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Impact of Community Fish Refuge on the Economic Conditions of the Members in the South-Eastern Region of Cambodia

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ABSTRACT

Cambodia, with an estimated two million hectares of lowland rice fields, is potentially very productive in rice field fisheries through a system of Community-managed Fish Refuges (CFR). It is assumed by the Mekong River Commission (MRC) that the rice field fisheries produce naturally on an average 100 kg/ha/year of many indigenous fish species. This is very important for the fish consuming community where fish provides up to 81.5 per cent of the total animal protein intake of the people. The total fish production from rice field fisheries is estimated as 200,000 tons per year, which contributes very significantly to improving the livelihoods of the rural indigents and the poor. Managing the rice field fisheries in a sustainable manner through a system of CFRs is one possible and promising option for the future of Cambodian rice field fisheries.

Against this background, an attempt is made in this study to analyze Community Fish Refuge (CFR) system in the country in general and South-Eastern region in particular along with assessing the change in fish production in the areas where CFRs have been introduced and the impacts of CFRs on the economic conditions of the members. The study found out that Community Fish Refuges played a very important role in improving the livelihoods of the rural poor farmers at the community level in terms of increase in fish production, income generation, expenditure, saving and asset position. Those aspects when compared before and after the formation of CFRs, signify the positive contribution of CFRs on the livelihoods of the poor farmers in the study area.

1. Introduction

The Kingdom of Cambodia though is one of the Least Developed Countries (LDCs) in the South-East Asia, but is quite rich in its natural resources. Cambodia is a country of rice fields, forest and rivers with the Tonle Sap Great Lake that was formed some 5-6,000 years ago (Carbonel, 1963; Rainboth, 1996) as its heart and the fish cradle of the country. Cambodia is a fish consuming community where fish contributes up to 81.5 per cent of the total animal protein intake of the people, especially the rural indigents and the poor living in the areas far away from important water bodies (Ahmed et al., 1998; Hortle, 2007; Thuok, 2009).

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By consuming on an average 52.4 kg/capita/year, fish maintains second position, next to rice (143 kg/capita/year), in the food equation of the Cambodian people (Van Zalinge et al., 2000; Thuok, 2009), but in terms of monetary value, fish occupied the first position in the equation (Thuok, 2009).

Apart from the exceptionally productive capture fisheries and infant aquaculture production, Cambodia is estimated to endow with the rice field fisheries that produces naturally on an average 100 kg/ha/year of indigenous fish species (Hortle et al., 2008). By assuming that the total area of lowland rice fields of about two million hectares all over the country, the total fish production from this kind of fisheries may account easily for about 200,000 tons annually (Hortle et al., 2008). These fisheries contribute very significantly to the daily livelihood of the rural indigents and the poor living far away from major water bodies. The natural fisheries, notably those in the lowland agricultural cropping ecosystem, are gradually depleted as a result of environmental degradation and the loss of habitats and/or fragmentations that make fishes become scarce and life difficult, especially for the rural dwellers. In this context, improving the rice field fisheries production to the maximum extent possible at a very low cost is extremely crucial to increase fish supply in the lowland rain-fed agricultural ecosystem, thereby improving nutritional protein, vitamins and minerals, particularly calcium and vitamin A and improving livelihood of rural indigent and the poor.

One possible option in the improvement of fish production in the lowland agricultural cropping ecosystem is the introduction of refugia and conservation areas for stock rehabilitation that has been proven beneficial to the maintenance of fish stock diversity and yields (FAO, 1997). The concept of "Community Fish Refuge Husbandry" (CFRH) developed originally 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. The CFRH system refers to a kind of village/community protected ponds established in seasonally inundated rice fields which is located far from natural permanent water bodies. The ponds are connected to rice fields through canals or fish pathway so that they can be able to reproduce, spawn and grow out naturally in the flooded rice fields during the rainy season (Doi and Viseth, 2005).

The Community Fish Refuges (CFR) system in Cambodia as a whole is now under different stages of development and as a concept it is still very new in the Cambodian context. Further, the establishment of CFR is following the understanding of each organization working on it during the transition period before the full set of legal framework is in place. All in all, each community is led by a CFR Committee with a set of regulation and by-law to be followed by the whole community. There are several sub-committees or groups responsible for some important tasks, such as patrolling, accounting, etc. The number of community members also varies from province to province according to the real situation of each location.

To be a CFR, the local people should organize themselves with assistance from the Community Fisheries Development Officers and NGO in the drafting of the CFR by-law, internal regulation and help them approved by the CFR General Assembly. After this, the CFR is required to draft the community fishing area management plan and sign a community fishing area agreement with the competent Fisheries Administration. Finally, the CFR shall register with the Ministry of Agriculture, Forestry and Fisheries which is the institution responsible for overseeing the CF. It is believed

that the Community-managed Fish Refuges (CFR) system can help to produce much more substantial amount of fish naturally in the lowland rice field ecosystem if appropriate management system is introduced and encouraged (Thuok, 2009).

In the Kingdom of Cambodia, a total of 52 Community Fish Refuges (CFRs) had been established spread among 13 provinces with a total of 6,986 members. Dividing the country geographically into various ecological regions, such as the Central Plain, the South-East, the South-West, the North-East and the North-West, it is found that the South-Eastern region which encompasses five provinces, namely, Svay Rieng, Prey Veng, Kandal, Takeo and Kompong Speu, has the presence of 40 CFRs, i.e., around 77 per cent of the total CFRs in the country. Moreover, in this region, while Kandal province has only one CFR, Svay Rieng province presents a maximum of 16 CFRs which is the highest in the region as well as in the country. However, though there are six CFRs in the Takeo province but they cover 1,610 members which is the highest. The South-Eastern region as a whole has 4,863 members covered under 40 CFRs, which is around 70 per cent of the total members under the 52 CFRs in the country.

As it is commonly believed that CFRs contribute to the improvement of the livelihoods of the rural communities, it is felt necessary to undertake a systematic study on the Fish Refuge Husbandry's contribution to fish production in the lowland rain-fed agricultural ecosystem and thereby its impact on the livelihoods of the rural communities.

2. Objectives

The main objectives of the study are as follows:

i. To discuss about the Community Fish Refuge (CFR) system in the country in general and South-Eastern region in particular.
ii. To assess the change in fish production in the areas where CFRs have been introduced and to examine the impacts of CFRs on the economic conditions of the members.

3. Hypotheses

The hypotheses of the present study are as follows:

i. There is no significant change in the fish production of the members after the formation of the CFRs.
ii. There is no significant change in the income position of the members after the formation of the CFRs.
iii. There is no significant change in the expenditure position of the members after the formation of the CFRs.
iv. There is no significant change in the saving position of the members after the formation of the CFRs.
v. There is no significant change in the asset position of the members after the formation of the CFRs.

4. Methodology

Cambodia is divided geographically into various ecological regions, namely, the Central Plain, the South-East, the South-West, the North-East and the North-west.The South-Eastern region encompasses five provinces, namely Svay Rieng, Prey Veng, Kandal, Takeo and Kompong Speu. This region is densely populated with scarce fisheries resources (except Kandal province) where 40 CFRs, i.e., 76.92 per cent of the total number of CFRs in the country (52) have already been organized.

Following the successful trials on CFRs in Svay Rieng province by the Aquaculture Division of the Fisheries Administration, Ministry of Agriculture, Forestry and Fisheries, Royal Government of Cambodia in collaboration with the Asian Institute of Technology, Bangkok through the AARM project, CFRs were introduced in the lowland rain-fed rice cropping ecosystem in Cambodia. These CFRs are proven to be very effective in enhancing

natural fish production in community-managed ponds. As of June 2006, a total of 52 CFRs had been established in 13 provinces of Cambodia. Table 1 shows province-wise CFRs in the country along with their position of members.

Table1: Province-Wise CFRs and Membership in Cambodia (June, 2006)

Sl. No.	Ecological Region	Province	Number of CFRs	Total No. of Members
1	South-East	1. Kandal	1	83
		2. Takeo	6	1,610
		3. Prey Veng	7	1,455
		4. Kompong Speu	10	867
		5. Svay Rieng	16	848
	Sub-total		40	4,863
2	South-West	1. Kampot	1	95
		2. Sihanouk	2	701
	Sub-total		3	796
3	North-East	1. Kratie	1	100
	Sub-total		1	100
4	North-West	1. Siem Reap	1	401
		2. Banteay MChey	1	170
		3. Battambang	3	155
	Sub-total		5	726
5	Central Plain	1. Kompong Thom	1	150
		2. Kompong Cham	2	351
	Sub-total		3	501
	Total		**52**	**6,986**

Source: DoF, 2007.

For the purpose of the study, after the selection of the South-Eastern region purposively, two-stage sampling was used to select the CFRs and the respondents. At first, one CFR from each province was selected randomly by lottery method, irrespective of the number of CFRs in the province. After the selection of CFRs, 30 per cent of the total members from each selected CFR were again randomly selected from a source list by lottery method. The name of the CFR of each province along with the total members and members selected are presented in Table 2.

Cambodia being an agricultural based country, about 2.4 million hectares of rice fields is cultivated every year. As per the rice growing practices, two types of rice cropping ecosystem are clearly identified, namely, the upland rain-fed rice cropping ecosystem, where slash and burn cultivation in the upland and mountainous region are practiced and the lowland rain-fed rice cropping ecosystem, where most of the dominant rice production activities are cultivated. Considering the presence of rich fisheries resources in the rice field, the present study selected the lowland rain-fed rice cropping ecosystem for its coverage. The study was confined to five provinces, i.e., Svay Rieng, Prey Veng, Kandal, Takeo and Kompong Speu. Five CFRs in total (one CFR from each province) were selected for the purpose of the study and 291

Table 2: Description of Sample Design

Sl. No.	Province	Total Number of CFR	Name of Selected CFRs	Total Members	Number of Members Selected
1	Svay Rieng	16	Phum Kandal	116	35
2	Prey Veng	7	Prey Kuy	163	49
3	Kandal	1	Prasat	83	25
4	Takeo	6	Prey Kduoch	510	153
5	Kompong Speu	10	Trapeang Piry	96	29
	Total	**40**	**5**	**968**	**291**

Note: While one CFR from each province was selected randomly by lottery method, in case of Kandal province, due to the existence of one CFR the same was taken for study purpose.

members were selected from those five CFRs for the purpose of interview.

The primary data for the purpose of the study were collected with the help of a structured questionnaire. Further, direct personal interview method was adopted in collecting relevant information from the target respondents. The questionnaire prepared for this purpose includes questions on several socio-economic characteristics of the respondents along with questions related to the fish production from the rice field fisheries, their income, expenditure, saving and asset positions before and after the formation of CFRs. The questionnaire was pre-tested before its finalization.

In order to measure the significance of the change on several aspects, such as production of fishes, income, expenditure, saving and asset positions of the members before and after the formation of the CFRs, the 't' test was carried out through the use of the following formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S} \times \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$$

Where,

$\bar{x}_1$ = **mean value of the members after the formation of CFR.**

$\bar{x}_2$ = **mean value of the members before the formation of CFR.**

n_1 **and** n_2 = **number of members after and before the CFR respectively.**

S = **combined Standard Deviation.**

The value of S is calculated as follows:

$$S = \sqrt{\frac{\sum (x_1 - \bar{x}_1)^2 + \sum (x_2 - \bar{x}_2)^2}{n_1 + n_2 - 2}}$$

Degrees of freedom (df) = n_1+n_2-2

The 't' test is used to test the null hypotheses set before the study.

5. Empirical Results

5.1 Annual Surplus of Fish Production

In the study area fish production from rice field fisheries had contributed to the supply of aquatic animals to the farmers. Moreover, the fish production from rice field fisheries had gradually increased after the formation of CFRs. As indicated in Table 3, before the formation of CFRs, around 39 per cent respondents had their average fish surplus of 38.47 Kg., whereas after the formation

of CFRs, around 42 per cent respondents had average fish surplus beyond their household consumption of 46.09 Kg. Similarly, around four per cent respondents had their average fish surplus of 164.09 Kg. before the formation of CFRs, which had marginally increased on an average to 164.17 Kg. for seven per cent respondents after the formation of CFRs. Further, less than one per cent (0.69 per cent) respondents had their average fish surplus of 245.00 Kg. before the formation of CFRs, while around three per cent had their average fish surplus of 264.17 Kg. after the formation of CFRs. Only one per cent respondents had their average fish surplus of 333.33 Kg. before the formation of CFRs, which had increased to 373.33 Kg. on an average for the same per cent respondents after the formation of CFRs. Finally, six per cent respondents had their fish production surplus of 577.78 kg. before the formation of CFRs which increased to 586 Kg. after the formation of CFRs with nine per cent respondents.

In general, the study revealed that the mean surplus of fish production before the formation of CFRs was 62 kg. per year, which had increased to 349 kg. after the formation of CFRs. It is important to see that the percentage of respondents having no surplus of fish production before the formation of CFRs had fallen from 49 to 38 after the formation of CFRs.

Table 3: Annual Average Surplus of Fish Production of Members before and after the Formation of CFRs

Fish Surplus (Kg)	Number of Respondents		Mean of Fish Surplus (Kg.)	
	Before CFR	After CFR	Before CFR	After CFR
Less than100	113 (38.83)	121 (41.58)	38.47	46.09
100 – 200	11 (3.78)	20 (6.87)	164.09	164.17
200 – 300	2 (0.69)	8 (2.75)	245.00	264.17
300 – 400	3 (1.03)	3 (1.03)	333.33	373.33
400 and above	18 (6.19)	27 (9.27)	577.78	586.00
Sub-Total	147 (50.52)	179 (61.51)	122.73	567.35
No Fish Surplus	144 (49.48)	112 (38.49)	-	-
Total	**291 (100.00)**	**291 (100.00)**	**62.00**	**348.99**

Note: Figures in parentheses indicate percentage to total.
Source: Computation from Primary Data.

5.2 Impact on Income Generation

The income of the members of CFRs was derived from a number of economic activities, such as surplus fish production, production of vegetables, animal raising, like chicken, duck, and pig and rice cropping. The results of the study reveal that the formation of CFRs had enabled the members to raise their income in the community. The mean income after the formation of CFRs had increased as compared to the mean income before CFRs for all member respondents of various categories of income groups. A significant increase in mean income after the establishment of CFRs was found as compared to before CFRs of the members in the income group of US$ 1,000 and above. In this income group, around eight per cent respondents

had an average income of USD 1,424.77 before the formation of CFRs, which had gone up to USD 2,024.36 after the CFRs was established by around 27 per cent respondents. In total, before the formation of CFRs, the respondents had the annual average income of US$ 442.10 which had increased to US$ 924.59 after the formation of CFRs as shown in Table 4.

Table 4: Annual Average Total Income of the Members before and after the Formation of CFRs

(in USD)

Income Group	Number of Respondents		Mean Income	
	Before CFR	After CFR	Before CFR	After CFR
Less than 200	85 (29.21)	27 (9.28)	102.02	113.35
200 – 400	74 (25.43)	50 (17.18)	293.62	317.12
400 – 600	60 (20.62)	57 (19.59)	493.83	495.87
600 – 800	36 (12.37)	45 (15.46)	691.01	720.69
800 – 1,000	14 (4.81)	33 (11.34)	885.80	894.49
1,000 and above	22 (7.56)	79 (27.15)	1,424.77	2,024.36
Total	**291 (100.00)**	**291 (100.00)**	**442.10**	**924.59**

Note: Figures in parentheses indicate percentage to total.
Source: Computation from Primary Data.

5.3 Impact on Expenditure

The expenditures of the members mostly comprised of food, clothing, education, family health and medical care, and fishing gears. It is revealed that the expenditure incurred by the members on all the above items had gone up after the formation of CFRs as compared to before the establishment of CFRs except members of expenditure categories of US$ 400-600 and US$ 800-1,000. Table 5 shows that mean expenditure per year which was US$ 445.12 had increased to US$ 611.46 after the formation of CFRs as compared to before the establishment of CFRs.

Table 5: Annual Average Total Expenditure of the Members before and after the Formation of CFRs

(in USD)

Expenditure	Number of Respondents		Mean of Expenditure	
	Before CFR	After CFR	Before CFR	After CFR
Less than 200	52 (17.87)	38 (13.06)	128.49	136.10
200 – 400	89 (30.58)	69 (23.71)	297.36	300.15
400 – 600	80 (27.49)	55 (18.90)	494.38	490.46
600 – 800	39 (13.40)	34 (11.68)	683.15	696.82
800 – 1,000	20 (6.87)	45 (15.46)	903.06	897.47
1,000 and above	11 (3.78)	50 (17.18)	1,102.74	1,220.02
Total	**291 (100.00)**	**291 (100.00)**	**445.12**	**611.46**

Note: Figures in parentheses indicate percentage to total.
Source: Computation from Primary Data.

5.4 Impact on Saving

So far as saving position of the members is concerned, it is revealed that before the formation of CFRs, only 36 per cent member respondents were able to save on an average USD 172.55 per year. However, after the formation of CFRs, the percentage of members having ability to save had increased to around 44 per cent. In all the saving categories, the percentage of members of saving had increased after the formation of CFRs as compared to before. The mean saving of members was USD 172.55 before the formation of CFRs, which had increased to USD 233.82 after the establishment of CFRs. Thus, as shown in Table 6, the annual average saving of the members was USD 62.26 which had increased to USD 102.05 after the formation of CFRs as compared to before the formation.

Table 6: Annual Average Total Saving of the Members before and after the Formation of CFRs

(in USD)

Saving Group	Number of Respondents		Mean of Saving	
	Before CFR	After CFR	Before CFR	After CFR
Less than 200	75 (25.77)	76 (26.12)	81.81	85.91
200 – 400	19 (6.53)	33 (11.34)	264.06	286.33
400 – 600	5 (1.72)	6 (2.06)	520.00	508.33
600 and above	6 (2.06)	12 (4.12)	727.50	888.96
Sub-Total	105 (36.08)	127 (43.64)	172.55	233.82
No saving	186 (63.92)	164 (56.36)	-	-
Total	**291 (100.00)**	**291 (100.00)**	**62.26**	**102.05**

Note: Figures in parentheses indicate percentage to total.
Source: Computation from Primary Data.

5.5 Impact on Family Asset

Surveyed member families had various types of assets, such as bicycles, motorbikes, radio sets, TV sets and CD/tape recorders, etc. Some families also owned more than one item compared to others. The percentages of the members having all the above types of assets after the establishment of CFRs were more than before the formation of CFRs. The total asset value before the formation of CFRs amounting to USD 70,810 had gone up to USD 169,370 after the formation of CFRs. The mean asset value of the members as shown in Table 7 had increased to USD 582.03 from USD 243.33, i.e., more than the double, after the formation of CFRs as compared to before the establishment of CFRs.

In the present study 't' test was used to test the significance of difference between the two population means of the selected variables before and after the formation of Community Fish Refuges. The hypothesis testing reveals the following results:

i. So far the change in the fish production of the members after the formation of CFRs is concerned, it is revealed that the calculated value of 't' is 4.21 at df 580 with p-value .000 (Table 8), which is more than the table value at one per cent level of significance. As explained, before the formation of CFRs the members had the annual average fish production of 62 Kg. which had increased to 349 Kg. after the formation of CFRs. This

Table 7: Family Assets of the Members before and after the Formation of CFRs

(in USD)

Family Assets	Number of Respondents		Value of Asset	
	Before CFR	After CFR	Before CFR	After CFR
Radio sets	74 (25.43)	115 (39.52)	740	1,150
CD/tape recorders	46 (15.81)	71 (24.40)	2,300	3,550
TV sets	94 (32.30)	191 (65.64)	14,100	28,650
Bicycles	161 (55.33)	206 (70.79)	11,270	14,420
Motorbikes	53 (18.21)	152 (52.23)	42,400	121,600
Total asset value			70,810	169,370
Mean asset value			243.33	582.03

Note: Figures in parentheses indicate percentage to total.
Source: Computation from Primary Data.

indicates that there was significant increase in the fish production of members from rice field fisheries after the formation of CFRs as compared to before the formation of CFRs. Thus the null hypothesis "There is no significant change in the fish production of members after the formation of CFRs" is hereby rejected.

ii. With regard to the change in income position of the members after the formation of CFRs, it is found that the calculated value of 't' is 4.95, which is more than the table value at one per cent level of significance with df 580 (Table 8). As mentioned, before the formation of CFRs the members had the annual average income of USD 442.10 which had increased to USD 924.59 after the formation of CFRs. This shows that there was significant increase in the income position of the members after the formation of CFRs as compared to before the formation of CFRs. Hence the null hypothesis "There is no significant change in the income position of the members after the formation of CFRs" is hereby rejected.

iii. So far the change in the expenditure position of the members after the formation of CFRs is concerned, it is revealed that the calculated value of 't' is 4.58 which is more than the table value at one per cent level of significance with df 580 (Table 8). Before the formation of CFRs, the members had the annual average expenditure amounting to USD 445.12 which had increased to USD 611.46 after the formation of CFRs. This implies that the expenditure position of the members after the formation of CFRs had increased significantly as compared to before the formation of CFRs. Therefore, the null hypothesis "There is no significant change in the expenditure position of the members after the formation of CFRs" is hereby rejected.

iv. Significant change in the saving position of the members after the formation of CFRs as compared to the same before the formation of CFRs was observed. This result is revealed from the 't' value, i.e., 2.49 with df 580 at five per cent level of significance as shown in Table 8. As explained before, the

average saving of the members before and after the formation of CFRs in the study area were USD 62.62 and USD 102.05 respectively. This indicates that there was significant increase in the saving position of the members after the establishment of CFRs. Hence this leads to the rejection of the null hypothesis "There is no significant change in the expenditure position of the members after the formation of CFRs".

v. With regard to the change in the asset position of the members between before and after the formation of CFRs, the 't' value, i.e., 9.53 with df 580 at one per cent level of significance shows the significant change in the asset position of the members (Table 8). The average asset value of the members before the formation of CFRs was USD 243.33 which had increased to USD 582.03 after the formation of CFRs. This shows a significant increase in the asset position of the members after the formation of CFRs. Thus the null hypothesis "There is no significant change in the asset position of the members after the formation of CFRs" is hereby rejected.

Table 8: Results of Testing of Hypotheses

	Hypothesis	t-Value	df	p-Value
1:	There is no significant change in the fish production of the members after the formation of CFRs.	4.21	580	0.000**
2:	There is no significant change in the income position of the members after the formation of CFRs.	4.95	580	0.000**
3:	There is no significant change in the expenditure position of the members after the formation of CFRs.	4.58	580	0.000**
4:	There is no significant change in the saving position of the members after the formation of CFRs.	2.49	580	0.013*
5:	The is no significant change in the asset position of the members after the formation of CFRs.	9.53	580	0.000**

Note: ** Significant at one per cent level of significance.
* Significant at five per cent level of significance.

6. Conclusion

The result of the present study shows that the Community Fish Refuges played a very important role in improving the livelihoods of the rural poor farmers at the community level in terms of increase in fish production, income generation, expenditure, saving and asset position. As CFRs in general have been significantly providing economic benefits to the members, particularly the poorer section of the society, measures to extend and strengthen the system of CFRs should be initiated at all levels.

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