5.3 Community perception issues and expectations on efficient culture-based fisheries production in irrigation reservoirs of Sri Lanka

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Abstract

This paper presents the results of a community awareness program for the fishing community associated with 48 irrigation reservoirs (13 small-scale irrigation reservoirs, 25 medium-scale irrigation reservoirs, and 10 large-scale irrigation reservoirs) in 10 districts. The introductory program examined the perceptions and expectations of the CBF farming communities on improving the productivity, efficiency and sustainability of finfish and GFP farming in the CBF in Sri Lankan irrigation reservoirs.

Common problems in GFP farming in all irrigation reservoirs include insufficient stocking of freshwater prawn larvae, predation by GFP, lack of formal methods for harvest of GFP, and predator damage. However, these issues can be different depending on the type of reservoir. Illegal fishing and trapping methods, and damage caused by wild elephants, are some of the other common problems that strongly affect the CBF.

Although freshwater production in Sri Lanka operates under the name of 'culture-based fishery industry', it is still not a competitive production industry or system aimed at maximising private profit, but rather fishing is perceived as a source of livelihood. Therefore, it is a production system that does not operate on a systematic business plan, nor does it implement small-scale guidelines that are accepted internationally. Policies should therefore be formulated based on experimental information on stocking, harvesting techniques and bioeconomic relationships to sustain GFP farming in CBF with the consideration of community perceptions and expectations.

Fish farmers expect continued government subsidies for fingerling supply. However, CBF can be developed as a profit-oriented industry rather than a source of livelihood, taking into account the rural protein requirement, the supply of fish, and GFP fingerlings finance through investment based on member funds, according to a business plan.

CBF can be sustained as an industry with the effective participation of the respective reservoir-based farmer–fisher cooperation for a more efficient district-level extension officer service, the understanding of problems and needs, participatory action research knowledge, and development of rural social and communication skills. The dependency of the fishing community on subsidies as well as the dependence of NAQDA for public finance can be gradually reduced. This consultation report suggests that NAQDA and the fishing community should make interdependent structural institutional reforms on an apolitical basis to make GFP farming a productive, efficient and sustainable 'industry'.

Community perceptions and expectations play a decisive role in the efficiency and sustainability of CBF. Strategies that centre on participatory engagement, capacity building, equitable benefit distribution and responsive governance systems are essential to align CBF production goals with local realities.

Keywords: *perception, expectations, community participation, self-financing*

Introduction

CBF involve the enhancement of water bodies (like reservoirs, lakes and floodplains) through the release and recapture of cultured fish, allowing them to grow using natural productivity. CBF have been increasingly promoted for rural livelihood development, especially in Asia, Africa and some parts of Latin America, to enhance fish supply, food security and rural livelihoods (De Silva and Funge-Smith 2005). CBF is also considered a low-input, community-managed, semi-intensive form of aquaculture. However, the success of CBF depends heavily on the perceptions, expectations and participation of local communities. Understanding community dynamics is essential for enhancing production efficiency and long-term sustainability.

CBF systems differ from intensive aquaculture in that they rely on existing water bodies and natural productivity, often with community-level management (De Silva and Davy 2010). The objective is to augment fish yield while maintaining ecological balance.

Community perceptions and expectations

Community perception encompasses local beliefs, knowledge systems, attitudes and social norms, while expectations relate to perceived benefits such as income, food security, employment and ecological outcomes (Torell et al. 2010). Several studies highlight that low awareness and technical knowledge are major barriers to community participation. In Sri Lanka and Vietnam, De Silva et al. (2006) found that communities often lacked understanding of stocking density, species compatibility and harvesting strategies. Kaminski et al. (2018) found in Malawi that extension services were insufficient to bridge local knowledge gaps, affecting perceptions of CBF efficiency. The perception of fairness, transparency and leadership in community fishery committees is crucial. Studies in Cambodia and Laos (Chou 2009; De Silva 2016) noted that weak local institutions and elite capture erode community trust and reduce the willingness to cooperate in CBF initiatives. Furthermore, in Bangladesh, community-based organisations supported

by NGOs saw better management outcomes (Islam et al. 2011), increasing positive expectations. Community expectations often revolve around improved income and employment, and sources of nutrition. De Silva (2006) found that communities expected quick economic returns, which clashed with the seasonal nature of CBF in India. Nevertheless, expectations of equal profit sharing often do not match reality, especially when roles in management and labour are unequal (Haque and Dey 2017).

Experience in Indonesia and the Philippines shows that women's involvement in CBF was low despite their significant contribution to post-harvest and management activities (Weeratunge et al. 2010). Cultural norms sometimes prevent marginalised groups from accessing water bodies or participating in governance (Ratner and Allison 2012). CBF employ existing water bodies that are used for multiple purposes. Therefore, communities are sensitive to ecological changes linked to CBF, such as overstocking, introduction of exotic species or water pollution, which can lead to scepticism or resistance (Amarasinghe and Nguyen 2010).

Perception issues can be resolved through participatory planning and co-management. Evidence from Thailand and Bangladesh suggests that co-management frameworks enhance legitimacy and shared ownership (Pomeroy et al. 2001). Also, the inclusion of traditional knowledge and active dialogue is vital to align expectations. Lack of knowledge on CBF activities is another drawback for the development of CBF. Proper extension programs addressing both men and women can improve understanding and reduce misinformation (FAO 2024). For this purpose, mobile-based advisories and farmer-to-farmer learning have proven effective in parts of Southeast Asia. Equity-focused benefit sharing is another issue for CBF development. Transparent systems for input allocation, labour contribution tracking and profit sharing are critical. Furthermore, institutional innovations such as fishery cooperatives with rotating leadership roles can help mitigate power imbalances (Sen and Nielsen 1996) and social conflicts.

Research methods

Using a participatory approach, a problem-tree analysis was conducted with the fishing communities that participated in the workshop to identify the causes, solutions and impacts of the problems of the sustainable development of the CBF industry. In addition, a focus group discussion was conducted with the participation of officials and members of the fishing groups using a set of open-ended questions to collect basic information related to the CBF industry.

Results and discussion

Rural farmer communities perceive some aspects of CBF based on their expectations. There are 2 main expectations on CBF production:

1. CBF should be a source of nutrition as a social goal.
2. CBF should be an income-generating activity as an economic goal.

The importance of aquaculture

The importance of aquaculture to livelihoods has been discussed in 3 ways. As presented in Table 5.3.1, overall, 100% of the fishers in all irrigation reservoirs consider it as an occupation for their livelihood. This statement is truest for full-time fishers, that is, active fishers who consider a higher percentage of their income contributes to their livelihood and they spend time on fisheries activities.

Table 5.3.1: Importance of CBF to 3 types of farmer communities (as a percentage)

Importance of CBF	Minor irrigation (%)	Medium irrigation (%)	Major irrigation (%)
As an occupation	100	100	100
As a source of nutrition	15	12	0
As an additional source of income	8	8	20

The common opinion of CBF as a source of rural nutrition suppliers is no longer true for large irrigation reservoirs, as shown in Table 5.3.1. However, about 15% and 12% of fishers in small and medium irrigation reservoirs, respectively, consider cultured fisheries as a source of nutrition. Fishers who have alternative sources of income but engage in fishing activities on a seasonal basis consider the CBF as an additional source of income. Expectation of quick returns often leads to over-harvesting or disagreement on harvest timing**.** Most communities expect CBF to provide a reliable, seasonal income stream, especially in dry or lean periods (Pant et al. 2014).

Rural fish consumption

Among the desired objectives of CBF is the improvement of rural nutrition. Although Sri Lanka is a country with a marine fishery around the island, the supply chain of marine fish production is not sufficiently organised. Therefore, the supply of marine fish available for rural consumption is limited and the market price for marine fish does not match the purchasing power of rural communities. On the other hand, although the accessibility and market price of freshwater fish are favourable for the rural consumer, there is still an excess demand. That means freshwater fish production has failed to meet the rural demand.

Fish production in small-scale irrigation reservoirs is a seasonal product and contributes significantly to rural fish consumption. Of the total production, 64% is sold for rural consumption in minor irrigation reservoirs and it has been observed that the leading consumption choice is the tilapia species (Figure 5.3.1). The main criteria for such a choice are taste, market price, and the number of pieces that can be provided in one kilogram. On the other hand, fishers are inclined to stock carp species and GPF because of their weights and higher market prices, respectively.

However, rural consumers have less interest in carp species, and there is a low demand for GFP due to the high market price and low number of pieces that can be consumed per kilogram. There is a slight increase in rural consumption of GFP due to an increase of rejected harvest by purchasing agencies because of improper techniques of GFP catching. Rejected GPF is sold by fishers to the village consumers for low prices.

The fishing industry in small-scale irrigation reservoirs is influenced by farmer organisations, and rural consumer interest is a decisive factor for profitable fishing activities such as GFP. As a result, some small-scale irrigation reservoirs have had to stop stocking GFP. Some medium-sized irrigation reservoirs also have such influence from the farmer organisations and the rural communities but such influence is not seen in large-scale irrigation reservoirs. Many rural households anticipate increased fish availability for household consumption, not just market sales. Misalignment of project goals (for example, commercial focus) and community expectations can cause tension.

Reservoir-related common issues affecting CBF

Table 5.3.2 shows the common reservoir-related issues affecting CBF. Illegal net use and illegal fishing were identified as major issues common to all irrigation reservoirs and these issues are reported in 100% of the major irrigation reservoirs.

The implementation of legal measures by NAQDA officials is a legal requirement for controlling illegal fishing activities. However, the implementation of rules and regulations are an insufficient mechanism. Among the factors affecting this are the nature of resource ownership for proper implementation of the law, the resources and technology available to law enforcement officers, and the socioeconomic and political context of the country. Furthermore, the restriction of fishing membership, the lack of a system for removing inactive members, the lack of alternative livelihood opportunities, and the high market price of GFP have contributed to the intensification of these illegal activities. Also, the dual nature of the duties of extension officers is an obstacle to the development of the GFP industry. That is, at one time, an officer may need to enforce the law and at another time, the same officer in the capacity of an extension service officer may implement welfare policies.

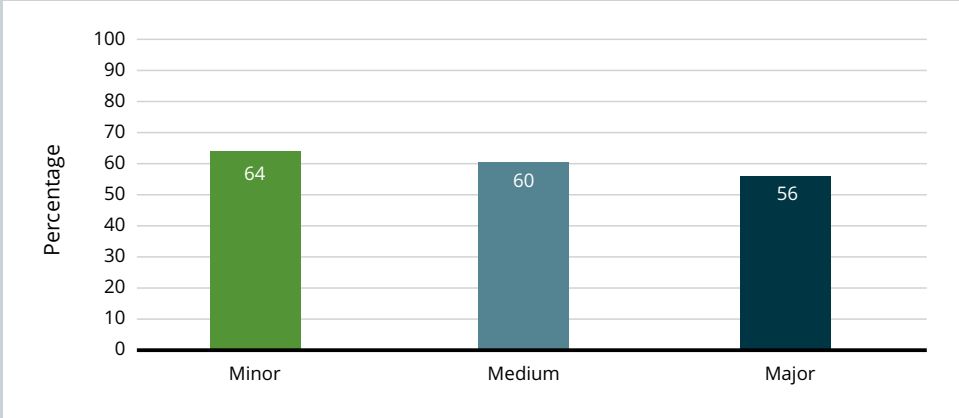

Figure 5.3.1: Rural inland fish consumption by reservoir as a percentage of total annual fish production

Table 5.3.2: Reservoir-related common issues affecting CBF (as a percentage)

Type of membership	Minor irrigation (%)	Medium irrigation (%)	Major irrigation (%)
Illegal fishing	85	84	100
Illegal net use	85	92	100
Elephant damage	77	60	80
Predator problems	31	8	20
Conflicts between fishers and farmers	31	24	10

In general, damage to nets by wild elephants is a common problem affecting many irrigation reservoirs and affects 80% of large irrigation reservoirs. Water management conflicts between fishers and farmers are often seen in small-scale irrigation reservoirs. Inter-sectoral water sharing (between paddy cultivation and fisheries), a problem in rain-fed small-scale irrigation systems, is strongly linked to farmer organisations. There is a lot of scope for solving this problem with good coordination between farmer organisations and fisheries committees in small-scale irrigation systems. Studies (for example, by Ahmed and Garnett 2011) highlight that CBF success depends on a strong sense of community ownership. Lack of clear tenure and benefit-sharing mechanisms often leads to low motivation and conflict. There is frequent concern about elite groups monopolising the benefits. This reduces trust among marginalised fishers and discourages their participation (Nunan 2006). Jentoft (2009) emphasises that perceptions of fairness in how benefits and responsibilities are shared play a central role in whether resource users participate in fisheries co-management. If communities feel benefits are inequitable, they may opt out or even sabotage the system. In Bangladesh and Sri Lanka, participatory studies found that women and small-scale fishers felt excluded from decision-making and harvest sharing (Crofton et al. 2024).

Religious practices associated with CBF

Compared to coastal fisheries, most inland fishers are Buddhist, with Hindu and Muslim also being identified in different regions. Agriculture and fishing have been part of the livelihood of Buddhist culture for a long time. This religious influence, which was strong during the era when fishing was limited to food only, has gradually eased with the expansion of commercial fishing. However, during the full moon days, Sri Lankan fishers generally refrain from fishing (both inland and at sea). However, there is no legal prohibition on fishing on those days; it is a religious consensus.

According to Table 5.3.3, 50% of the fishers in large irrigation reservoirs do not engage in fishing activities on full moon days and Fridays, while 85% and 96% in small and medium irrigation reservoirs do not engage in fishing activities on full moon days only. On the other hand, the very low rate of abstention from fishing activities on Fridays is reported because most of the fishers are not Muslim. The right to use water in small and medium irrigation reservoirs is linked to land ownership, and therefore, elderly landowners are often not interested in fishing activities for religious reasons. However, their young male adults participate in fishing activities. Nevertheless, in most cases, young adults are not members of farmer organisations. Therefore, the relationship between farmer organisations and Fisheries Cooperative Societies (FCS) is distant. The relationship between the farmer and the fishing group

Table 5.3.3: Religious practice associated with CBF (as a percentage)

Type of membership	Minor irrigation (%)	Medium irrigation (%)	Major irrigation (%)
Refrain from fishing on full moon days	85	96	50
Refrain from fishing on Fridays	15	4	50

is more important because the water management decisions in the irrigation reservoirs are linked to fishing activities. Cultural beliefs around fishing (for example, caste restrictions in South Asia) can limit participation. Bailey and Jentoft (1990) found cultural norms resistance to particular management interventions. Religious or local taboos on fish stocking practices (for example, releasing exotic species) may generate resistance.

Women's participation in CBF

Women's participation in the cultivated fisheries industry is notable for its greater focus on supply-chain activities in the southern regions of Sri Lanka, while the northern and eastern regions are more involved in harvesting activities. This may be largely due to the recent civil unrest in those regions.

Although participation by women in fishing activities is 41% in the medium and major irrigation reservoirs, low female participation is observed in the minor irrigation reservoirs due to the fact that they are engaged in agricultural and alternative employment, the seasonal nature of the fisheries activities and the high demand for finfish in rural areas (Figure 5.3.2). Women are also mainly involved in post-harvest fisheries activities such as drying and trading of dried fish. Women in the Northern, Eastern and North Western provinces are involved in fishing as members of fisheries societies.

The recruitment of new female members for fisheries societies is a bottleneck inherent in the recruitment process. This is due to membership restrictions, lack of evaluation or change of inactive, inefficient and illegal fishers of the society. In addition, there is a surplus of unemployed male labour due to the scarcity of alternative employment opportunities in rural areas.

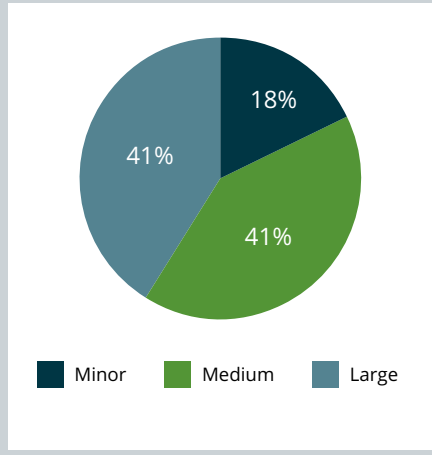

Figure 5.3.2: Women's contribution to CBF in irrigation reservoirs

GFP farming is more suitable for women because it is a potential supplementary source of income that can be occupied in a short period enabling them to add a significant portion of their family income in addition to their daily household chores. Women's roles in CBF are often limited to post-harvest activities. However, research (for example, Kruijssen et al. 2018) shows women want involvement in decision-making and guarding/harvesting. Gender-sensitive approaches are often lacking, despite growing evidence that inclusive governance increases project sustainability.

GFP farming in the CBF

GFP farming, which can be identified as a turning point in the CBF, has been rapidly expanding in the last decade. Although there is a strong attraction among fishers for GFP, which has high commercial and nutritional value, it was confirmed during community awareness workshops that the understanding of it is at a very low level.

Knowledge about GFP

Most people considered GFP to be a species of prawn introduced from another country, while only a handful knew that they are endemic to Sri Lanka.

As shown in Figure 5.3.3, about 70% of fishers in small-scale irrigation reservoirs do not know about GFP, while 60% of fishers in large irrigation reservoirs know about it. The factors considered in measuring knowledge were stocking of prawns, feeding patterns, harvesting, market chain and post-harvest handling. There is no evidence that the institutions that initially provided the fingerlings for stocking or NAQDA have conducted adequate awareness programs on GFP. However, with the commencement of the project on improving the productivity, efficiency and sustainability of finfish and GFP farming in Sri Lankan irrigation reservoirs, informal awareness sessions have been held by NAQDA and researchers involved in the project. Many communities are unaware of the technical and ecological basis of CBF, leading to unrealistic expectations about fish yield and timelines (Kularatne et al. 2009). Misconceptions about overstocking or water pollution by cultured species can breed resistance.

Willingness of the aquaculture industry to cultivate shrimp

Irrigation reservoirs are aimed at supplying water for agriculture, and these reservoirs are the main water source for aquaculture. Similarly, GFP farming is a new approach to aquaculture. Accordingly, reservoir water use in agriculture, aquaculture and GFP farming are interrelated. The will of all stakeholders using irrigation reservoirs is a very important factor. Therefore, the perception of the rural consumer community, farmer organisations and fishery members as key stakeholders were sought for their willingness to cultivate GFP.

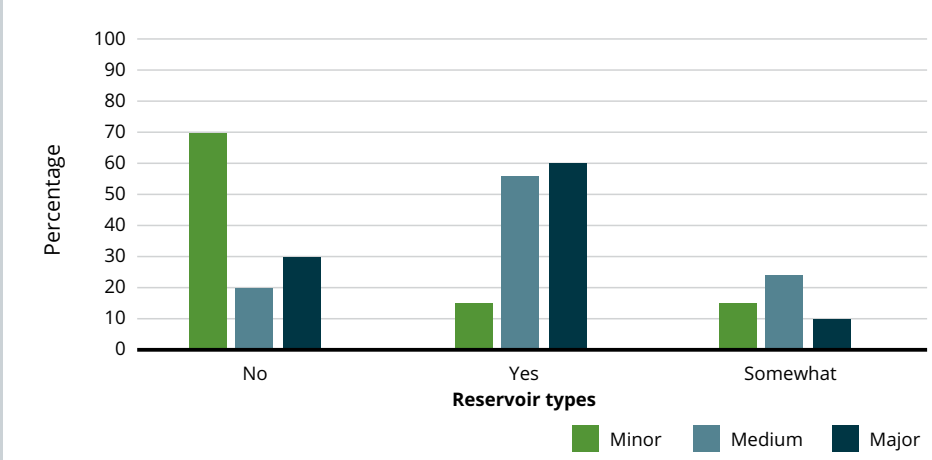

Figure 5.3.3: Fisher awareness of GFP by reservoir (as a percentage)

Perceptions of GFP farming in minor irrigation reservoirs

As per Figure 5.3.4, 69% and 77% of the consumer community and farmer organisations are somewhat in favour, respectively, while 69% of fishers expressed their preference for GFP farming in minor irrigation reservoirs.

The consumer community expects GFP reduces their dependence on finfish consumption. They do not fully agree with GFP due to agricultural water use, poor coordination and agreement between fishing groups and farmers organisations, and the low returns from aquaculture. While most fishers are more willing to do so due to its financial attractiveness, a small number of people expressed their disapproval due to concerns that GFP reduced the yield of other finfish species.

Perception for GFP farming in medium irrigation reservoirs

The reasons for the slight preference for GFP farming in medium irrigation reservoirs are similar to those for small irrigation reservoirs. Although the slight dislike is lower than for small irrigation reservoirs, 16% of the farmer organisations in these irrigation reservoirs are not fond of GPF (Figure 5.3.5). This is because in most cases, more than one farmer organisation is active in these irrigation reservoirs and the fishers do not have a direct connection with these organisations and do not receive direct benefits. In medium-sized irrigation reservoirs, farmer organisations and fisher groups operate separately.

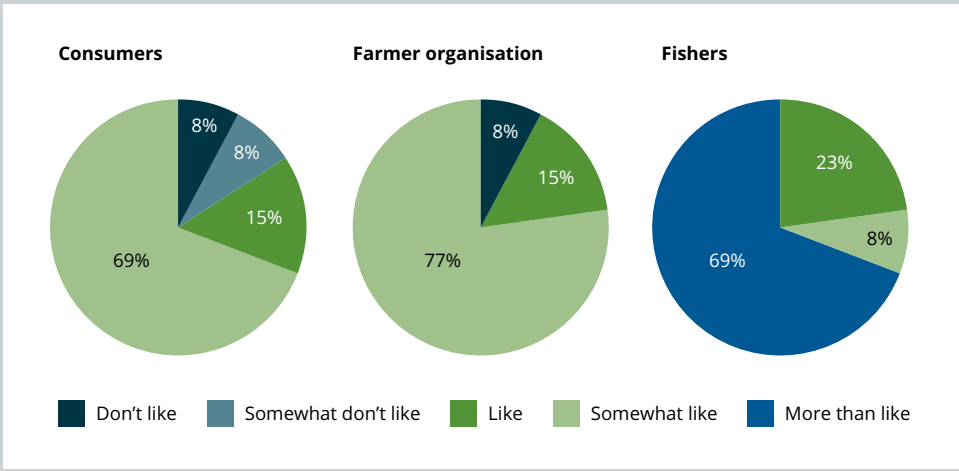

Figure 5.3.4: Perception of GFP farming in minor irrigation reservoirs by stakeholders (as a percentage)

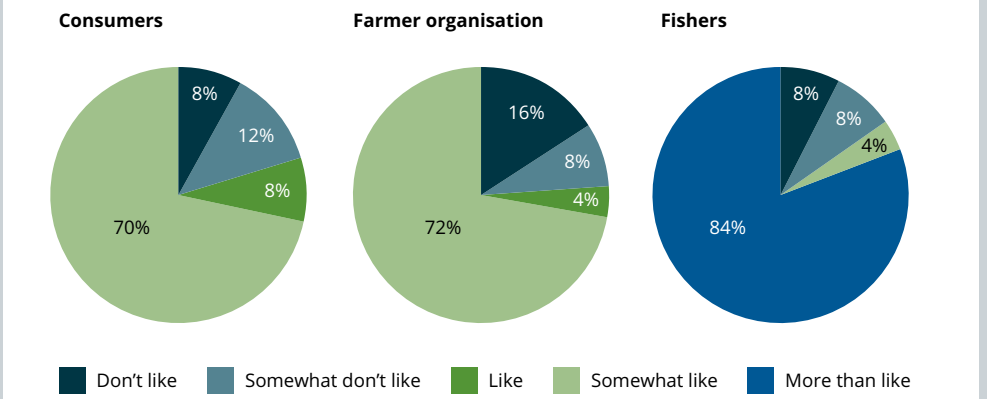

Figure 5.3.5: Perception of GFP farming in medium-sized irrigation reservoirs (as a percentage)

Perception for GFP farming in major irrigation reservoirs

The willingness of stakeholders in large irrigation reservoirs towards GFP farming is completely different from the situation in small and medium irrigation reservoirs. That is, no rural consumer or farmer organisation expressed any displeasure for GFP cultivation.

A high percentage of fishing groups (80%) are more interested in GFP farming while 20% of large irrigation reservoirs are somewhat interested because they suspect that GFP will reduce other finfish yields and may not receive the targeted harvest or income (Figure 5.3.6). The need for some financial or social benefit exchange between fisher societies and farmer organisations is important not as a payment but as social security for maintaining the fishing industry. Similarly, in the reservoir culture, such agrofishery integration is important as a tool that can be used to influence water management decisions and reduce social conflicts.

Key issues affecting GFP farming in freshwater irrigation reservoirs

One of the criteria considered in the selection of irrigation reservoirs at the beginning of the ACIAR project was to select irrigation reservoirs with the highest potential for the most efficient operation of the project. The key issues that are important in terms of their impact on GFP farming in such irrigation reservoirs are shown in Table 5.3.4.

Perceptions on major issues affecting GFP farming in the irrigation reservoirs

Although the issues common to the 48 irrigation reservoirs considered are presented in percentage terms, it is more important to identify the issues ranked according to impact. According to the fishers, the major issue affecting them is the insufficient number of GFP fry stocking into the irrigation reservoirs. This issue was clarified as one of the research areas of the project and accordingly, the density of fry stocking should be determined at the level of each reservoir and appropriate methods

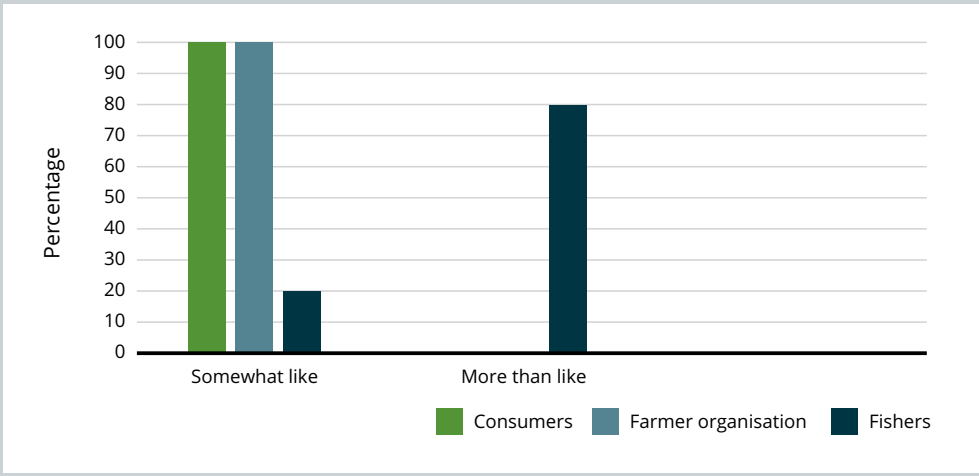

Figure 5.3.6: Perception of GFP farming in major irrigation reservoirs by stakeholders (as a percentage)

should be studied. The project proposal has been able to identify this issue as the first objective of the study.

Table 5.3.4: Major issues in terms of impact

Major issues affecting GFP farming	%
1. Insufficient stocking of GFP fry	31
2. GFP are predators of finfish fry	29
3. Lack of a formal method for GFP harvest	27
4. Predation of GFP by animals such as turtles, eels	21
5. GFP escape from sluices gates, spill and water access routes	17
6. Inactivity/disorganisation of fisheries cooperatives	17
7. Slow growth of GFP	8
8. Market-related issues	6
9. Issues regarding water sharing between sectors (fisheries–agriculture)	4

Among the main problems mentioned in Table 5.3.4, problems 1 to 3 and problem 8 are already being solved experimentally by various research groups of the project, so appropriate recommendations will be made based on the results. In some irrigation reservoirs, catching eels is considered as an inappropriate fishing activity (for example, at Weerawila reservoir) and law prohibits catching turtles. However, a persistent pattern of catching only eels during a specific period can be observed. An experimental solution needs to be found to reduce the growth of GFP.

Fishers consider the lack of a formal method for GFP harvest as the main problem in GFP farming in small irrigation reservoirs. However, this problem is a third-order obstacle in other irrigation reservoirs. There are 4 main problems affecting GFP farming in medium irrigation reservoirs and large irrigation reservoirs. These are:

1. Insufficient stocking of GFP.
2. GFP are predators of finfish fry.
3. Lack of a formal method for GFP harvest.
4. GFP escape from sluices gates, spill and water access routes.

Initially, during the discussion on harvesting, it was mentioned that fishers catch shrimp. However, at the end of the awareness program, it was acknowledged that shrimp are caught as an untargeted harvest in nets used for catching finfish, and accordingly, it was acknowledged that fishers are not 'shrimp catchers' but 'shrimp by-catchers'.

Among these basic problems, the escape of shrimp from the spills, sluice and water access routes can be identified as unorganised fishing groups that do not have a system in place to protect their stock as a common product. Also, since the stocking of fry in many irrigation reservoirs is based on subsidy schemes rather than full investment by the fishing groups, such problems have become 'unsolvable' problems due to the lack of significant attention to the risk of investment. Community perceptions are influenced by the presence (or lack) of strong local institutions such as fisheries committees or co-operatives (FAO 2024). Poor institutional transparency leads to suspicion and disengagement (Ratner et al. 2012).

Causes of the main problems in GFP shrimp farming by reservoir type

The causes of the main problems are specific to each reservoir. Accordingly, fishers in small irrigation reservoirs do not have sufficient knowledge about shrimp farming. Also, there is a risk of destroying immature shrimp fry due to the risk of balancing agricultural activities and CBF with a limited amount of water within a certain period. In addition, when small irrigation reservoirs are connected to large irrigation schemes, there may be a shortage of fish food due to the reduction in fish feeding areas (for example, at Van Ela small irrigation reservoir). The fact that the irrigation reservoirs remain full of water throughout the year has led to a decrease in the number of cattle and other animals, and the lack of plant growth. Similarly, the inability to place shrimp in the right place due to difficulties in obtaining fry from the breeding grounds has led to the decline in shrimp farming. The weak participation of the societies and the lack of a business plan to organise a suitable program for fishing activities are also affecting to the unsustainability of GFP farming. Furthermore, since the majority of fishers are engaged in alternative sources of income (for example, at Ranawa Morowara reservoir), fishing activities are not seen to go beyond the level of mere subsistence.

Common reasons for central irrigation and large irrigation reservoirs are that fishers do not have the ability to breed, and the breeding centres that exist are few and far away. Due to this, the transportation costs to be borne are high. Accordingly, the opportunity to stock fingerlings at an appropriate time has been lost. Also, the spread of irrigation reservoirs over a large area and the number of landing sites is more than one, which reduces the risk management of production and fails to develop a systematic program to protect the harvest.

Proposed solutions to the problems of GFP farming by reservoir type

Based on the knowledge and experience of GFP fingerling stocking, several suggestions were presented for the existing problems as shown in Table 5.3.5. Considering their feasibility, they should be implemented without rejection, and before implementation, they should be actively tested through action research in collaboration with fisheries technicians.

Among the solutions proposed by the fishers, 3 common solutions can be identified for each reservoir. These are:

Table 5.3.5: Causes of major problems in GFP farming by reservoir type

Minor irrigation	Medium irrigation	Major irrigation
• Lack of knowledge • Destruction of fry • Reduction of fish feeding areas in irrigation reservoirs • Insufficient availability of shrimp at the right time • Inadequate water due to seasonal irrigation reservoirs • Alternative economic activities • Difficulty in obtaining from breeding grounds	• Fishers lack breeding capacity • Beliefs about catching eels • Risks of production and insecurity of harvest	• Reduction in breeding centres • Risk of production and insecurity of harvest • Inability to identify GFP and small shrimp • Failure to stock fry on time • Different prices from buyers

1. Stocking GFP fingerling at the right time and at the right density.
2. Government institutions should take action to breed shrimp fry and provide fishers with the necessary knowledge and equipment to grow immature fish fry.
3. Identifying suitable methods for catching GFP.
4. Creating a competitive market.

A closer look at these solutions reveals that the stock of fish fry is a primary factor of production in appropriate quantities at the right time. The uncertainty of fry supply and the dependence on fry suppliers and institutions, the reduction of the risk of spoilage through harvesting technology, and the competitive market have a strong impact on price and profit stability. In addition, the specific solutions proposed for each reservoir are presented in Table 5.3.6.

Among the proposed solutions, several of the most important solutions can be identified. Strengthening fisheries cooperatives for financial investment in fry, working together with farmer organisations or all water users, providing fishers with the necessary knowledge and equipment for shrimp fry breeding or rearing, and adjusting the relative ratio of GFP and finfish fry, can be considered important solutions.

In addition, obtaining extension service support is a solution for medium irrigation reservoirs. However, a number of steps could be observed to make the existing extension service effective and efficient. Problems such as the inactivity/disorganisation of fisheries associations and the sharing of water between sectors (fisheries–agriculture) can be solved by regularising extension services with the participation of all stakeholders using the irrigation reservoirs through business plans related to each reservoir.

Overall impact of major issues affecting GFP farming in freshwater irrigation reservoirs

As a result of uncertain production processes (such as irregular stocking of fry, technical weaknesses in harvesting,

Table 5.3.6: Suggested solutions

Minor irrigation reservoirs	Medium irrigation reservoirs	Major irrigation reservoirs
• Selection of a suitable location for GFP in the reservoir • Having a proper system for providing fry • Building unity and support within the community • Increasing the productivity and efficiency of the fishing industry • Enforcing the law against illegal fishers • Negotiating with the farmers' association • Placing fry in the prescribed quantity at the prescribed times • Providing training and equipment to fishers to breed shrimp fry • Placing grown shrimp fry • Not placing shrimp all at once • Scientific investigation into whether shrimp are predators	• Covering the pond and the outlet • Controlling predators and identifying markets • Strengthening fishing associations to invest financially in the hatchery • Regulating water use • Enlisting the support of fisheries extension officers • Building shrimp cages • Placing food-bearing rocks • Providing training and equipment to fishers to breed shrimp fry • Increasing productivity and efficiency of the fishing industry • Closing shrimp farming and exploring the growth of tilapia • Minimising intermediate trade • Joint efforts by all stakeholders related to the reservoir	• Stocking finfish at a level comparable to shrimp • Linking buyers • Creating markets • Controlling illegal fishing • Cultivating shrimp only in selected areas of the reservoir • Distinguishing between shrimp and fry • Providing food for shrimp • Predator control and marketing • Covering the hatchery and hatchery • Strengthening fishing associations to finance investments in fry • Replacing grown shrimp fry

incomplete knowledge of the biological process, and an increase in the proportion rejected by buyers from the total harvest), the supply of GFP is not stable due to the decrease in yield and price levels, especially in a monopolistic market situation, which inevitably leads to a reduction in income. Accordingly, savings decrease, and investment capacity decreases. Meanwhile, long-term input subsidies (through purchasing agencies or government programs) do not encourage investment, and the lack of a business plan due to the reliance on subsidies has been identified as the main impact, leading to a decline in income (Figure 5.3.7).

Conclusion

Although freshwater production in Sri Lanka operates under the name of the 'culture-based fisheries industry', it is still not a competitive production 'industry' or system aimed at maximising private profit, but rather a source of livelihood. CBF are considered a semi-industry with those who do not operate on a systematic business plan, depend on daily income, have more members engaged in fishing activities (in small and medium irrigation reservoirs) than regular members, do not have enough information to make sound savings and investment decisions, and have minimal

use of modern technology. In addition, there is no approach to implementing co-management methods or internationally accepted small-scale fisheries guidelines.

Considering the annual fish production, finfish and GFP production at all irrigation reservoirs are at a level that needs further improvement. Although CBF are not considered a source of nutrition, more than 50% of the annual fish production is sold for local fish consumption. Accordingly, finfish production is supported as a source of protein for the rural community and GFP production is directed to high-income consumers or export markets. Although there is a slight increase in rural demand for GFP consumption, mostly only GFP is marketed in rural areas and rejected by buying agencies or agents.

The use of illegal fishing gear and illegal fishing were identified as major problems in all irrigation reservoirs and these problems were reported in 100% of major irrigation reservoirs. Although the control of illegal fishing activities is the duty of extension officers – who are sometimes officers who implement the law while also implementing welfare policies. Therefore, the dual nature of the duties of the extension officers is a hindering factor to uplift CBF activities effectively. The relationship between farmers' organisations and fisheries societies is distant. However, the relationship between farmers and fisher's groups is more important because the water management decisions in the irrigation reservoirs are curtailing factors for CBF.

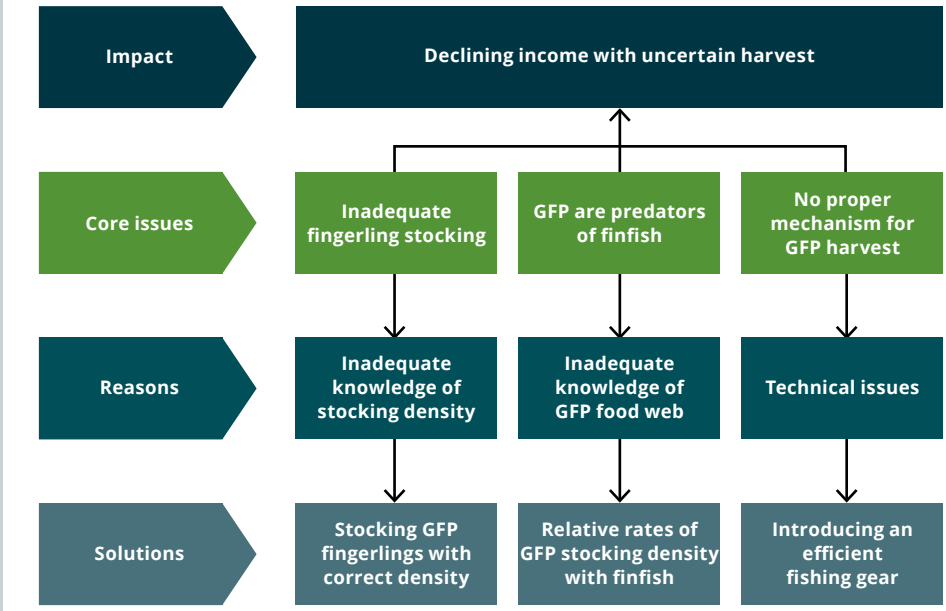

Figure 5.3.7: Problems, causes, solutions and impacts for GFP production

About 70% of fishers in minor irrigation reservoirs have no idea about GFP and 60% of fishers in large irrigation reservoirs understand GFP farming. Reservoir water use in agriculture, CBF and GFP farming are intertwined. Therefore, the rural consumer community, farmers' organisations and members of the fisheries groups are the key stakeholders in CBF and GFP production. Their interest in CBF and GFP farming is an important factor affecting the development of the industry. The need for some financial or social benefit exchange between fishing societies and farmers' organisations is important because it provides social protection for maintaining CBF farming. The agrofishery integration can be used as a tool in the 'irrigation reservoir culture' and is important as a tool that can be used to reduce social conflict and influence water management decisions.

Proper road facilities, information and communication are more important for the rapid development of CBF production as a product that targets the market. Since GFP production mainly targets the export market, the availability of adequate road facilities can lead to rapid growth of this industry. In addition, the rehabilitation of irrigation reservoirs has affected the decline of fish growth at certain times.

In the marketing of finfish and GFP, the fisher is a 'price taker'. Although some established mechanisms can be seen in the sale of finfish in all the irrigation reservoirs, various uncertainties must be faced in the sale of GFP. Agreements where a specific company agrees to stock GPF fingerlings for irrigation reservoirs and sell its harvest to that agreed company can lead to a problematic situation in the GFP market and it can hinder the creation of a fully competitive market. However, the demand for freshwater fish still has an excess for local consumption. Therefore, there is a good market potential for freshwater finfish production in the local market.

More important than enumerating the problems common to the 48 irrigation reservoirs was the identification of problems aligned by impact. Depending on the type of reservoir, the main problems of GFP farming are unique. Accordingly, fishers in minor irrigation reservoirs do not have enough knowledge about shrimp farming. The common reasons for medium irrigation and large irrigation reservoirs are the lack of breeding/stocking capacity for fishers, and the reduction of available breeding centres and the transport costs of fingerlings, as well as the missing opportunities to stock fingerlings at the right time. In addition, due to the spread of these irrigation reservoirs in a large area and the number of landing sites being more than one, the risk management of the production is minimal, and a systematic work plan has failed to protect the yield. Also, every fishing committee prepares a fund by saving some money from the commission tax but there is great reluctance to spend the money, especially for stocking GFP fingerlings in the face of uncertainty. The local consumption demands the tilapia species; therefore, tilapia production should be considered as an essential requirement at the reservoir level.

Based on the knowledge and experience of the fishers, many suggestions were made for the existing problems of GFP farming. Considering the usefulness of suggestions, these should be implemented as an active experimental exercise with the fishers before putting it into practice. Even so, it was possible to observe several steps to be taken to make the existing extension service effective and efficient. There is a possibility of finding solutions with the coalition of all the stakeholders using the irrigation reservoirs through the business plans related to the respective irrigation

reservoirs, by streamlining the extension services, and so on.

As a result of an uncertain production process, supply is unstable due to reduced yield and price levels, especially in a monopolistic market situation, which can inevitably lead to lower income. As a result, savings will decrease and investment power will decrease. Meanwhile, due to ongoing input subsidies, there is no incentive to invest and the lack of a business plan due to reliance on subsidies has been identified as the main impact of lower income. Community perceptions and expectations play a decisive role in the efficiency and sustainability of CBF. Strategies that centre on participatory engagement, capacity building, equitable benefit distribution and responsive governance systems are essential to align CBF production goals with local realities.

Recommendations

1. To improve the productivity, efficiency and sustainability of finfish and GFP farming in the CBF industry, the existing economic efficiency (technical and allocative) and productivity, and factors affecting these, should be studied.
2. Policies should be formulated based on empirical information on stocking, harvesting techniques and bioeconomic relationships to sustain CBF.
3. Maintain a program as an industry with investments based on member funds according to a business plan with the participation of the farmer and fisher groups related to the respective irrigation reservoirs. The need for rural protein should be prepared as a program that can be maintained as an industry with the participation of the respective reservoir-related farmer and fisher groups.
4. The following alternative methods are suggested to ensure a regular and efficient supply of finfish and GFP fingerlings:

   4.1 A hatchery centre of the NAQDA should be set up in each district extension area, whereby the fish fry at the initial stage should be bred and the responsibility of growing them to a size suitable for stocking should be assigned to the fishers of the medium irrigation reservoirs individually or collectively. Grown fish fingerlings should be sold from those irrigation reservoirs to fishers in minor irrigation reservoirs at a cost-based price. However, some financial return from the hatchery sales revenue is proposed to be paid as an incentive allowance to the employees and officers engaged in the work.

   4.2 Encouraging rural investment for private-sector breeding opportunities and improving the supply of fish fingerlings, thereby creating rural employment opportunities.

   4.3 Members (including women members) with capacity, access, and experience in irrigation reservoirs should guide the NAQDA with knowledge and facilities for fry to fingerling.
5. For a more efficient district-level extension officer service, an understanding of problems and needs, participatory action research knowledge and rural social and communication skills should be developed. In addition, the district-level extension officer service should be implemented in an insurance policy.

6. Agreements for a specific company to stock fingerlings for irrigation reservoirs and to sell their harvest to that company may stop and fishers should have the freedom to sell their product for a higher price.
7. Inactive fisher members are hampered and should be discouraged through an annual membership revision. The resources of the industry should be effectively managed to maintain the welfare of fishers as well as the sustainability of fish production.
8. The NAQDA should be made into a revenue-generating institution that can gradually reduce its dependence on public finances. It is suggested that the fisheries industry and NAQDA should make interdependent structural reforms.
9. Since the rural consumption demand around each reservoir is highly concentrated for the tilapia species, it is suggested that breeding should be done using the seeds obtained from the most suitable broodstock and for that, a method based on scientific research information should be maintained.
10. By providing free or subsidised fish fry, the responsibility of the industry is absolved by the fishers, and there should be a program where the right and responsibility of the investment is transferred to the fishers.
11. GFP farming should be considered as a more suitable alternative livelihood for women as a fishing industry with the ability to earn more income in less time while maintaining their household activities.

Finally, community perception, expectation and local knowledge are key to the successful CBF development of the irrigation reservoirs in Sri Lanka.

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5.4 Institutional robustness markedly aids in managing the long-term culture-based fisheries in selected dry zone reservoirs of Sri Lanka

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Abstract

Developing CBF in Sri Lanka's inland reservoirs represents a promising strategy for enhancing rural livelihoods, food security and sustainable fisheries management. This study assesses the institutional arrangements governing CBF in 23 irrigation reservoirs across 6 administrative districts of Sri Lanka, applying Ostrom's modified design principles for common-pool resource management as the analytical framework. Primary data were collected through semi-structured interviews, focus group discussions, participant observation and key informant interviews, with compliance levels evaluated using a 5-point Likert scale. The study confirms that fishers govern the fisheries through self-governing institutions. Results further highlight the critical role of Rural Fisheries Organizations (RFOs) in ensuring community participation, enforcement of fishery regulations and equitable benefit distribution. Community-based management structures facilitate the effective regulation of fishing practices and resource monitoring, but challenges persist in areas such as inter-organisational collaboration and legal enforcement against non-member infractions. The study highlights the significance of nested institutional arrangements, local governance legitimacy and supportive policy frameworks in maintaining CBF systems. Findings contribute to the growing literature on decentralised fisheries management and offer practical insights for enhancing institutional resilience in the CBF sectors.

Keywords: *aquaculture, fisher communities, inland fisheries, Sri Lankan reservoirs, stocking*

Introduction

Global demand for fishery products is expected to be largely supported by the growth of aquaculture production. Decentralisation, climate change, demographic transition and resource user rights influence the contributions of aquaculture to poverty alleviation, but

the mechanisms defining these influences are poorly understood. In addition to the challenges that can hinder contributions of aquaculture to poverty alleviation, aquaculture development poses threats to the environment (Costa-Pierce 2002). Therefore, engaging in environmentally friendly and efficient approaches that consider the interlinked social factors in accounting to enhance fish production is essential. CBF in inland waters are recognised as an environmentally friendly method for fish production that also supports poverty alleviation (De Silva 2003).

Sri Lanka is a country rich in irrigation reservoirs that vary significantly in size, age, hydrology and catchment characteristics. The cumulative area of these reservoirs is approximately 260,000 ha, which is categorised into perennial and seasonal reservoirs based on their hydrological regimes (Pushpalatha and Chandrasoma 2010). Perennial reservoirs are classified into 3 categories based on the extent of water spread at full supply level: major (>800 ha), medium (200–800 ha) and minor (<200 ha). Seasonal reservoirs are small bodies of water that are less than 30 ha in size and can retain water for 8 to 10 months. Almost all Sri Lankan reservoirs have been constructed in the past primarily for irrigating paddy fields. The country's dry zone has more than 10,000 small village reservoirs (Pushpalatha 2001). In these seasonal reservoirs, strategies for CBF are well established (Amarasinghe and Nguyen 2010). The NAQDA of Sri Lanka has initiated a program to introduce CBF in minor perennial reservoirs across Sri Lanka. The fish fingerlings of catla (*Catla catla*), rohu (*Labeo rohita*), common carp (*Cyprinus carpio*) and Nile tilapia (*Oreochromis niloticus*) are introduced into irrigation reservoirs (Pushpalatha and Chandrasoma 2010). Recently, NAQDA also initiated the stocking of post larvae of the GFP, *Macrobrachium rosenbergii*, in several reservoirs, which has begun to gain momentum in CBF.

As Sri Lanka has plenty of reservoirs, CBF development in village reservoirs has a positive impact on enhancing inland fisheries. Rural development activities involving artisanal fisher communities and agricultural farming communities are essential strategies for CBF development in inland reservoirs (Amarasinghe and Nguyen 2010), and community participation is also a crucial component for success and sustainability (Pushpalatha et al. 2020). This approach is thought to be for ensuring the sustainability of resources by self-organising resource use mechanisms as an alternative to centralised management mechanisms, which involve imposing regulations by the fisheries authorities. In irrigation reservoirs utilised for CBF development, NAQDA, through its extension arm, has established fisheries management societies. These community-level institutions can thus be viewed as grassroots units for empowering communities in the management decision-making processes. The success of the management depends on the robustness of the institutions. Ostrom's design principles (Ostrom 1990) can be used to evaluate the robustness of the institutions managing common-pool resources (CPR), such as fisheries. Eight design principles of Ostrom are expanded to 11 principles by Cox et al. (2010) to investigate the strengths and weaknesses of institutional arrangements in community-based management of natural resources. Rural communities manage CBF systems, similar to traditional capture fisheries (Amarasinghe and Weerakoon 2009). The present study reveals the robustness of the self-governing

institutions that govern the CBF of dry zone reservoirs in Sri Lanka.

Materials and methods

Study sites

The study was carried out in 23 irrigation reservoirs located within 6 administrative districts in Sri Lanka (Figure 5.4.1).

Data collection

A questionnaire survey was conducted through a series of interviews (Pushpalatha et al. 2020). Data collection continued until the researcher felt comfortable that the desired saturation level had been achieved. The respondents for this study were selected based on their voluntary participation in the data collection process. Accordingly, Table 5.4.1 shows the number of fishers who participated in data collection at the study reservoirs.

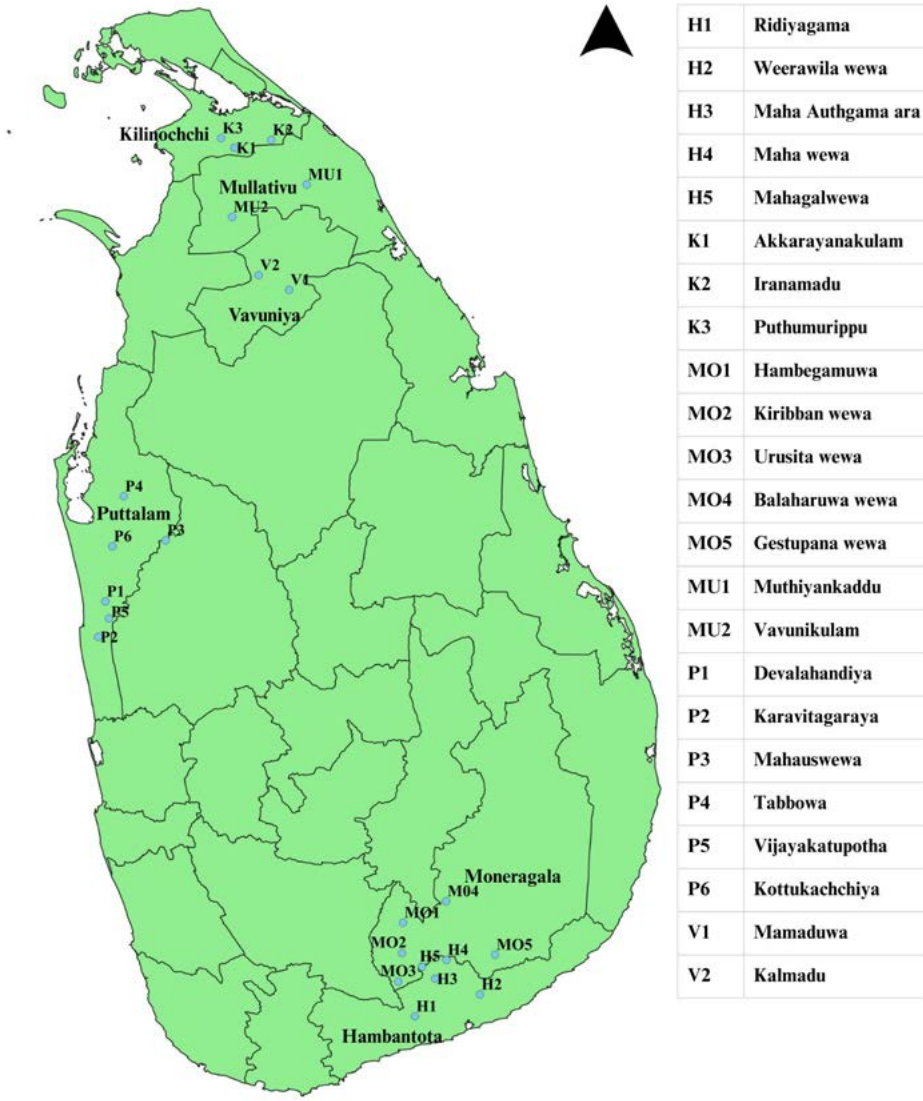
Primary data were gathered through (1) semi-structured interviews, (2) participant observation, (3) focus group discussions, and (4) key informant interviews. Semi-structured interviews served as the primary instrument for data collection, widely recognised as a standard ethnographic method for gathering information in an open-ended format. A questionnaire was prepared to collect relevant data aimed at identifying the characteristics of the prevailing management system of CBF. Ostrom's modified design principles were employed as benchmarks to assess the community-based governance of CBF in study reservoirs. Consequently, a tool was developed to evaluate robust compliance with the modified design principles. In this context, a total of 3–6 components were prepared for each design principle. For example, design principle 1A is characterised by 4 components, including whether:

1. clearly defined user boundaries exist
2. non-appropriators accept the user boundaries
3. government authorities acknowledge the user boundaries
4. the user boundaries are employed for resource management purposes.

All components were pre-tested before final evaluation. In the final assessment, a 5-point Likert scale was applied as a psychometric approach (Likert 1932), constructed with a 5-point hedonic scale ranging from very prominently exist (value 5) at one end to non-exist (value 1) at the other end, with values 4, 3, and 2 assigned to reflect 'prominently', 'moderately', and 'slightly' exist, respectively. Each component was then assigned the corresponding value (from 1 to 5 on the Likert scale) based on the information extracted from the fishers and the researcher's observations and experiences. The veracity of the compliance level assigned by researchers was verified with community leaders and the aquaculture extension officer in the area. All interviews and discussions with respondents were conducted in the native languages of fisher communities – either Sinhalese or Tamil.

Data analysis

The information gathered was categorised into the principal organisational characteristics of community-based fisheries management systems proposed by Ruddle (1994) for coastal fisheries systems. To evaluate the compliance level of the prevailing institutional architecture of the governing system, overall mean values for each component and the design principle at each study site were computed to describe the level of compliance of each design principle, which were collected through interviews with traditional fishers and key informants.



H1	Ridiyagama
H2	Weerawila wewa
H3	Maha Authgama ara
H4	Maha wewa
H5	Mahagalwewa
K1	Akkarayanakulam
K2	Iranamadu
K3	Puthumurippu
MO1	Hambegamuwa
MO2	Kiribban wewa
MO3	Urusita wewa
MO4	Balaharuwa wewa
MO5	Gestupana wewa
MU1	Muthiyankaddu
MU2	Vavunikulam
P1	Devalahandiya
P2	Karavitagaraya
P3	Mahauswewa
P4	Tabbowa
P5	Vijayakatupotha
P6	Kottukachchiya
V1	Mamaduwa
V2	Kalmadu

Figure 5.4.1: Map of Sri Lanka showing study reservoirs across 6 administrative districts

Table 5.4.1: The number of registered active fishers and the number of fishers interviewed for gathering requested information

No.	District	Reservoir type	Name of reservoir	Number of registered active fishers	Number of fishers interviewed
1	Hambantota	Major	Ridiyagama	47	12
2	Hambantota	Medium	Weerawila Wewa	39	11
3	Hambantota	Minor	Maha Aluthgam ara	18	8
4	Hambantota	Minor	Maha wewa	21	12
5	Hambantota	Minor	Mahagal wewa	31	10
6	Kilinochchi	Major	Akkarayankulam	24	8
7	Kilinochchi	Major	Iranamadu	60	15
8	Kilinochchi	Minor	Puthumurippu	21	12
9	Monaragala	Medium	Hambegamuwa	35	11
10	Monaragala	Medium	Kiribban wewa	24	8
11	Monaragala	Medium	Urusita wewa	31	9
12	Monaragala	Minor	Balaharuwa wewa	24	11
13	Monaragala	Minor	Gestupana wewa	8	8
14	Mullaithivu	Major	Muthiyankaddu	33	11
15	Mullaithivu	Major	Vavunikulam	38	9
16	Puttalam	Medium	Devalahandiya	26	9
17	Puttalam	Medium	Karavitagaraya	34	11
18	Puttalam	Medium	Mahauswewa	21	8
19	Puttalam	Medium	Tabbowa	41	15
20	Puttalam	Medium	Vijayakatupotha	35	13
21	Puttalam	Minor	Kottukachchiya	21	7
22	Vavuniya	Medium	Mamaduwa	18	8
23	Vavuniya	Minor	Kalmadu	19	15
Total				**669**	**241**

Results

Principal organisation characteristics

The study encountered 5 principal organisational characteristics proposed by Ruddle (1994) among the RFOs of the study reservoirs.

Authority

The RFO in each reservoir regulated fishing schedules, allowing netting activities in the evenings and fish harvesting in the mornings. To sustain its operational activities, the RFO maintained a financial fund, supported by a set membership fee and a fixed contribution per unit of fish harvested. These funds were designated for fish stocking and the overall management of the organisation.

Fishing rights
A structured fishing society was established for each reservoir, with membership being a prerequisite for participating in fishing activities. The constitution of each fishing society outlined the procedures for recruiting members into the RFO. In certain societies, membership was hereditary, with transfers occurring from father to son or, in cases involving female offspring, to the son-in-law. The general assembly of the RFO governed these inheritance-based admissions.

Rules and norms
RFOs enacted regulatory measures during monthly meetings, where new bylaws and operational protocols were established. In some instances, RFOs consulted extension officers of NAQDA to gain technical guidance for formulating these regulations.

Defining fishing boundaries: All reservoirs remained under governmental ownership and were managed by the Irrigation Department, the Mahaweli Authority and/or the Department of Wildlife Conservation. These agencies were responsible for delineating the boundaries. Seasonal fluctuations in water levels influenced the spatial extent available for fishing activities. Fishing boats (that is, fibre-reinforced plastic outrigger canoes) were employed for transportation within the reservoirs.

Eligibility rules: Eligibility criteria stipulated that individuals above 18 years of age, residing within the 'Grama Niladhari divisions' (that is, the smallest administrative unit in a village) bordering the reservoir, could apply for membership. Membership fees were mandatory, and each society-imposed restrictions on the number of fishers allowed, thereby limiting recruitment. These regulations were embedded within the constitution of the RFO and were endorsed by government officials and relevant stakeholders.

Intercommunity access rules: Individuals who were not members of the RFOs were granted limited access to fishing activities, specifically to use traditional fishing rods for subsistence or recreational purposes. However, those wishing to engage in fishing as a livelihood were required to obtain formal membership within the RFO. Admission as a member was contingent upon approval by the general assembly of the RFO, ensuring regulatory oversight and adherence to established community-based fisheries management protocols.

Gear rules: Fishing operations using gillnets were exclusively permitted for RFO members with valid fishing licences. Government regulations established a minimum mesh size for fishing; however, some societies opted for larger mesh sizes based on collective decisions within the RFO. Furthermore, operational guidelines restrict each member to a maximum of 6 net pieces, as specified in the fishing licence. Gillnets served as the primary fishing gear for harvesting. Nevertheless, some societies permitted specialised fishing techniques, such as striking the water with a lead ball attached to a string or wooden stick (Amarasinghe and Pitcher 1986) and utilising cast nets to capture native fish species like *Puntius dorsalis*.

Temporal allocation rules: The RFOs implemented a comprehensive regulatory framework outlining specific penalties for violations of bylaws. The nature and severity of each infraction dictate the appropriate sanctions. A notable form of disciplinary action includes the imposition of operational suspensions, whereby the violator's fishing vessel is prohibited from engaging in fishing activities for a specified period following its detention. These enforcement mechanisms aim to enhance regulatory compliance and support the sustainable governance of community-based fisheries.

Fishing behaviour rules: Harvesting operations typically occurred between 7 am and 10 am, during which fish were transported to designated landing sites for sorting by species and weight. Some RFOs facilitated wholesale and retail trade by purchasing catches from their members and selling them to external traders and local consumers. Other RFOs permitted direct transactions between fishers and buyers. After unloading the fish harvest, fishers cleaned and maintained their fishing crafts to ensure operational readiness and hygiene. Cultural and religious practices were also incorporated into their occupational routine before departing for fishing activities. Fishers commonly participated in religious observances. Notably, on 1 January, it was customary for them to allocate a portion of their income or resources as offerings to deities, accompanied by religious rituals, before commencing fishing activities for the new year. Fishing activities were occasionally suspended for religious observances. In predominantly Buddhist communities, fishing was forbidden on full moon (*Poya*) days each month. In mixed-religion societies, additional restrictions, such as bans on fishing during Easter, were enforced. The governing bodies of each fishing society established these regulations. Each fishing society upheld a code of conduct for its members, prohibiting activities such as fishing under the influence of alcohol (for example, Iramadu RFO).

Conservation rules: RFOs lacked an established framework for evaluating daily fish yield requirements and identifying fish aggregation sites. Barrier nets were installed at reservoir outlets and sluice gates to reduce the escape of stocked fish through the sluice gates. According to the Fisheries and Aquatic Resources Amendment Act No. 35 of 2013, it is possible to gazette the designation of fisheries management areas. It can enact laws to conserve natural resources.

Cost-benefit distribution rules: A standardised pricing mechanism was introduced at landing sites. Furthermore, RFO members were required to pay a levy for each kilogram of fish harvested, a regulation adopted by the RFO. This levy varied among societies and was allocated to the Aquaculture Revolving Fund, which financed the stocking of fish seed for CBF and welfare initiatives. Government and non-governmental organisations periodically provided financial assistance to these societies, with funds distributed among members according to proportional allocation models, often under government supervision. Additional financial resources were obtained from membership fees, penalties imposed on members breaching RFO regulations and external donations.

Monitoring and accountability

The Fisheries and Aquatic Resources Act No. 2 of 1996, along with various government gazettes, provided the legal framework for fisheries management. Compliance with these regulations was mandatory for all communities. Each fishing society adhered to the RFO constitution, and resolutions passed during official meetings became binding regulations. The NAQDA monitored compliance with fisheries legislation. Additionally, enforcement officers appointed under the Fisheries and Aquatic Resources Act No. 02 of 1996 facilitated regulatory oversight. Fishing societies designated officers to ensure adherence to internal regulations, with enforcement authority granted by the RFO constitution. The NAQDA also conducted inspections and regulatory enforcement activities in conjunction with other government agencies. Fishing societies organised

patrol teams to monitor compliance with regulatory mandates.

Conflict resolution and sanctions

The conflicts often arise from competition over water rights, land use, fishing territories, and differing perceptions of sustainability and resource management. To tackle these issues, conflict resolution strategies in Sri Lanka's CBF sector typically involve a mixture of mediation, stakeholder dialogue and community-based management approaches. Additionally, sanctions are enforced to address non-compliance with regulations and unethical practices that jeopardise the sustainability of CBF systems. These sanctions can include fines, licence suspensions, and more severe measures such as confiscation of equipment or legal prosecution. Implementing sanctions is essential for safeguarding aquatic ecosystems, preserving fish stocks and maintaining the social fabric of local communities. However, the effectiveness of these sanctions depends on transparent governance, active engagement of local communities in enforcement, and a robust legal framework that considers the socioeconomic dynamics of the region.

In the CBF industry, fishing organisations were responsible for developing and implementing regulations that govern the conduct of their members. These regulations were typically formulated in response to issues that arose during regular monthly meetings. When a conflict or concern was identified, the necessary steps to address the problem and the corresponding procedures for managing members who deviated from established rules were defined in accordance with these internal regulations. The primary focus of these regulations pertains to fishing activities and member participation within the association. The association imposes various penalties on members found to have violated the established rules, which may include monetary fines or temporary suspensions from fishing activities. However, enforcing these regulations requires the approval of at least two-thirds of the association's members during a general assembly, ensuring democratic participation in decision-making processes.

In instances where members fail to comply with imposed penalties, the leadership of the RFO may seek assistance from NAQDA officials for enforcement. Notably, the RFO possesses no authority to regulate illegal fishing activities conducted by non-members. Nevertheless, some fishing organisations implement surveillance measures, such as patrols, to protect their designated fishing areas. If unauthorised activities are detected, the association promptly informs the relevant government authorities for further action. Furthermore, in addition to the regulations established by the fishing organisations, national fisheries laws empower NAQDA extension officers to take necessary actions to protect and manage aquatic resources.

Institutional architecture and design principles

Evaluating institutional architecture with modified design principles reveals that 11 modified design principles were in place in the institutions governing the CBF of the study reservoirs in Sri Lanka. More importantly, the nested enterprises within these institutions were facilitated by the government's involvement and support in fisheries management, which was extended through the aquaculture extension officers. Legislative authority within the RFO was exercised through resolutions ratified by the general assembly. Government officials evaluated

the alignment of these resolutions with the Fisheries and Aquatic Resources Act. Additionally, RFO officers were appointed to oversee the implementation of RFO regulations. Conflict resolution mechanisms within the RFO relied on the leadership competencies of society representatives. However, the government had not granted formal jurisdiction to these societies for independent enforcement actions. While government officials supported ensuring compliance with the Fisheries Act, assistance in broader fisheries management remained limited. RFO members can influence policy decisions by passing resolutions. The effectiveness of society-led initiatives largely depends on the commitment and engagement of aquaculture extension officers. However, inter-organisational collaboration among different RFOs is minimal, and there are concerns that some RFO mergers are politically motivated. District-level and island-wide Fishermen's Associations show limited functionality. NAQDA appointed several officials, including aquaculture extension officers, district aquaculture extension officers, assistant directors, directors, and directors general, to assist in managing CBF. Additionally, designated officials responsible for overseeing CBF implementation in the Ministry of Fisheries and Aquatic Resources, the Provincial Ministry of Fisheries and the Mahaweli Authority were supported in fisheries management where applicable. Figure 5.4.2 illustrates the organisational hierarchy of NAQDA, the Provincial Ministry of Fisheries and the Mahaweli Authority.

Compliance with Ostrom's modified design principles

CBF demonstrated a strong adherence to principles such as clearly defined boundaries and collective choice arrangements, as local communities often manage fishery resources with established memberships and shared decision-making processes. The levels of compliance by institutional arrangements with most design principles vary from level 3 (moderate compliance) to level 5 (very prominent compliance). Design principles 7 and 8 showed moderate compliance (level 3) with the institutional architecture, while principles 2A and 4A demonstrated prominent compliance (level 4) with the local institutional arrangements. Design principle 6 exhibited either moderate (level 3) or prominent (level 4) compliance with institutions governing CBF in study reservoirs. The components evaluated under design principles 1A and 5 showed compliance levels ranging from level 3 (moderate) to level 5 (very prominent) in the institutions governing CBF. However, only the components assessed under design principle 2 demonstrated subtle compliance (level 2). The compliance level for each component evaluated under 11 design principles, along with the RFOs observed at each compliance level, is summarised in Table 5.4.2.

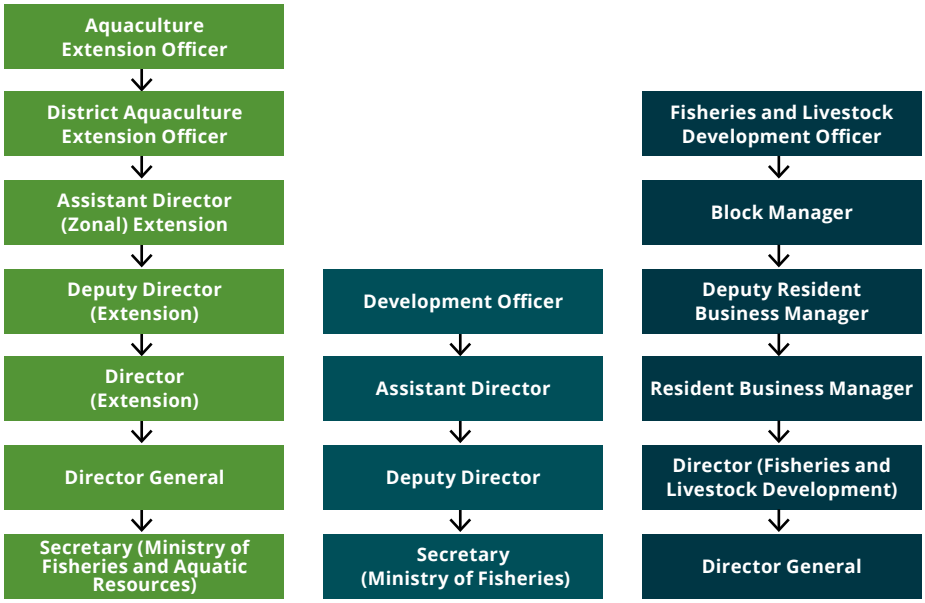


Figure 5.4.2: Organisational hierarchy (from lower level to higher position) of the NAQDA (left), Provincial Ministry of Fisheries (middle) and Mahaweli Authority (right), designated in supporting CBF management

Table 5.4.2: Level of compliance by component evaluated under 11 modified design principles, and RFO compliance level

Design principle	Components evaluated / examined	Level of compliance	RFOs / Reservoir
1A: Clearly defined user boundaries	Non-appropriators do not accept user boundaries User boundaries are not accepted by the government authority / legitimacy	3	H3, P3, H4, H1, H2
	User boundaries exist at proximity to the home User boundaries accepted by non-appropriators Getting membership from generation to generation	4	MO4, P1, MO1, V2, P2, MO2, H5, V1, K3, P4, MO3, P5
	The RFO recruits people above 18 years of age from the personnel of the 'Grama Niladhari division' domains bordering the reservoir User boundaries exist at proximity to the home	5	K1, K2, P6, MU1

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Design principle	Components evaluated / examined	Level of compliance	RFOs / Reservoir
1B: Clearly defined resource boundaries	There are no clearly defined resource boundaries	4	MU1, H1, K1, P1, P6, P3, V1, P4
	Government agencies have the power to control the reservoirs Those agencies have marked the boundaries of the reservoir	5	MO4, MO1, K2, V2, P2, MO2, H3, H4, H5, K3, MO3, H2, P5
2A: Congruence with local conditions	User rights are restricted to members of RFO	4	MO4, P2, P6, V1, K1, P1, MO1, K2, V2, MO2, H3, P3, H4, H5, MU1, K3, P4, MO3, H2, P5, H1
2B: Appropriation and provision	A certain amount is given to the RFO every month	4	V1, H3, H4, H2
	For every 1 kg of harvested fish, the fishers should give a certain amount to society	5	K1, MO4, P1, MO1, K2, V2, MO2, P3, H5, MU1, K3, P4, MO3, P5, H1, P2, P6
3: Collective-choice arrangements	RFO conducts activities according to the Fisheries Act	4	V1, P2, K3
	Members of the society have the right to make, enforce and amend existing laws without challenging the Fisheries Act	5	K1, H1, MO4, P1, MO1, K2, V2, MO2, P6, H3, P3, H4, H5, MU1, P4, MO3, H2, P5
4A: Monitoring users	The officials appointed by the RFO and the aquaculture extension officers of the NAQDA will check whether the fisheries activities are being done in the reservoir according to the legal framework The RFO has appointed a committee to monitor the fisheries, but the effectiveness of these committees is low, and there is no law enforcement power for non-members of the RFO	4	V1, V2, P3, K3, P4, MO3, K1, P1, P2, P6, H4, H5, MU1, P5, MO4, MO1, K2, MO2, H3, H2, H1
4B: Monitoring the resources	The fisheries society does not care about the daily fish harvest There is no investigation of the places where fishing is A barrier net is applied to the sluice and spillway to prevent fish from escaping – Ridiyagama wewa, Mahagal wewa, Urusita wewa, Kottukachchiya Barrier nets are not allowed in sluice and spillway to prevent fish escape – Irrigation Department – Thabbowa, Maha Uswawa	2	P1, V2, P2, P3, P5, MO4, P6, H3, H4, K3, P4, MO3, H2, K1, MO1, MO2, V1, MU1, H1, K2, H5

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Design principle	Components evaluated / examined	Level of compliance	RFOs / Reservoir
5: Graduated sanctions	RFO formulates fishing rules, but the implementation process is weak	3	P4, P2, H3, H4
	RFO formulates and implements fishing rules through a collective agreement	4	K1, P1, MO1, V2, V1, MU1, P5
	RFO officers are appointed to implement and monitor the rural fisheries organisation system, and it is monitored by the aquaculture extension officer	5	MO4, K2, MO2, P6, P3, H5, K3, MO3, H2, H1
6: Conflict resolution mechanisms	Society assists government officials in making submissions under the Act The government has not delegated any special powers to the RFO	3	V2, P6, H3, V1, H1, K1, P2, P3, H4, MU1, P4, H2, P5
	It is decided based on the leadership qualities of the relevant organisation's officials to resolve the conflicts of RFO members and to take appropriate action for those who do not follow the rules	4	MO4, P1, MO1, K2, MO2, H5, K3, MO3
7: Minimal recognition of the right to organise	RFO members can pass resolutions of the RFO The government recognises the right of RFO members to self-governance There is a collaborative decision-making process between the RFO and government officers	3	V1, P1, P3, H1, H4, H5, MO4, MO1, P4, H2, P5, P2, V2, H3, K1, K2, MO2, P6, MU1, K3, MO3
8: Multi-level institutional structure	Vertical integration between one RFO and another RFO is minimal Officials have been appointed at various levels under the Fisheries Ministry, and officials from the Mahaweli Authority and the Provincial Fisheries Ministry Office have also been appointed for this purpose There are organisations at the district level covering the entire island, and these organisations are less active	3	K1, MO1, V2, P2, MO2, H3, H4, V1, MU1, K3, P4, MO3, P5, MO4, P1, K2, P6, P3, H5, H2, H1

Note: refer to Figure 5.4.1 for the names of study reservoirs where the community organised as RFOs in managing fisheries.

Discussion

CBF have been recognised as an effective means of providing a reliable supply of protein in rural areas at an affordable price. CBF also offer rural dwellers employment and supplemental income by strengthening their economy. The key factors for the successful implementation and sustainability of CBF in perennial reservoirs include the existence of active community-based organisations and their involvement in the planning and execution of CBF, adequate stocking of fish species and the establishment of a proper legal framework that facilitates the implementation of CBF (Chandrasoma and Pushpalatha 2018). In agreement with Pushpalatha et al. (2020), the findings confirm that self-governing institutions govern CBF in dry zone reservoirs of Sri Lanka. In this context, RFOs play a primary role as the authority in governing fisheries. Government support, provided through its bureaucratic officers, such as aquaculture extension officers, is significant in the process, primarily through the legitimacy it affords, which helps manage fisheries in the long run. As a communal activity, equity-sharing mechanisms for the benefits derived from CBF are essential for their sustainability. Therefore, effective community participation in the entire process, from stocking and harvesting to marketing and adopting mechanisms that strengthen the community's financial status, helps achieve equitable procedures for sharing the social and economic benefits of CBF. Effective conflict resolution heavily relies on local knowledge, which fosters cooperation through shared decision-making processes and ensures equitable access to resources for all parties. However, limited resources and informal enforcement mechanisms hindered effective compliance with the law, resulting in weaknesses in monitoring and sanctions. Dispute resolution mechanisms were often informal, making it difficult to resolve disputes effectively. The government advisory support helps effectively implement the sanctions. There was also partial compliance with the principle of proportionality between costs and benefits, as fishers generally contribute equally to fish stocking efforts, but not for sharing the harvest. The sustainable fishing practices in CBF affirm that bottom-up mechanisms effectively manage fisheries, for which government bureaucratic support is integral.

The results divulge that institutions governing the CBF in dry zone reservoirs are aligned with the design principles of Ostrom (1990) and Cox et al. (2010), indicating well-recognised institutional arrangements. The existence of all design principles in institutional arrangements is evident, indicating that self-governing institutions have been formed with consideration for the socioeconomic aspects of the fisheries. The higher compliance of institutional arrangements with design principles indicates that institutions have evolved over time, providing maximum benefits to stakeholders. In this context, nested enterprises within institutional arrangements substantially support the formulation of robust institutions in the long run. Government support has become an integral part of the CBF, and the support of the officials in the appropriate government hierarchy in managing the fishery successfully is commendable. The high compliance further confirms that CBF in dry zone reservoirs are well established, with the knowledge gained and accumulated through engagement and management of the fishery. In light of the discussion, fishery associations govern the fisheries, maximising benefits for the appropriators, which aids in developing robust institutions for managing these resources.

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