, there is a little management effort required to ensure that branches or other materials are submerged as water level changes with season. Any substrate above water level is serving no purpose to increase available fish food. It is recommended the whole samrahs be replaced or added every 3-5 years mainly due to natural decomposition.

Fish stock management

Stocking of local fish species may be necessary to recreate a balanced wild fish population. At locations where indigenous fish species highly favored by local people have disappeared, stocking is recommended as a way to reintroduce these species. However, poor conditions in the CFR can result in the aquatic environment being unable to sustain certain species. See M&E of impacts of the interventions and Annex 1 for further information about methods and indicators for monitoring wild fish species, and ideal scenarios for stocking specific fish species.

At the moment, FiA has no specific stocking policy for CFRs, but does recommend stocking large size fingerlings (to reduce predation) between November - January after the CFR water body has become disconnected from the surrounding wetlands. At this time the water may be biologically rich as the water recedes from the rice fields, providing good conditions for stocked fish to grow and thrive, although most CFRs will have abundant predatory fish present at this time.

Re-stocking CFRs with indigenous species from the surrounding area, including from one CFR to another, is allowed in Cambodia; however, currently there are no Government regulations or guidelines on stocking native fish (FiA pers. comm. April 2018). However, FiA encourage fish from a pond that has dried out or been pumped out to be re-stocked into another CFR (FiA, pers. comm. April 2018).

In some CFRs, the stocking of silver barb (*Barbonymus gonionotus*) or similar cyprinid species

is recommended to boost their abundance and rice field yields for the benefit of local fishers. Stocking density rates are recommended at 2,000 large 8-10cm fingerlings per hectare of water area (De Silva et al. 2006; Murray 2006; Hortle 2013). Apart from the immediate benefits of harvesting stocked fish later in the year, another good reason for doing this is that as local farmers enjoy the benefits of increased CFR and rice field productivity they will retain their interest in managing the system. If the system is managed well, repeated stocking should not be necessary. This is an obvious benefit to the rural people since no high investment costs for repeated fish stocking are required.

Climbing perch, snakehead and catfish are favored by rural people and may be deliberately stocked in the CFR. The RFFEP conducted a fish species preference study involving 400 respondents to better understand the fish species people like to catch and consume. The top three favored species were climbing perch, snakehead and catfish, which was predictable. However, the small *Esomus* sp. was also shown to be favored. As mentioned above, an abundance of small 'prey' species will likely increase the populations of the highly favored channids and clariads. The Parambassis species (glass perches) are very abundant at poorly managed locations. It is believed that decrease in the abundance of this species can be used as an indicator of good CFR management (based on Sieu et al. 2015).

Re-introduction of locally extinct species

It is recommended that re-introducing 'locally extinct species' to CFR should follow the protocol below.

- Step 1:** Agree a short list of species to be (re) introduced to the CFR;
- Step 2:** Understanding the reason for species x decline;
- Step 3:** Setting goals and objectives;
- Step 4:** Government permission for relocating of species;
- Step 5:** Deciding on the size and number of fish to be introduced;

- Step 6:** Improving CFR habitats that will favour the species to be introduced;
- Step 7:** Reintroducing brood stocks or juveniles of the species to the CFR;
- Step 8:** Facilitate the movement of the rare species to and from the CFR;
- Step 9:** Observe the status of the species, as it becomes caught by local people;
- Step 10:** Monitor of impact of re-introduction.

Removal of fish from the CFR

Some experts are of the opinion that communities should be allowed to harvest some fish from the CFR at certain times or for certain periods. Others argue that allowing communities to fish in the CFR at any time would undermine the whole approach. It can be argued that the job of the CFR is to protect the minimum fish stock required to repopulate the surrounding ricefields. Anything above this is surplus and should be harvested by the community. Once community capacity, awareness and understanding had been built to a high level, then allowing communities to make local rules determining when and how they are removed from the CFR and how much biomass can be removed each year would encourage more informed management of the CFR. Harvesting fish from CFRs as a traditional/customary practice for village events can be acceptable in some cases (FIA pers. comm. May 2018). Traditional harvesting from CFRs is or has recently been practiced as part of annual village ceremonies.

The selling of tickets on designated 'fishing days' could generate useful funds for the CFR committee to use in habitat restoration work etc. There is also the need to remove giant predatory fish (e.g. Wallago attu) that may stay in a CFR for several years, and have significant negative effects on fish biomass and biodiversity. Community fishing days targeting 'giants' would give something back to the community for managing the resource well.

Management of migration channels

To ensure that fish are free to migrate from the CFR

water body into the rice fields, enforcement and awareness of the designated 'no fishing zones' must be dispersed across the whole Zone of Influence. Migration channels should require little attention other than ensuring that they do not become blocked by debris or become badly silted. Channels should have plenty of grass and shrubs on their embankments, and thus provide soil stabilization from erosion and prevent the loading of CFRs with water that is heavily laden with silt. It may be necessary for guards to patrol the channel regularly to ensure that no traps are installed, either during the out migration or back migration periods. Fishing is particularly productive around culvert areas or other 'bottlenecks' in the RFF system, so special measures may be necessary to prevent poaching at such locations.

Management of rice fields

As ricefields are usually individually owned, it is up to the farmer to decide whether he manages his field in a way that promotes or harms aquatic life. Good management can include ensuring that: water depths exceed 15 cm throughout the rice growing period; cement rings or small ponds are built in the corners of fields prone to drying during the early monsoon; pesticides and herbicides are used sparingly.

Fishing in and around the ricefield can commence at any time and farmers are encouraged to invest in species-specific gillnets for small cyprinids, especially the micronutrient rich *Esomus* and *Darkina* species (Roos et al. 2012; Thilsted 2012; Bogard et al. 2015). These nets may be 10-30m long and placed in the fields and checked every day.

The use of harmful pesticides is a key threat to fish and other aquatic animals (Halwart and Gupta 2004). In some instances fish appear to not be seriously affected by pesticides applied during the wet season, although an in-depth study is required to assess this more thoroughly. Pesticides and herbicides are usually used early in the wet season in Cambodia, and as the whole floodplain becomes inundated with water during the flood, pesticide residue may become

diluted to less harmful levels. Recent advances in rice genetics and pest eradication have resulted in less use of pesticides, but there is anecdotal evidence of unscrupulous traders selling harmful products to farmers and recommending the application of too-high doses.

2.4.4. M&E of impacts of the interventions

Monitoring consists of regular, iterative, assessments of progress to determine whether the intervention is on track to deliver intended results and whether changes to its course of action are needed. Results or outcomes of the intervention's progress are recorded (for example, amounts of fish and OAA in the CFR may be regularly measured to determine the effects of physical improvements and increased patrolling). Best practice is to align monitoring with relevant objectives (for example, if a project provides critical funding to CFR interventions, monitoring can be aligned with the project's results model), as well as to align planned results (outputs and outcomes) with the FiA's long-term Strategic Planning Framework (SPF) for Fisheries (FiA, 2015) – maintaining capture fisheries production (Pillar 1, indicator 1.1.) and ensuring communes have a sustainable and effective fish refuge.

If funding for professional M&E is available the following surveys could be conducted:

1. **Biological monitoring survey** was conducted on a quarterly basis to observe trends / changes in water quality and the diversity and abundance of fish, water birds, and other aquatic animals. Gillnets, fyke traps, and hook and lines were used to sample the fish and OAA within each CFR. Other sampling methods are possible and are discussed in FAO guidelines (Backiel and Welcomme 1980). Types and number of gear were modified in subsequent years according to CFR size and resources available. More detailed information on the sampling method is provided in a separate Biological Monitoring Survey protocol (Hortle 2012).
2. **Capacity assessment survey** measured the effectiveness of the CFR committee in making and implementing decisions to meet their CFR-RFF objectives. To assess governance, five characteristics were measured: 1) organizational management, 2) planning and implementation, 3) resource mobilization, 4) networking/communications and 5) representation and participation. Regular monitoring of the governance capacity of CFR committees encouraged the committees to commit to further improvement and achievement of the rating for good governance practices and sustainability (see section 2.4.1, and Annex 2 for the capacity assessment tool).
3. **Catch and consumption survey** was conducted six times annually to observe trends and changes in households' fishing activity, catch and use of fish and other aquatic animals (OAAs) and aquatic plants, and household food consumption. Although ideal sample size would be proportionate to the number of households in each CFR, a sampling of 10 households per RFF system was utilized in consideration of resources available. Another option is to conduct four surveys annually (rather than six). The frequency of this survey was reduced to two times annually in phase II of the project. More detailed information on the sampling method is available in a separate Catch and Consumption Survey Protocol.
4. **Livelihood survey** was conducted to assess whether and how the income, assets, and overall welfare of households within the CFR-RFF and the surrounding area (Zone of Influence) may have changed as a result of the project intervention. While this survey is not essential to CFR-RFF management, it helps characterize the targeted population and the importance of fish and fishing for rice-farming households. Such information can be used to improve the design of the intervention.

2.4.5. Monitoring the benefits to local livelihoods and food security

Catch within the CFR zone of influence by local communities

Because fishers are numerous and dispersed over large areas, catch monitoring is highly time- and resource-intensive, and is beyond the scope of most community-level management programs. During RFFEP, catch monitoring was infrequent (initially six times each year) and relied upon fisher recall captured in household surveys. To provide more rigorous measurement of rice field catch that could be integrated with national data from other inland fisheries, an adaptation of Daily Catch and Effort methods in Boon et al. 2016, as a supplement or replacement to the recall-based data,

is recommended. Improvements in monitoring rice field catch are important for CFR-RFF interventions, and also have potential to contribute to improved statistics about catch from rice fields in Cambodia.

If resources are available, a formal evaluation can provide critical insight on the efficacy and significance of the intervention, as well as lessons learned to inform the remaining intervention period and similar future interventions. An evaluation typically takes place near the end of the intervention, with an optional mid-term evaluation. Reflection meetings or workshops are recommended as part of a participatory evaluation wherein CFR committee members and other interested stakeholders discuss progress and CFR committee capacity, reflecting on challenges and lessons, and planning ahead with future commitments.

What to measure	How	How often	By whom	Resource demand
Fish caught in the rice fields	Household surveys and/or catch diaries	Quarterly	Project team and CFR-RFF committee	High

Contribution to local fish consumption and income

What to measure	How	How often	By whom	Resource demand
Consumption of fish and OAA	Household surveys	Quarterly	Project team and CFR-RFF committee	High
Participatory assessment of changes in the livelihoods of community members within the zone of influence	Livelihood survey if resources are available; participatory qualitative assessment – questions about changes in livelihoods which may be related to increased catch, consumption and sale of fish and OAA.	At start and completion of project; or after two years of CFR-RFF management	Project team and CFR-RFF committee	High

CONCLUSION

The CFR-RFF system is an open-access resource. It is a sustainably improved environment, which is very useful for resource conservation and management, as well as for improved food and nutrition security and improved livelihoods. The improved bio-physical environments mean that fish are protected from habitat loss during dry seasons, and increased patrolling provides fish with protection from unsustainable fishing practices. The CFR thus maintains a source of local genetic fish resources. This contributes to increased fish numbers. In tandem with improvements to bio-physical environments, the RFF/CFR approach engages people as stakeholders in this resource who stand to benefit from such improvements. By carefully identifying communities who have high potential to benefit, based on proven experience, the approach provides good potential for sustained benefits to both community fisheries and to communities' food and nutrition security and livelihoods.

In order to provide good potential for such impacts, it is very important for a CFR-RFF intervention to follow

all the steps outlined in this manual, starting from site selection and participatory planning. It is important to have a very good facilitator to engage people in the planning stage, and to encourage them to participate actively throughout the process, including changing their attitudes and behaviors as needed. To be successful, a CFR-RFF intervention needs to build trust with communities, elicit a successful vision, and create future expectations to drive action in line with this manual. It is important to know how to encourage and empower people to engage and take on-going responsibility for sustaining the system and its benefits.

Key to creating lasting benefits is ensuring that key 'mechanisms' exist to implement the relevant activities. When a need or a problem in the CFR-RFF system appears (for example, illegal fish harvesting from the CFR), is there a mechanism in the RFF/CFR system to recognize this and to provide solutions? And does this exist irrespective of external, donor-funded/charitable support?



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Annex 1: Characteristics of CFR ideal scenarios

(Sub) Component	Key elements	Characteristics under Ideal Scenario for Cat. 2 CFR - No Flooding
CFR		
Environment	Dimensions - Area, minimum dry season	0.5 ha minimum
	Dimensions - Depth, minimum dry season	1-1.5 m deep over 60% of area, 1.5-3m deep over 40% of area
	Aquatic vegetation percent surface area cover	25% in patches and some low density
	Density of Brush parks/ tree branches	10 Brush parks x 20 m ² = 200 m ²
	Trees in and near CFR	Plant around south and west banks, 50% of total edge minimum
	Water quality - nutrients	Secchi disc 30-45 cm in March-May, green water
	Water quality - turbidity	No clay in water column
Fish	Indigenous fish	Acceptable minimum catch rates from bio-monitoring and committee believes there are sufficient fish
	Silver barb density	2000 fish per hectare (stock at 10 cm)
Fishers	No fishing in CFR	No fishing in CFR
Channels		
Environment	Number position	At least 2 channels on each side of CFR where there are RFs, total minimum 4 channels
	Size/shape	1-1.5 m wide, 20-50 cm deep
	Connectivity	Connect to some rice field refuge ponds near CFR by RF
	Culverts/pipes	None on channels
	Water-gates to canals	None
	Large irrigation canals	None
	Secondary canals to RFs	None

(Sub) Component	Key elements	Characteristics under Ideal Scenario for Cat. 2 CFR - No Flooding
Management-Fishers	Fishing activity - seasonal closure	Fish only in open season
	Fishing activity - restricted area	No fishing within 50 m around CFR and in channels
	Fishing activity - illegal methods	No electrofishing, pumping, poisons, fine mesh
Rice Fields		
Environment	Water depth/duration	Depths > 30 cm for 3 months
	Rice field refuge ponds	One pond per ha
	Rice field refuge rings	One ring per ha
Management-Farmers	Use of chemicals (pesticides, herbicides...)	No pesticides within 50 m of CFR IPM in RFF area
Management-Fishers	Fishing activity - seasonal closure	Fish only in open season
	Fishing activity - restricted area	Rice field refuge ponds closed in dry season
	Fishing activity - illegal methods	No electrofishing, pumping, poisons, fine mesh
Others	Income Generating Activities (IGA)	Increase fish catch by family: up to 50 kg/ha

a) Ideal CFR Scenario

Key Elements	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
Area, minimum dry season	5% or 1ha	0.5ha	0.5ha	5% or 1ha
Depth / % Area, minimum dry season	1-2m/60% 2-3m/40%	1-1.5m/60% 1.5-3m/40%	1-1.5m/60% 1.5-3m/40%	1-2m/60% 2-3m/40%
Aquatic vegetation, % surface area cover	25%	25%	25%	25%
Eco-shelter / tree branches	10 x 40m ²	10 x 20m ²	10 x 20m ²	10 x 40m ²
Trees in and near CFR	Within 20m of drawdown zone	S/SW banks 50% edge	S/SW banks 50% edge	Within 20m of drawdown zone

Key Elements	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
Water quality – nutrients	Secchi Disc 30-45cm dry season; green water – no clay			
Fish stocking	Indigenous sp. seeding	Indigenous sp. seeding + silver barb 2000/ha	Indigenous sp. seeding + silver barb 2000/ha	Indigenous sp. seeding
Fishing	No fishing in CFR; Rules on gears and seasons are followed in the rest of large water body for Categories 1 and 4			

b) Ideal Channel Scenario




Key Elements	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
Number of channels	2+ water gates linked to more sub-channels with RFs adjacent	Min. 4 channels (2+ channels on each side of the CFR where there are RFs)	Min. 4 channels (2+ channels on each side of the CFR where there are RFs)	At least 3 channels where RFs are adjacent
Size & shape of channel	Variable, but directly linked to RFs	1-1.5m wide 20-50cm deep	1-1.5m wide 20-50cm deep	Variable, but directly linked to RFs
Connectivity	Connect to some rice field refuge ponds by rice field near CFR	Connect to some rice field	Connect to some rice field	Connect to some rice field refuge ponds by rice field near CFR
Water gates/culverts/pipes	Traditional bottom-up or flap gates	None on channels		
Fishing in Channels	No fishing within 50m around CFR and in channel (100m for Cat: 4). No electrofishing, pumping, poisons, fine mesh			




c) Ideal Rice Field Scenario

Key Elements	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
Rice field water depth	Depth > 30cm for 3 months			
# Refuge ponds in rice fields	One pond per ha	One pond per ha	One pond per ha	One pond per ha

Key Elements	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
# Cement rings in rice fields	One ring per ha	One ring per ha	One ring per ha	One ring per ha
Use of chemicals	IPM in RFF area	No pesticides within 50m of CFR IPM in RFF area	No pesticides within 50m of CFR IPM in RFF area	No pesticides within 50m of CFR
Fishing season	Fish only in open season (Categories 1 and 4). Rice field refuge ponds closed in dry season			
Fishing methods	No electrofishing, pumping, poisons, fine mesh			

Annex 2: CFR management capacity assessment tool

Characteristics of governance of CFR committee	Poor (1 score) or Seed sowing 	OK (2 scores) or young tree 	Good (3 scores) or Tree 
1-Organization management	<p>No regular meeting, rules and regulations were decided by only a few of the members of CFR committees, communication is not regular, verbal communication to (general) members, most members have unclear idea of the role of the CFR committees.</p>	<p>Regular meetings (less than 6 times per year), rules and regulations were decided by some of the members of CFR committees, communication is less regular, verbal communication to (general) members, some members have unclear idea of the role of the CFR committees.</p>	<p>Regular meetings (at least 6 times per year), rules and regulations were decided by most of the members of CFR committees, regular communication, verbal communication to (general) members, few members have unclear idea of the role of the CFR committees.</p>
2-Planning and Implementing the plan	<p>Activities are not planned and no activities are implemented by the committee independently. Conflicts are not able to be solved by CFR committees with consensus from all members. They always wait for support from NGOs.</p>	<p>Activities are planned by only a few CFR committee members, with little support from the majority of members and other stakeholders. Some activities are implemented by the committee independently. Conflicts are sometimes solved by CFR committees with consensus from all members.</p>	<p>Activities are planned by community people with support from the majority of members and other stakeholders. Most activities implemented by the committee with support from the majority of members and other stakeholders. Conflicts are always solved by CFR committees with consensus from all members.</p>
3-Resource mobilization	<p>CFR committees have not mobilized community contributions and have no appropriate book keeping system.</p>	<p>CFR committees have regularly mobilized community contributions and also find external technical / financial support. Has appropriate book keeping system, but general members are mainly unaware of their resource status.</p>	<p>CFR committees have regularly mobilized community contributions and also find external technical / financial support. Has appropriate book keeping system regular updating of records, which are known by all members of CFR committees and community people.</p>

Characteristics of governance of CFR committee	Poor (1 score) or Seed sowing 	OK (2 scores) or young tree 	Good (3 scores) or Tree 
4-Linkages / Networking	<p>The CFR committee is officially recognized by the commune council (CC) and FiAC, CFR committee executives not attend coordination meetings with the CC.</p> <p>No submission of priority plans to be included in commune investment plan (CIP).</p>	<p>The CFR committee is officially recognized by the commune council (CC) and FiAC, CFR committee executives regularly attend coordination meetings with the CC – at least <5 times per year.</p> <p>The CFR committee develops and submits priority plans to be included in commune investment plan (CIP) and very few activities get support from the CC.</p>	<p>The CFR committee is officially recognized by the commune council (CC) and FiAC, CFR committee executives regularly attend coordination meetings with the CC – >6 times per year.</p> <p>The CFR committee develops and submits priority plans to be included in commune investment plan (CIP) and some activities get support from the CC. Succeeded in gaining support from other NGOs and in involving the private sector in its activities.</p>
5-Representation and Participation	<p>Mostly women do not participate in decision making do not inform members of decisions made, finances or lessons learned.</p>	<p>Some women members are active in decision making and implementation of activities.</p> <p>Members are regularly informed about decisions made, finances and lessons learned through formal communication (village meetings, etc.).</p>	<p>Majority of members are active in decision making and implementation of activities.</p> <p>Members are regularly informed about decisions made, finances, lessons learned through formal communication (village meetings, etc.).</p>

Endnotes

- i The project was extended to a second phase: Feed the Future Cambodia Rice Field Fisheries II project – (RFF II) funded by USAID 2016 to 2021.
- ii CFRs only exist in rice field systems if they are created or improved by human activity. The information in this guideline is based on the availability of existing CFRs (i.e. the context of Cambodia rice field fisheries).
- iii Not all CFR committees will follow this exact structure
- iv It should be noted that the site selection process proposed is based on there being sufficient numbers of existing CFR water bodies available for selection. Therefore, this process does not include explanation of how to find a suitable location for a new CFR and establish a new CFR in that location.
- v Importantly, not all CFR-RFF systems in Cambodia have all three of these domains.
- vi An 'external expert' includes someone with a suitable qualification and Cambodian experience in inland fisheries management, preferably specifically in relation to the several key elements identified in 'Annex 1: Characteristics of CFR ideal scenarios'
- vii Half a morning should be enough for such a meeting.
- viii However, it may be impractical to ask earthworks companies to create irregular-shaped CFRs.
- ix Some research has shown that creating an artificial reef from plastic bottles proved to be just as good as branches, would be more durable than branches, and may be usefully combined with the collection of rubbish, including waste plastic, from around the CFR (Sreymon 2015).
- x In some instances a spillway may also work.
- xi WorldFish has developed guidelines for good governance of a rice field fishery. This includes specific, measurable characteristics of good governance: Miratori and Brooks 2015. Good governance of rice field fishery management. Penang, Malaysia: WorldFish. Program Brief: 2015-19. Available from: http://pubs.iclarm.net/resource_centre/2015-19.pdf
- xii <http://irri.org/our-work/research/better-rice-varieties/disease-and-pest-resistant-rice>
- xiii A copy of this document may be requested from WorldFish Cambodia.
- xiv A copy of this protocol for the Feed the Future Cambodia Rice Field Fisheries Phase II project may be requested from WorldFish Cambodia.



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