Asian Fisheries Science **30** (2017):139−151

ISSN 0116-6514
E-ISSN 2073-3720
https://doi.org/10.33997/j.afs.2017.30.3.001

Asian Fisheries Science
The Journal of the Asian Fisheries Society

Impacts and Importance of Introduction of Culture-based Fisheries in Three Medium Sized Perennial Reservoirs in Sri Lanka

K.B.C. PUSHPALATHA[1*], JAYANTHA CHANDRASOMA[2], W.A.J.R. FERNANDO[1] and K. D. SANJEEWA[1]

[1]National Aquaculture Development Authority of Sri Lanka (NAQDA), 41/1 Parliament Road, Pelawatta, Battaramulla, Colombo, Western 11850, Sri Lanka
[2]153, Horana Road, Panadura, Sri Lanka

Abstract

Sri Lanka is endowed with a large number (>12,000) of irrigation reservoirs, which are primarily used for irrigation. Culture-based fisheries in perennial reservoirs are a recent development in Sri Lanka. The government of Sri Lanka has recognised culture-based fisheries as an effective way to increase fish supplies in rural areas at affordable prices, providing livelihood opportunities, strengthening rural economy and thereby contributing towards poverty alleviation. In this paper, the impact of the introduction of culture-based fisheries into three reservoirs, namely Amparawewa, Hambegamuwa and Aluthdiulwewa, is assessed. Introduction of culture-based fisheries resulted in significant increases in fish production in all three reservoirs. Stocking of Nile tilapia *Oreochromis niloticus* (Linnaeus 1758), catla *Catla catla* (Hamilton 1822), rohu *Labeo rohita* (Hamilton 1822), mrigal *Cirrhinus mrigala* (Hamilton 1822) and freshwater prawn *Macrobrachium rosenbergii* (De Man 1879) in these reservoirs resulted in positive monetary gains. Culture-based fisheries provided livelihoods for 55, 77 and 37 villagers in Amparawewa, Hambegamuwa and Aluthdiulwewa, respectively. Gross income generated from culture-based fisheries in these three reservoirs was 88.9 %, 68.1 % and 50.6 % of that of downstream paddy cultivation. Profits earned through culture-based fisheries in the three reservoirs were 133.2 %, 129.4 % and 86.3 % respectively of that of downstream paddy cultivation. Introduction of CBF in these three reservoirs resulted in increased availability of fish in rural areas, enhanced food security, more livelihood opportunities and strengthening of the rural economy.

Keywords: livelihood, rural economy, community based organisations

[*] Corresponding author. E-mail address: pushpakbc@gmail.com; pushpakbc@yahoo.com

Introduction

In Sri Lanka, reservoir construction and use have always been an integral part of human activity, with some major reservoirs being over 2000 years old. It is reported that Sri Lanka has over 12,000 reservoirs, with an estimated water surface area of 260,000 ha (Anonymous 2002). On average, reservoirs range in size from a few ha to 4,000 ha and, depending on the hydrological regimes, are either perennial or seasonal. For irrigation management purposes perennial reservoirs are classified into three broad size categories: large (>800 ha), medium (200–800 ha) and small (<200 ha).

Almost all reservoirs in Sri Lanka, barring a handful that have been impounded in recent decades for generation of hydroelectricity, have been primarily for irrigation. Reservoirs are secondarily used for inland fisheries and culture-based fisheries. Culture-based fisheries, a form of stocking and recapture that is managed communally, are essentially a form of extensive aquaculture which has several advantages over most other conventional forms of aquaculture, including being less resource intensive, utilising existing water resources, being technically far less complicated than conventional aquaculture, and being relatively easy to extend to farming communities (De Silva 2003, De Silva et al. 2006, Amarasinghe and Nguyen 2009). Culture-based fisheries involves planned stocking of water bodies that often results in sub-optimal fish yields, providing some degree of care of the stock, and ensuring ownership of the stocked fish. In culture-based fisheries the natural productivity of the water body is utilised by the stocked fish. As culture-based fisheries are relatively a low-cost activity, with the main external input being seed stock, most developing country governments regard culture-based fisheries as relevant to and an integral part of rural development (De Silva 2015). It is an environmentally acceptable practice with minimal external inputs (De Silva 2003). Culture-based fisheries is a very effective and non-consumptive secondary use of water resource for food fish production, and is not in conflict with downstream agricultural activities. In general, culture-based fisheries is practised in rural areas, where the bulk of water bodies suitable for such activities are located. Culture-based fisheries and/or related practices are becoming increasingly popular in many countries in Asia and are considered as appropriate strategies for improving food security in rural areas (see, for example, Lorenzen et al. 2001, Sugunan and Katiha 2004, Nguyen et al. 2005, Saphakdy et al. 2009, Lim Song et al. 2013, Phomsouvanh et al. 2015). Under the Aquatic Resource Development and Quality Improvement Project (ARDQIP) of the Ministry of Fisheries and Aquatic Resources of Sri Lanka, implemented during 2003–2010, emphasis was placed on the development of culture-based fisheries in perennial reservoirs. Since then the government of Sri Lanka has recognised culture-based fisheries as an effective means of increasing fish supplies in rural areas at affordable prices, while also providing livelihoods and additional income to rural farmers, strengthening rural economy and thereby contributing towards alleviation of poverty.

This paper evaluates the impact of the introduction of culture-based fisheries into three medium-sized perennial irrigation reservoirs. Impact assessment is based on evaluation of changes

in fish production, provision of livelihoods and income generation. Furthermore, economics of stocking and the contribution made by culture-based fisheries (non-consumptive secondary use of water) in the three reservoirs to the rural economy is also discussed in comparison with that of downstream paddy cultivation (consumptive primary use of water). It is expected that such a comparison will enable more effective coordination of the two activities that often come under the purview of different governmental authorities, and thereby facilitate both primary production activities catered to by a shared water resource.

Materials and Methods

Three medium sized perennial reservoirs, namely Amparawewa (240 ha) in Ampara district, Hambegamuwa (480 ha) in Monaragala district and Aluthdiulwewa (239 ha) in Anuradhapura district (Fig.1), were purposively selected for the study due to the fact that there are well-functioning Community Based Organisations in these reservoirs. The presence of effective mechanisms to record daily fish catch data in a log book or a computerised database also facilitated reliable data collection.

The main activities involved in the introduction of culture-based fisheries in perennial reservoirs are formation/ re-organisation and strengthening of fisher Community Based Organisations, planned stocking with suitable species of fish seed, introduction of fishery management measures with the participation of fishers, harvesting and data collection. Procedures adopted for the introduction of culture-based fisheries into perennial reservoirs and the role of fisher Community Based Organisations of the reservoirs have been described in detail previously (Pushpalatha and Chandrasoma 2009, Chandrasoma et al. 2015, Pushpalatha et al. 2015). Culture-based fisheries were introduced to Amparawewa and Aluthdiulwewa in 2007 and Hambegamuwa in 2008.

These reservoirs were stocked regularly with hatchery produced Nile tilapia, *Oreochromis niloticus* (Linnaeus 1758); catla, C*atla catla* (Hamilton 1822); rohu, *Labeo rohita* (Hamilton, 1822); mrigal, *Cirrhinus mrigala* (Hamilton 1822) and freshwater prawn, *Macrobrachium rosenbergii* (De Man 1879).

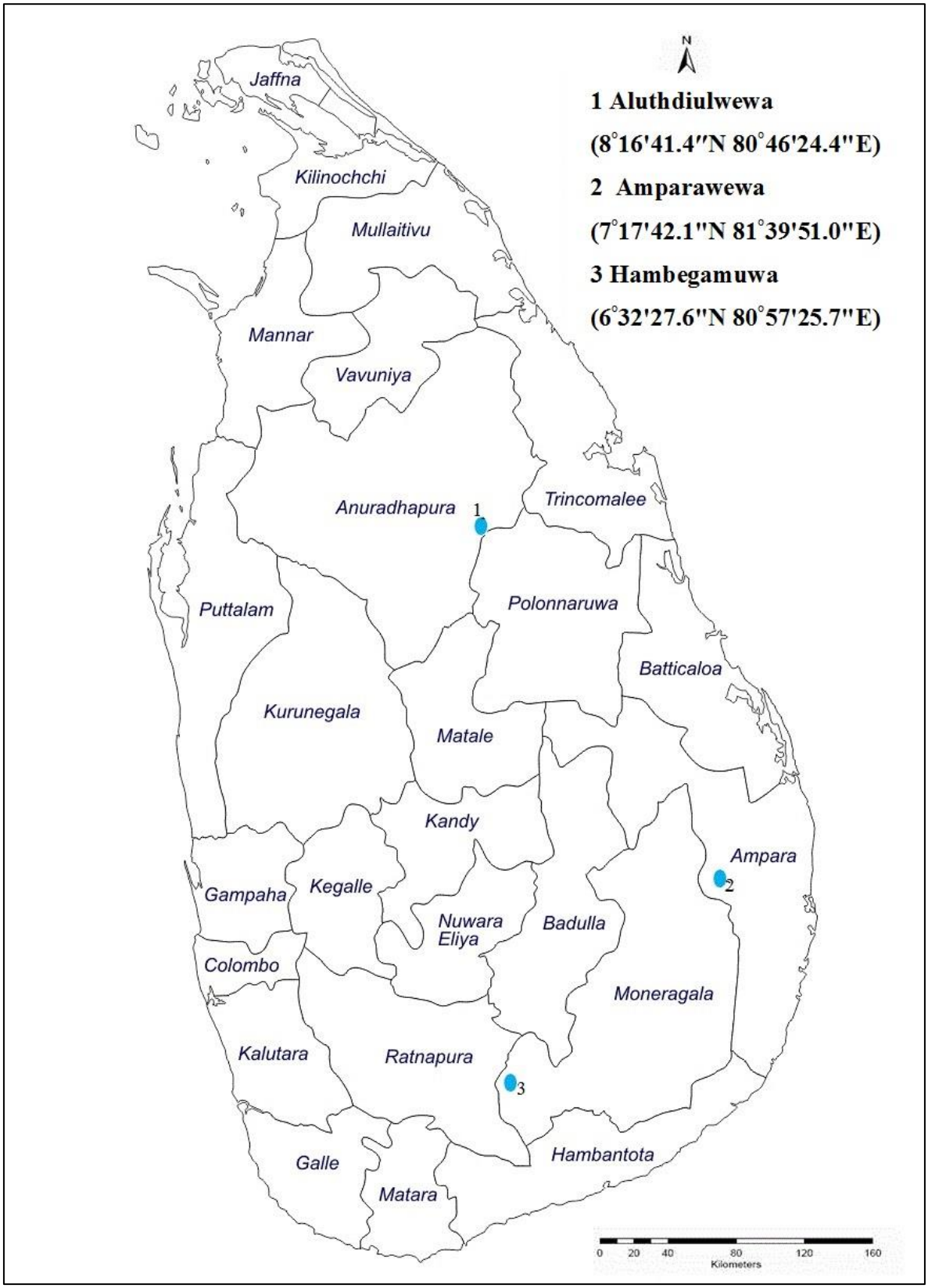

Fig. 1. Locations of reservoirs in Sri Lanka where culture-based fisheries was studied.

Harvesting of fish is a year-round activity in perennial reservoirs. Non-mechanised fibre-glass outrigger canoes are used for fishing. Fishing gear used are gill nets with stretched mesh sizes ranging from 115–200 mm. In general, each boat is operated by two fishers, who place their nets in the evening and haul them the following morning.

Since the introduction of culture-based fisheries, species-wise fish catch data were collected by respective fisher Community Based Organisations on a daily basis and maintained in a log book or in a computerised database. These data indicated the post-culture-based fisheries status and the relevant data on this activity were collated for 3 years from 2012–2014. Fish catch data available with fisheries extension officers prior to the introduction of CBF, for the period 2004–2006 were used to reflect the pre-culture-based fisheries status.

Information on the extent of lands cultivated under each reservoir was obtained from the relevant farmer organisations of these reservoirs, while information pertaining to yield, return, income, cost and profit from paddy cultivation for the period 2012–2014 (six cultivation seasons) given in the relevant publications of the Department of Agriculture of Sri Lanka (2013, 2014a,b, 2015a,b) was used for comparative evaluation of the economic gains/ losses.

Results

Fish production

Introduction of culture-based fisheries into the three reservoirs resulted in significant increases in fish production, compared to the pre-culture-based fisheries period (Fig. 2).

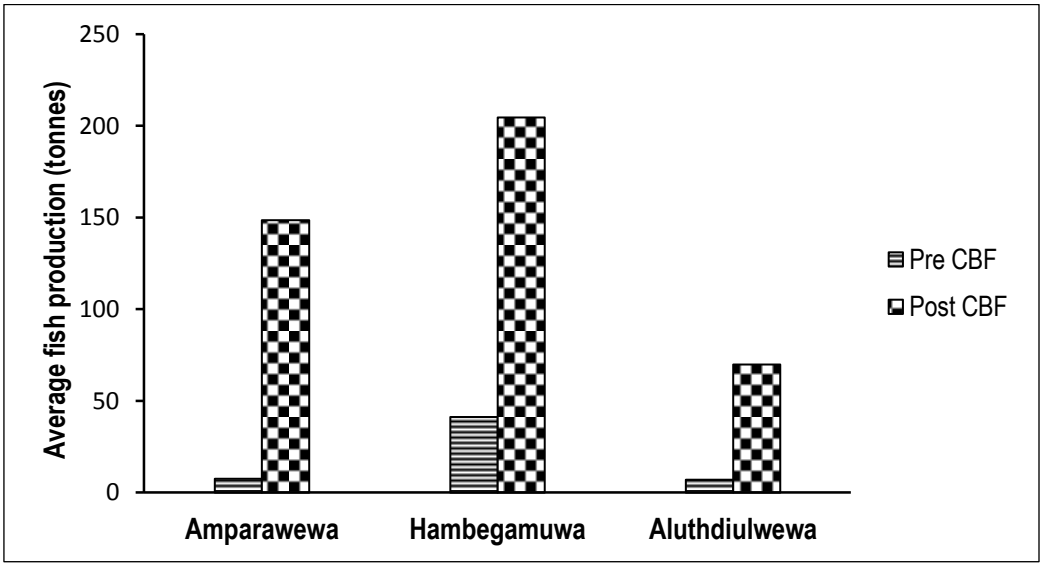

Fig. 2. Average annual fish production of Amparawewa, Hambegamuwa and Aluthdiulwewa during pre- and post-culture-based fisheries (CBF) period.

Average annual fish production in Amparawewa increased from 7.5–189.3 tonnes (SE ± 96.15). Similarly, average annual fish production (over four years) in Hambegamuwa and Aluthdiulwewa increased from 41.2–309.6 tonnes (SE ±59.97) and from 7.1–127.3 tonnes (SE ±62.41), respectively. Fish production per unit area per annum increased from 31.3, 85.8 and 29.7 $kg.ha^{-1}.year^{-1}$ to 789.9, 645.2 and 532.7 $kg.ha^{-1}.year^{-1}$ after the introduction of culture-based fisheries in Amparawewa, Hambegamuwa and Aluthdiulwewa, respectively.

Monetary gains from stocking

Details of biomass and monetary gains from stocked fish species are given in Table 1. Average biomass gains of stocking 100 fish fingerlings or prawn postlarvae (PL) in three reservoirs ranged from 0.6 kg for freshwater prawn in Amparawewa and Hambegamuwa to 86.0 kg for catla in Hambegamuwa. Selling price of tilapia was Rs.160 kg^{-1}; catla, rohu and mrigal was Rs. 100 kg^{-1} and fresh water prawn was Rs. 850 kg^{-1}. Price of fish fingerling was Rs. 2.00 and postlarva of FWP was Rs. 1.00. Consequently, monetary gains per stocking of 100 fingerlings or PL ranged from Rs. 410.00 for fresh water prawn in Amparawewa and Hambegamuwa to Rs. 11,880.00 (in 2012, US Dollar 1 = SL Rs. 133) for Nile tilapia in Hambegamuwa. Stocking of Nile tilapia, catla, rohu, mrigal and fresh water prawn had positive monetary gains. Monetary gains from stocking tilapia and catla in all three reservoirs, rohu in Hambegamuwa, mrigal and fresh water prawn in Authdiulwewa were found to be very attractive.

Provision of livelihoods

Development of culture-based fisheries resulted in providing more livelihood opportunities (Table 2) in all three reservoirs. The introduction of culture-based fisheries supported livelihoods for 55, 77 and 37 villagers in Amparawewa, Hambegamuwa and Aluthdiulwewa, which reflected an increase of 323 %, 140 % and 147 %, respectively from that of the pre-culture-based fisheries period.

Contribution of culture-based fisheries towards rural economy

Average gross income generated and the profits obtained per annum through culture-based fisheries during the period 2012−2014 are given in Table 3. Similarly, average gross income generated and profits earned per annum through paddy cultivation downstream from the reservoirs during six paddy cultivation seasons in 2012, 2013 and 2014 are given in Table 4. Two paddy cultivation cycles per year were considered. A comparison of total income and profits generated through culture-based fisheries in the three reservoirs with that of paddy cultivation are given in Table 5. Gross income generated from culture-based fisheries are 88.9 %, 68.1 % and 50.6 % of the gross income generated through downstream paddy cultivation in Amparawewa, Hambegamuwa and Aluthdiulwewa, respectively. These correspond to profits of 133.2 %, 129.4 % and 86.3 % of that of paddy cultivation earned through CBF in these three reservoirs.

Table 1. Details on the biomass and monetary gain from stocking fingerlings or postlarvae (PL) of Nile tilapia, catla, rohu, mrigal and fresh water prawn. In 2012, US Dollar 1 = SL Rs. 133.

Reservoir/ fish species	Weight gain of fish per100 fingerlings/PL stocked (kg)	Market value of fish obtained per 100 fingerlings/PL stocked (Rs.)	Monetary gain from stocking 100 fingerlings/PL (Rs.)
Amparawewa			
Nile Tilapia	32.2	5152.00	4952.00
Catla	15.6	1560.00	1360.00
Rohu	9.5	950.00	750.00
Fresh water prawn	0.6	510.00	410.00
Hambegamuwa			
Nile Tilapia	75.5	12080.00	11880.00
Catla	86.0	8600.00	8400.00
Rohu	32.6	3260.00	3060.00
Mrigal	9.5	950.00	750.00
Fresh water prawn	0.6	510.00	410.00
Aluthdiulwewa			
Nile Tilapia	61.4	9824.00	9624.00
Catla	55.8	5580.00	5380.00
Rohu	13.9	1390.00	1190.00
Mrigal	23.1	2310.00	2110.00
Fresh water prawn	1.8	1530.00	1430.00

Table 2. Details on provision of livelihoods through the development of culture-based fisheries (CBF) in Amparawewa, Hambegamuwa and Aluthdiulwewa

Reservoir	Pre –CBF period		2013	
	Full time fishers	Part-time fishers	Full time fishers	Part-time fishers
Amparawewa	13	-	33	21
Hambegamuwa	16	16	57	20
Aluthdiulwewa	-	15	37	-

Table 3. Average income and profits generated per annum from culture-based fisheries (CBF) in three reservoirs during 2012−2014 period. In 2012, US Dollar 1 = SL Rs. 133.

Reservoir	Gross income from CBF (Rs. million)	Expenditure		Profits from CBF (Rs.million)
		For fishing nets (Rs. million)	For fish seed (Rs. million)	
Amparawewa	21.290	1.566	1.207	18.517
Hambegamuwa	47.287	2.555	0.463	44.269
Aluthdiulwewa	19.446	1.538	1.152	16.756

Table 4. Average income and profits generated per annum from downstream cultivation of paddy under Amparawewa, Hambegamuwa, Aluthdiulwewa during 2012−2014 period. In 2012, US Dollar 1 = SL Rs. 133.

	Amparawewa (±SE)	Hambegamuwa (±SE)	Aluthdiulwewa (±SE)
Gross income (GI) per acre per cultivation cycle (Rs)	59845.00 (± 4525.22)	62566.00 (± 10319.18)	60152.00 (± 6190.04)
Cost per acre per cultivation cycle (Rs)	25093.00 (± 569.95)	31742.00 (± 450.21)	29733.00 (± 2103.46)
Average extent cultivated with paddy per cultivation cycle (acres)	200	555	319
GI from total extent cultivated per cultivation cycle (Rs million)	11.969	34.724	19.188
Profit from total extent cultivated per cultivation cycle (Rs. million)	6.950	17.107	9.703
GI from paddy cultivation per annum (Rs. million)	23.938	69.448	38.376
Profit from paddy cultivation per annum (Rs. million)	13.900	34.214	19.406

Table 5. Comparison of gross income (GI) and profits per annum from downstream paddy cultivation and culture-based fisheries (CBF) in Amparawewa, Hambegamuwa and Aluthdiulwewa during 2012−2014. In 2012, US Dollar 1 = SL Rs.133.

Name of Reservoir	GI from downstream paddy cultivation (Rs. mln)	GI from CBF (Rs. mln)	GI from CBF as % of GI from paddy cultivation	Profit from downstream paddy cultivation (Rs. mln)	Profit from CBF (Rs. mln)	Profit from CBF as % of profit from paddy cultivation
Amparawewa	23.938	21.290	88.9	13.900	18.517	133.2
Hambegamuwa	69.448	47.287	68.1	34.214	44.269	129.4
Aluthdiulwewa	38.376	19.446	50.6	19.406	16.756	86.3

Discussion

Culture-based fisheries in perennial reservoirs is a recent development in Sri Lanka. Stocking, coupled with proper management of fisheries in the three medium-sized perennial reservoirs under consideration, resulted in significant increases in fish production. Pushpalatha and Chandrasoma (2009) reported production increases of 42.8–1,344.0 % after the introduction of CBF in 15 minor perennial reservoirs. Average annual fish production during the post-culture-based fisheries period reported in this study was 789.0, 645.2 and 532.7 $kg.ha^{-1}.yr^{-1}$. Pushpalatha and Chandrasoma (2009) reported an average fish yield of 208.1 $kg.ha^{-1}.yr^{-1}$ (ranging from 81.3–533.0 $kg.ha^{-1}.yr^{-1}$) after the introduction of culture-based fisheries in 15 minor perennial reservoirs. Average fish yield of 310.1 $kg.ha^{-1}.yr^{-1}$ after introduction of culture-based fisheries has been reported by Chandrasoma et al. (2015) in respect of seven medium sized reservoirs. Li (1988) reported fish yield of 75–675 $kg.ha^{-1}.yr^{-1}$ in five reservoirs (in China) ranging in size from 160 to 40,000 ha. Lao PDR has embarked on culture-based fisheries development in small water bodies in rural areas recently and these are managed under three contrasting regimes decided upon by each community (Saphakdy et al. 2009). Phomsouvanh et al. (2015) reported that in Lao PDR the overall mean gross production levels under the three management regimes ranged from 1,350–2,844, 650–4,622, and 2,750–8,759 $kg.cycle^{-1}$ for Categories 1, 2 and 3 water bodies, respectively, and the corresponding revenues per cycle ranged from Kip 108,000−61,500,000, Kip 1,700,000−78,150,000, and Kip 697,000–171,750,000 (in 2012, Kip 8,000 = 1 US$).

It was interesting to note that stocking of Nile tilapia, catla, rohu, mrigal and fresh water prawn in all three reservoirs resulted in monetary gains. A similar situation has been reported by Pushpalatha and Chandrasoma (2009) for fifteen minor perennial reservoirs and Pushpalatha et al. (2015a,b) for two large perennial reservoirs. It was observed that biomass gains from stocking fresh water prawn are comparatively low, but monetary gains are positive mainly due to the higher market price of fresh water prawn, with comparable observations being reported from Thailand reservoirs (Sripatrprasite and Lin 2003). Fisher Community Based Organisation members and fisheries authorities can consider monetary gains as one of the indicators to evaluate the impact of stocking of fish species.

Introduction of culture-based fisheries into the three reservoirs resulted in providing enhanced livelihood opportunities for rural communities, which is one of the expectations of the government. Pushpalatha et al. (2015a,b) reported that introduction of culture-based fisheries in Amparawewa resulted in significantly higher income for fishers and raised their standard of living.

Almost all the irrigation reservoirs, both seasonal and perennial, are situated in rural areas of the country. The main economic activity in rural areas is downstream paddy cultivation in the command areas of the reservoirs. Gross incomes and profits generated from culture-based fisheries, which is a non-consumptive secondary user of water, indicate that culture-based fisheries has developed into an important economic activity.

It is important to note that profits obtained from culture-based fisheries have surpassed the profits generated from downstream paddy cultivation (primary economic activity) in respect of Amparawewa and Hambegamuwa. These observations illustrate the important contribution made by culture-based fisheries towards strengthening the rural economy. Culture-based fisheries is a relatively new activity. As such further improvements in management of the stocked seed could be expected as the skills of the community improve with time, as has been reported, for example, in Lao PDR (Phomsouvanh et al. 2015).

The only external input provided for culture-based fisheries is fish seed. Introduction of culture-based fisheries in these reservoirs has resulted in increased availability of fish in rural areas thus enhancing food security, providing more livelihood opportunities and strengthening the rural economy. All the evidence suggests that culture-based fisheries is a strategy that should be adopted by most developing countries.

Effective use of primary resources, in particular land, water and energy, for food production is considered an important facet in providing food security to an increasing global population **(**Hanjra and Qureshi 2010, Godfray et al. 2010). It is also believed that problems associated with increasing global food needs are likely to be exacerbated by climate change impacts, including those on fisheries and aquaculture (Cochrane et al. 2009, De Silva and Soto 2009, Leung and Bates 2013). In such a context, multiple use of irrigation waters for different forms of food production is becoming increasingly important, and more so as such positive impacts are felt to be mostly beneficial to rural communities.

Conclusion

Introduction of culture-based fisheries has resulted in significant increases in fish production and increased availability of fish in rural areas. In addition, culture-based fisheries resulted in the provision of enhanced livelihood opportunities for rural communities. Stocking of Nile tilapia, catla, rohu, mrigal and fresh water prawn is positive in all three reservoirs indicating the importance of these species in stocking strategies.

Observations made on gross income and profits generated through culture-based fisheries show the important contribution made by culture-based fisheries towards strengthening the rural economy. Multiple use of irrigation water for different forms of food production is becoming increasingly important towards ensuring food security and culture-based fisheries, a low-input and low-cost strategy, needs to be given high priority not only by Sri Lanka but by most developing countries, where suitable resources exist.

Acknowledgements

The authors would like to express their sincere thanks to Professor Sena S. De Silva of the School of Life and Environmental Sciences, Deakin University, Australia for his critical comments on the manuscript.

References

Amarasinghe, U.S. and T.T.T. Nguyen. 2009. Enhancing rural farmer income through fish production: Secondary use of water resources in Sri Lanka and elsewhere. In Success Stories in Asian Aquaculture (eds. S.S. De Silva and F.B. Davy), pp 103–130. Springer Science, Netherlands.

Anonymous. 2002. Sri Lankan Fisheries Year Book 2001. National Aquatic Research and Development Agency, Colombo. 77 pp.

Chandrasoma J., K.B.C. Pushpalatha and W.A.J.R. Fernando. 2015. Impact of introduction of culture-based fisheries on fish production in perennial reservoirs of Sri Lanka. In Perspectives on Culture-based Fisheries Development in Asia (eds. Sena S. De Silva, B.A. Ingram and S. Wilkinson). pp 83–90. Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

Cochrane, K., C. De Young, D. Soto and T. Bahri, 2009. Climate change implications for fisheries and aquaculture: overview of current scientific knowledge. FAO Fisheries and Aquaculture Technical Paper No. 530. 212 pp.

Department of Agriculture. 2013. Cost of cultivation of agricultural crops, 2011/12. No. 62. Maha. Department of Agriculture, Peradeniya, Sri Lanka. 97 pp.

Department of Agriculture. 2014a. Cost of cultivation of agricultural crops, 2012. No 63. Yala. Department of Agriculture, Peradeniya, Sri Lanka. 97 pp.

Department of Agriculture. 2014b. Cost of cultivation of agricultural crops, 2012/13. No. 64. Maha. Department of Agriculture, Peradeniya, Sri Lanka. 97 pp.

Department of Agriculture. 2015a. Cost of cultivation of agricultural crops, 2013. No. 65. Yala. Department of Agriculture, Peradeniya, Sri Lanka. 97 pp.

Department of Agriculture. 2015b. Cost of cultivation of agricultural crops, 2013/14. No. 66. Maha. Department of Agriculture, Peradeniya, Sri Lanka. 99 pp.

De Silva, S.S. 2003. Culture-based fisheries: an underutilized opportunity in aquaculture. Aquaculture 221: 221–243.

De Silva, S.S. 2015. Culture-based fisheries: why, what, where, how and for whom? In Perspectives of culture-based fisheries developments in Asia (eds. Sena S. De. Silva, B.A. Ingram and S. Wilkinson.). pp 17–25. Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

De Silva, S. S. and D. Soto. 2009. Climate change and aquaculture: potential impacts, adaptation and mitigation. In Climate change implications for fisheries and aquaculture: overview of current scientific knowledge. (eds. K. Cochrane, C. De Young, D. Soto and T. Bahri), pp 137–215. FAO Fisheries and Aquaculture Technical Paper. No. 530. FAO, Rome.

De Silva, S.S., U.S. Amarasinghe and T.T.T. Nguyen. 2006. Better-practice approaches for culture-based fisheries development in Asia. ACIAR Monograph No 120. 96 pp.

Godfray, H.C.J., J.R. Beddington, I.R. Crute, L. Haddard and D. Lawrence. 2010. Food security: the challenge of feeding 9 billion people. Science 327: 812–818.

Hanjra, M.A. and M.E. Qureshi 2010. Global water crisis and future food security in an era of climate change. Food Policy 35: 365–377.

Leung, T.L.F. and A.E. Bates 2013. More rapid and severe disease outbreaks for aquaculture in the tropics: implications for food security. Journal of Applied Ecology 50: 215–222.

Li, S. 1988. The principles and strategies of fish culture in Chinese reservoirs. In Reservoir Fishery Management and Development in Asia, Proceedings of a workshop held in Kathmandu, Nepal, 23–28 November 1987. (ed. S. S. De Silva) pp 214–233. International Development Research Center, Ottawa, Canada.

Limsong, S., H. Sitha, O. Sary, O. Vutha, C.V. Mohan and S.S. De Silva. 2013. Introduction of culture based fishery practices in small water bodies in Cambodia: issues and strategies. Aquaculture Asia Magazine XVIII(4): 12–17.

Lorenzen, K., U.S. Amarasinghe, D.M. Bartley, J.D. Bell, M. Bilimo, S.S. De Silva, C.J. Graway, W.D. Hartman, J.M. Kapetsky, P. Laleye, J. Moreau, V.V. Sugnan and D.B. Swar. 2001. Strategic review of enhancements and culture-based fisheries. In Aquaculture in the third millennium. Technical proceedings of the conference on aquaculture in the third millennium, 20–25 February 2000. (eds. R.P Subasinghe, P. Bueno, M.J. Phillips, C. Hough, S.E. McGladdery and J.R. Arthur), pp 221–237. NACA, Bangkok, Thailand and FAO, Rome, Italy.

Nguyen H.S., A.T. Bui, D.Q. Nguyen, D.Q. Truong, L.T. Le, N.W. Abery and S.S. De Silva. 2005. Culture-based fisheries in small reservoirs in northern Vietnam: effect of stocking density and species combinations. Aquaculture Research 36: 1037–1048.

Phomsouvanh, A., S. Bounthong and S.S. De Silva. 2015. Production trends, monetary returns and benefit sharing protocols from the extensive aquaculture practice of culture-based fisheries in rural communities in Lao PDR. Aquaculture 439: 29–38.

Pushpalatha, K.B.C. and J. Chandrasoma. 2009. Culture-based fisheries in minor perennial reservoirs in Sri Lanka: variability in production, stocked species and yield implications. Journal of Applied Ichthyology 26: 98–103.

Pushpalatha, K.B.C., W.A.J.R. Fernando and J. Chandrasoma. 2015a. Impact of introduction of culture based fisheries on fish production in two perennial reservoirs in Sri Lanka. International Journal of Fisheries and Aquatic Studies 2(4S): 5–9.

Pushpalatha, K.B.C., J. Chandrasoma and W.A.J.R. Fernando. 2015b. Impact of introduction of culture-based fisheries on fish production and socio-economic conditions of fishers in Amparawewa, a medium perennial reservoir. Sri Lanka Journal of Aquatic Sciences 20: 1–8.

Saphakdy, B., A. Phomsouvanh, B. Davy, T.T.T. Nguyen and S.S. De Silva. 2009. Contrasting community management and revenue sharing practices of culture-based fisheries in Lao PDR. Aquaculture Asia Magazine, XIV (3): 2–6.

Sripatrprasite, P. and C.K. Lin. 2003. Stocking and recapture of freshwater prawn (*Macrobrachium rosenbergii* De Man) in a run-of-river type dam (Pak Mun Dam) in Thailand. Asian Fisheries Science 16: 167–174.

Sugunan, V.V. and P.K. Katiha. 2004. Impact of stocking on yield in small reservoirs in Andhra Pradesh, India. Fisheries Management and Ecology 11: 65–69.

Received: 11/03/2017; Accepted: 28/06/2017 (AFSJ-2017-0027)