1.2 Status of Sri Lankan culture-based fisheries: an overview

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Abstract

In Sri Lanka, due to the extensive availability of productive reservoir resources, there is a high potential for the development of CBF. With concerted research and development efforts on this fisheries enhancement strategy, CBF development in inland reservoirs is gaining momentum. In small village reservoirs of the country, there are no established fisheries and as such, CBF development in such reservoirs involves mobilising agricultural farmers to adopt this activity. In perennial reservoirs on the other hand, where there are established fisheries, fishers should be motivated to adopt CBF technologies. Giant freshwater prawn, *Macrobrachium rosenbergii*, is also used for CBF development in many reservoirs. Presently, freshwater prawn is caught as incidental catch in gillnets targeting finfish varieties. It is necessary to introduce an effective method of harvesting freshwater prawn, such as traps. Optimal stocking densities in relation to biological productivity of water bodies, post-harvest product qualities, bioeconomic aspects of CBF, value chain analysis, gender-related aspects and livelihood analysis, are the aspects that are effectively addressed by the research and development (R&D) project of ACIAR. Most importantly, there should be strategies for addressing the issue of fingerling scarcity, and for strengthening the extension mechanism of the National Aquaculture Development Authority (NAQDA) to introduce effective co-management for sustainability of CBF in Sri Lankan reservoirs.

Introduction

Intensification of food production systems has become an urgent need to feed humankind, and CBF are relatively environmentally friendly fisheries enhancement strategies to contribute to this need (De Silva 2003 and 2016). CBF development in the multitude of reservoirs is a recent trend in the Sri Lankan inland fishery sector (Wijenayake et al. 2005; Amarasinghe and Nguyen 2010; Amarasinghe and Wijenayake 2015; Pushpalatha and Chandrasoma 2010). Generally, CBF is recognised as a strategy which involves release of hatchery-reared fish fingerlings and/or post larvae of culturable species such as freshwater prawns to open water such as reservoirs for subsequent capture. In Sri Lanka, CBF development in irrigation reservoirs is gaining momentum (Amarasinghe and Nguyen 2010; Amarasinghe et al. 2022; Kularatne and Amarasinghe 2025), and this contribution is an overview of CBF in the country.

Water resources for CBF development

The extant freshwater resources in the country, except for lotic systems such as rivers, streams and standing lentic waters such as floodplains, are exclusively formed by ancient irrigation reservoirs and recently

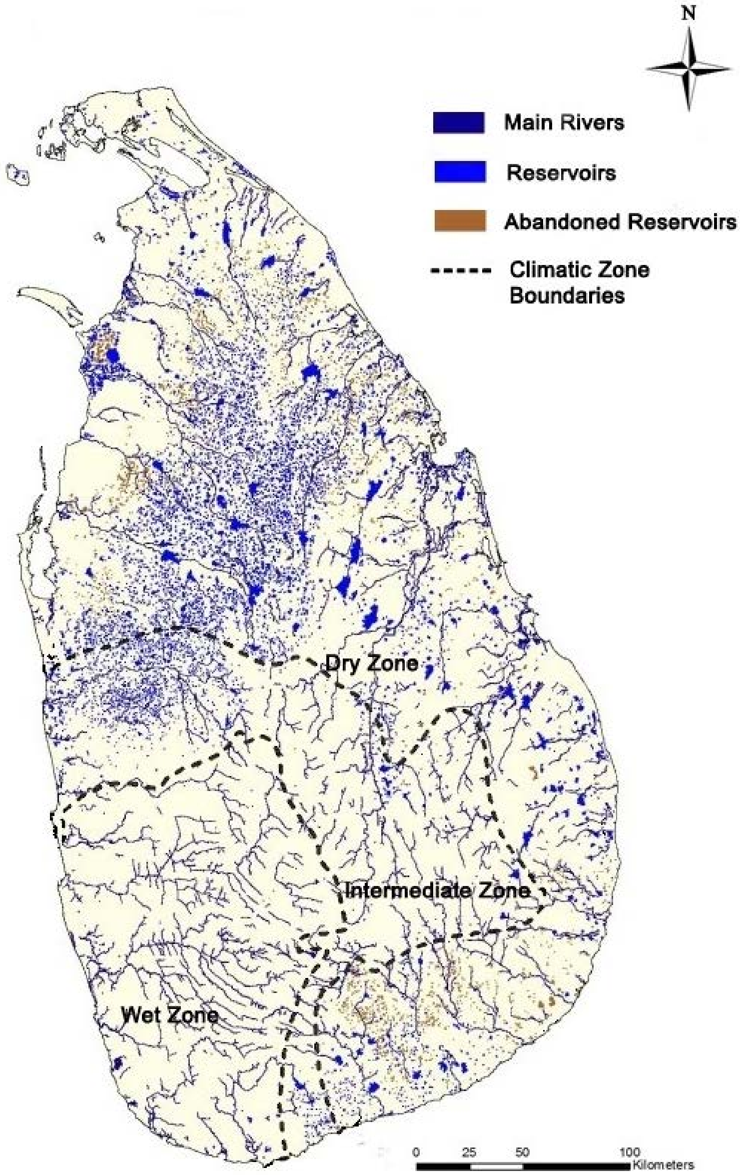

Figure 1.2.1: Rivers and reservoirs in Sri Lanka (source: Jayasinghe and Amarasinghe 2018)

built multipurpose (mainly for generation of hydroelectricity) reservoirs. The cumulative extent of these reservoirs is estimated to be around 206,000 ha (Jayasinghe and Amarasinghe 2018; Figure 1.2.1), which forms about 3.1 ha for every km^2 of the island, perhaps the highest density of standing waters in the world (Fernando 1990). These reservoir resources of the country provide vital opportunities for the development of CBF. The reservoirs of Sri Lanka can be broadly divided into 2 categories:

a. small village reservoirs

b. perennial reservoirs.

Small village irrigation reservoirs

Small village irrigation reservoirs (SVIR) are those which consist of irrigable areas less than 80 ha. They are situated in the low rainfall zones of the country receiving less than 175 mm annual precipitation. These water bodies come under the jurisdiction of the Department of Agrarian Development. Mendis (1965 and 1977) has shown that as these water bodies, most of which go dry during the dry season in August to October, are biologically productive and that they can be utilised for stocking fish fingerlings for subsequent harvesting. Based on these findings, Rosenthal (1979) and Oglesby (1981) recommend adopting this strategy, which was subsequently adopted by the fisheries authorities as a means of inland fisheries development in Sri Lanka (Thayaparan 1982).

However, there are no established fisheries in almost all, if not all, SVIRs, and the water uses of reservoirs are managed by farmers' organisations (FOs) established under the legal provisions of Agrarian Development Act No. 46 (2000) and the Agrarian Development (Amendment) Act No. 46 (2011). Under these Acts, there are legal provisions for the FOs to incorporate CBF as a community-based activity during the planning stage of an irrigation schedule for the 2 cultivation seasons in the command areas of each reservoir. In this context, CBF activities in SVIRs are jointly facilitated by the Department of Agrarian Development and NAQDA. A research project funded by ACIAR was instrumental to formulate scientifically sound better practice approaches for CBF development in these village reservoirs without interfering with ongoing agricultural farming practices (Amarasinghe and Nguyen 2010; Amarasinghe and Wijenayake 2015).

Perennial reservoirs

Unlike SVIRs, there are established capture fisheries in perennial reservoirs. Although the primary uses of these reservoirs are to irrigate agricultural lands and/or to generate hydroelectricity, they are secondarily utilised for the development of inland fisheries. Development of reservoir fisheries in Sri Lanka is a relatively recent development after the introduction of exotic cichlid species, *Oreochromis mossambicus* in 1952 and *O. niloticus* in 1975 into Sri Lankan freshwaters (Amarasinghe et al. 2022). Trends in the inland capture fisheries production, mainly based on the self-recruiting exotic cichlid stocks, are documented by Amarasinghe and Weerakoon (2009) and Amarasinghe et al. (2022). The perennial reservoirs of Sri Lanka are broadly categorised for irrigation purposes as minor (<200 ha), medium (200–800 ha) and major (>800 ha) reservoirs. These categories are also used by NAQDA for fisheries development purposes. Initial preliminary attempts to develop CBF in perennial reservoirs were made by Illukkumbura (1986) and Chandrasoma (2007). Pushpalatha and Chandrasoma (2010) also reported results of CBF activities in several minor perennial reservoirs of the country.

CBF management in reservoirs

As mentioned above, CBF development initially commenced in 1980s in SVIRs (Thayaparan 1982). As many of these village reservoirs are seasonal, with water retention period of 6 to 9 months, species suitable for CBF were essentially those which would grow to the marketable size within a short period, such as Chinese and Indian major carps and common carp. However, due to the absence of scientific inputs such as methodologies to select water bodies suitable for CBF development, lack of mechanisms for social mobilisation to get farming communities involved in the strategy, together with the abrupt government policy decision to discontinue state patronage for inland fisheries and aquaculture development during 1990 to 1994, CBF efforts did not sustain.

Renowned efforts for CBF development in irrigation reservoirs were made in the early 2000s based on the research findings of an ACIAR-funded R&D project, which were effectively utilised by an inland fisheries development activity under the auspices of the Asian Development Bank (ADB) (Aquatic Resources Development and Quality Improvement Project – ARDQIP) during 2002 to 2010. Under the ARDQIP, apart from CBF development in SVIRs, attempts were also made to introduce CBF to fisher communities in perennial reservoirs. CBF management approaches, however, are quite different in the 2 types of reservoirs due to the fact that the resource users in SVIRs are agricultural farmers without prior experience in fishing, whereas in perennial reservoirs, there are established fisher communities. In the following sections, these CBF management approaches are briefly mentioned.

CBF development in small village reservoirs

As most SVIRs dry off during August to October and get filled during inter-monsoonal rains in December to January, CBF planning should be based on a crop calendar where stocking should be done in January or so and harvesting after a growth period of 7 to 10 months (Wijenayake et al. 2021; Kularatne and Amarasinghe 2025). For this purpose, hatchery production of fish fry and rearing them up to fingerling size should be in tune with this period of fingerling requirement for stocking. The optimal stocking density of fingerlings of major carps was determined to be 2,500–3,000 per ha considering the effective reservoir area as 50% of the extent at full supply level (Wijenayake et al. 2005). In Sri Lanka, as in many parts of the world, stocked fish rely on natural food sources in the aquatic environment and as such, there is no supplementary feeding. As Chinese and Indian major carps with varying food habits are ideal candidates for simultaneous stocking, in conformity to the principles of polyculture (Bardach et al. 1972), and as cichlid species such as *O. niloticus* tend to mature early in small water bodies such as SVIRs, the CBF practices invariably stock fingerings of major carps depending on the availability in hatchery production. Since 2007 or so, NAQDA hatcheries have been producing fingerlings of the Genetically Improved Farmed Tilapia (GIFT) strain of *O. niloticus*. However, GIFT strain, which is suitable for aquaculture systems involving supplementary feeding, is not appropriate for stocking in CBF where they are incapable of competing with wild counterparts of fish to ingest natural food resources (Wijenayake et al. 2010).

For sustainable CBF in SVIRs, socioeconomic settings of farming communities play a major role. According to a socioeconomic analysis of agricultural farming communities in SVIRs where CBF was carried out, it was found that social mobilisation of rural communities to adopt CBF in village reservoirs would be easier when there are leadership qualities of members of aquaculture management committees (AqMCs), and good education levels among members of communities.

Kularatne et al. (2019) also evaluated technical efficiency of CBF in these irrigation systems and found that CBF production could be increased substantially with better management using existing technology and resources such as removing subsidies, improving consultation with extension officials and improving water user rights through introduction of a transferable community quota system. Furthermore, rainfall anomalies causing shifting of monsoonal rainfall pattern makes it difficult to plan CBF in SVIRs as the reservoir filling period cannot be accurately predicted (Wijenayake et al. 2021). Also, as the entire CBF activities in the country in different types of water bodies rely on induced breeding of major carps in state-owned hatcheries, fingerling scarcity is also a major constraint for further development of CBF in SVIRs, and as a result less than 6% of such water bodies are annually stocked (Wijenayake et al. 2021). It is also necessary that selection of suitable reservoirs for CBF development should be based on a multi-criteria decision-making approach consisting of several of those such as biological productivity, catchment land-use characteristics influencing nutrient enrichment in reservoirs, and socioeconomic factors (Wijenayake et al. 2016). Most importantly, there should be a mechanism for social mobilisation to adopt CBF by agricultural farmers through transforming agricultural farmers to fishers, and for introducing co-management where both resource users and government fisheries officials take equal responsibilities for management decision-making (Kularatne and Amarasinghe 2025).

CBF development in perennial reservoirs

Although preliminary attempts were made in the 1980s to develop CBF in perennial reservoirs, methodical stocking commenced in 2003 as part of the ADB-funded development project, ARDQIP, utilising knowledge gained through the CBF initiative in SVIRs. As mentioned above, unlike in SVIRs, where agricultural farmers without previous experience in fishing are mobilised to adopt CBF, in perennial reservoirs mobilisation of experienced fishermen to adopt CBF is necessitated. Also, due to the water availability throughout the year, unlike in many SVIRs where CBF strategies are to be dependent on the monsoonal rainfall pattern, CBF development in perennial reservoirs does not have to rely on rainfall pattern.

In selected minor perennial reservoirs, social mobilisation was facilitated through implementation of a community-based approach termed as introduction of a 'business plan' (that is, entrepreneurship plan; Wijenayake et al. 2021). In the social mobilisation approach, members of fisher communities are trained on leadership qualities, simple accounting, bookkeeping and so on (Amarasinghe et al. 2022). The CBF efforts in minor perennial reservoirs resulted in increased annual fish yield from 57.3 kg ha^{-1} to 208 kg ha^{-1}, resulting in a major contribution of stocked Indian major carps in the landings (Pushpalatha and Chandrasoma, 2010; Amarasinghe 2010). Pushpalatha et al. (2021) also reported spectacular increases of CBF production by 3,811% in Ampara wewa, 339% in Hambegamuwa, 502% in Jayanthi wewa, 414% in Senanayake Samudra and

216% in Urusita wewa, after introduction of CBF, showing the great potential for increasing inland fish production through CBF in perennial reservoirs. From these case studies, it was evident that the principal reason for success of CBF in these reservoirs was almost entirely due to the active participation of resource users (such as fishers) in management decision-making, the most important feature in fisheries co-management.

Giant freshwater prawn in CBF

NAQDA established a freshwater prawn (FWP), *M. rosenbergii* hatchery in Kandamodera, southern province in 2003 under the technical assistance of Food and Agriculture Organization (FAO), which has a production capacity of 17 million post larvae per year. Also, another FWP hatchery was established in Kallarawa in the eastern province, which has a capacity to produce 25 million post larvae annually. The FWP hatchery in Pambala, North Western Province produces 13.5 million post larvae annually. Also, there is a small FWP hatchery established by a private company. In the absence of well-developed aquaculture practices for *M. rosenbergii* in Sri Lanka, the oversupply of post larvae from the hatcheries was used for stocking in reservoirs to develop CBF.

Presently, FWP is caught as incidental catch in gillnets targeting finfish varieties. It is therefore necessary to introduce an effective method of harvesting FWP such as traps. Optimal stocking densities in relation to biological productivity of water bodies, post-harvest product qualities, bioeconomic aspects of CBF, value chain analysis, gender-related aspects and livelihood analysis are the aspects that are effectively addressed by the R&D project of ACIAR. When the cost of stocking of FWP incurred by the fisheries societies is compared with the value of FWP harvest that they receive at the landing sites, the CBF production of FWP in reservoirs appears to be close to economic breakeven point.

Recommendations for future strategies and conclusion

Due to concerted R&D efforts, CBF in Sri Lankan reservoirs are gaining momentum. However, there are certain issues that are needed to be addressed as short-term solutions for their sustainability. There are differences in CBF management strategies that are to be adopted for SVIRs and perennial reservoirs. In SVIRs, there are no established fisheries, and as a result, the agricultural farmers using water resources should be educated through social mobilisation approaches to practice CBF. In perennial reservoirs, however, there are established fisheries and as such, only the technicalities related to CBF should be introduced to those communities.

There are certain mistakes of fisheries and aquaculture authorities in CBF development activities. Despite scientific evidence indicating that the GIFT strain of Nile tilapia, suitable for aquaculture systems such as pond culture and cage culture where supplementary feeding is done, it is not suitable to use in CBF (Wijenayake et al. 2010), stocking of GIFT fingerlings in reservoirs has been continued. It is also a fact that at present, pure Nile tilapia broodstocks are not available at NAQDA hatcheries and import of pure Nile tilapia is a lengthy process. It is therefore recommended that Nile tilapia broodstocks are developed from the wild-caught specimens in large perennial reservoirs such as Padaviya, Senanayake Samudra, Kaudulla, and so on. On the other hand, all scientific evidence indicates that significantly higher increases in CBF production in perennial reservoirs is due to stocking of Indian major carps (catla, mrigal and rohu) and that tilapia stocking does not contribute significantly to increase of CBF production. While it is necessary to rebuild Nile tilapia stocks which have been deteriorated as a result of reduced genetic fitness caused by stocking of GIFT fingerlings in some reservoirs, proportion of stocking of Nile tilapia, where stocked, should be restricted only up to 10%.

As the size of fish fingerlings stocked in reservoirs is 5–6 cm, CBF harvests are heavily impacted by predation (Wijenayake et al. 2005). Stocking of advance fingerlings (>10 cm) is an effective means of overcoming this issue. As fry-to-fingerling rearing in floating net cages is already carried out in many reservoirs, this approach can be expanded to raise fingerlings up to bigger sizes (>10 cm) in net cages. It is possible to produce feed using hitherto unexploited or underexploited small indigenous fish species (SIS) occurring in reservoirs, to reduce feed cost. The dried fish powder of SIS can also be added to the fish feeds that are used for feeding fish fingerlings reared in floating net cages. Exploitation of SIS using small mesh (18 mm–37 mm) gillnets is possible without adverse effects on juveniles of finfish species in capture and CBF (Schiemer et al. 2024). For this purpose, legal provisions for exploitation of SIS using small mesh gillnets should be provided, which can easily be accommodated within the Fisheries and Aquatic (Amendment) Act No. 35 of 2013.

CBF production of *M. rosenbergii* in Sri Lankan is destined at the export market and as such, this CBF strategy supports fisher communities to uplift their living standards.

Another constraint to CBF sustainability is that in many parts of the country there are lower priorities for utilising SVIRs and perennial reservoirs for CBF mainly due to conflicting interests of multiple users (Amarasinghe et al. 2022). Furthermore, due to weakening of the extension mechanism in NAQDA during the last decade or so, the success of CBF development in the village reservoirs has shown a downfall. Hence, there should be strategies for addressing the issue of fingerling scarcity, and for strengthening the extension mechanism of NAQDA to introduce effective co-management.

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