ISSN 0859-600X

Volume XX No. 3 July-September 2015

AQUACULTURE ASIA

Bio-remediation of sewage recycled in aquaculture

Coastal ecosystem management, India

Status of alien fish, India

Extension via ICT

AQUACULTURE ASIA

Aquaculture Asia

is an autonomous publication that gives people in developing countries a voice. The views and opinions expressed herein are those of the contributors and do not represent the policies or position of NACA.

Editor

Simon Wilkinson
simon@enaca.org

NACA

An intergovernmental organisation that promotes rural development through sustainable aquaculture. NACA seeks to improve rural income, increase food production and foreign exchange earnings and to diversify farm production. The ultimate beneficiaries of NACA activities are farmers and rural communities.

Contact

The Editor, Aquaculture Asia
PO Box 1040
Kasetsart Post Office
Bangkok 10903, Thailand
Tel +66-2 561 1728
Fax +66-2 561 1727
Website http://www.enaca.org

Submit articles to:
magazine@enaca.org

Printed by
Scand-Media Co., Ltd.

Volume XX No. 3
July-September 2015
ISSN 0859-600X

Changes to the magazine (and website)

As foreshadowed there will be some significant changes to the magazine coming up, in part because we are rebuilding the website in a way that is going to change the operational model.

Instead of publish an entire issue at once as a single downloadable file (as we do now) we will begin publishing articles as individual downloads. When enough are available to form an "issue" they will be bound together and published as a collection, but the individual articles will still be available as separately downloadable files, each of which will have its own description, authorship and subject indexing.

This will make individual articles are lot more prominent as far as search engine results go, and it will make them easier to find within the site as well. Most importantly, it will drastically cut the lead time between submitting an article and having it published, as publication will not be dependent on having a sufficient number and diversity of articles to produce a well-rounded issue for press. We will also cease printing paper copies of the magazine after the next issue, it is going to be electronic-only from here on.

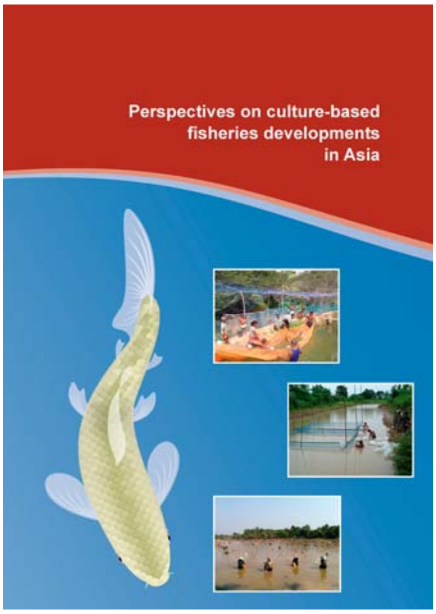
As each article will be published separately, we request that from here on authors supply an abstract with their articles. The length limit will be relaxed, as it is no longer a layout constraint, but as a rule shorter is still much better and please don't send in a thesis – editorial time is still a constraint.

The website is currently being rebuilt from scratch using a purpose-built software system written in house. Rather than being divided into sections such as news, publications, podcasts etc., it will simply provide a single stream of the latest information regardless of type. You'll be able to stay up to date just looking at the front page, although there are facilities to search and to filter by type or subject if you wish. Photographs, video and audio presentations will play a much more important role going forward and the site is mobile friendly.

Moving 15 years of content over to a new system, rewriting descriptions for everything and indexing it all is a huge job, but I hope the new system will be available in late January or early February.

Simon Wilkinson

AQUACULTURE ASIA



CONTENTS

Status of alien fish species farming and its implications for Andhra Pradesh, India

B. Laxmappa

Fisheries Development Officer, Department of Fisheries, Mahabubnagar – 509 001, Andhra Pradesh, India.
E-mail: laxmappaboini@gmail.com

Over the past two decades, many alien fish species have been clandestinely brought into India by private aquaculturists, entrepreneurs and industrialists hoping for quick gains. Such unauthorised activities are causing indiscriminate spread of alien species, with potentially adverse ecological consequences (Singh & Lakra 2006; Lakra et al. 2008). In spite of an already rich and diverse fish genetic resource of India, more than 300 alien / exotic species have been introduced into the country so far. While a vast majority of them are ornamental fishes, which remain, more or less, confined to aquaria, others have been introduced into aquaculture and open water systems with varying degrees of success.

However, unauthorised culture of alien species and their unintentional or deliberate spread is emerging as one of the greatest threats to the biodiversity of aquatic ecosystems. The impacts are typically greater in systems already affected by human activity (Vaughn 2010). Increased appearance of alien species particularly in degraded aquatic environments has further significantly aggravated threats to biodiversity (Lakra et al. 2008).

Alien fish species farming

In recent years, there has been an alarming increase in the number of alien fish species being detected in the rivers, lakes and reservoirs of India (Lakra et al. 2008; Raghavan et al. 2008). Most escapee alien species were from unauthorised culture species and moved into open waters inadvertently or because farmers were unaware and / or lacked knowledge of the potential adverse effects.

Tilapia, *Oreochromis mossambicus* (Peters), was first introduced into pond ecosystems in 1952 and thereafter stocked in several reservoirs of south India for production enhancement (Sugunan 1995). This species is now found abundantly in almost every environment particularly almost all reservoirs and reservoir fed tanks / and natural ponds in Andhra Pradesh.

In 1957, a Bangkok strain of the common carp and the Chinese silver carp, *Hypophthalmichthys molitrix*, were brought into the country with the objectives of broadening

Fisherman throwing castnet in canal.

Tilapia caught in the net.

the species spectrum in aquaculture and increasing yields through better utiliSation of vacant trophic niches. Of the alien carps, the common carp *(C. carpio var communis)* is now widely cultured all over the country in ponds and tanks.

Both silver carp *(H. molitrix)* and grass carp *(C. idella)* were introduced in 1959 for a specific purpose and have led to the development of high yielding composite fish culture systems, after several years of experimentation. The grass carp *(C. idella)* was introduced mainly to control weeds in natural water bodies. It is an important species used in composite fish culture and is widely cultured throughout India, including in the hill states.

Unauthorised fish introductions

India's neighbouring states of Bangladesh and Nepal culture a number of alien species (Barua et al. 2001; Gurung 2005). Many alien species, such as *Clarias gariepinus, Pangasianodon hypophthalmus, Aristichthys nobilis,* and

Table1: Alien fish species introduced in India & present status in Andhra Pradesh

Common name	Scientific name	Origin	Introduced from	Year	Present status in A.P
Common carp	*Cyprinus carpio*	Europe	Bangkok	1957	Aquaculture
Grass carp	*Ctenopharyngodon idella*	China	Japan	1959	Aquaculture
Silver carp	*Hypophthalmichthys molitrix*	China	Hong Kong	1959	Limited culture
Pangas	*Pangasianodon hypoph-thalmus*	Southeast Asia	Vietnam	2004	Aquaculture
African catfish	*Clarius gariepinus*	Africa	Bangladesh	1990	Cultured in limited areas and some are present in natural waters
Red-bellied Pacu	*Piaractus brachiopomus*	S. America	Bangladesh	2012	Limited culture
Tilapia	*Tilapia mossambica*	Africa	Bangkok	1952	Exists in rivers, backwaters, reservoirs and tanks naturally
Big head carp	*Aristichthys nobilis*	China	Bangladesh	987	Limited culture

Piaractus brachypomus, have been surreptitiously smuggled into India from there to Andhra Pradesh and are being cultivated (Table 1). These unauthorised introductions have achieved popularity in aquaculture.

Among the catfishes, the African catfish *Clarias gariepinus* was also clandestinely introduced into the state of Andhra Pradesh in early 1990s from Bangladesh through West Bengal (Ramakrishna et al. 2012), created severe environmental problems including pollution of water and air in the vicinity of farm ponds. It is largely cultured in the states of West Bengal, Punjab, Tamil Nadu, Karnataka, Assam, Maharashtra, Western Ghats and Andhra Pradesh. However, alien fish species seed production is mainly practiced in the state of West Bengal. Although its culture is unauthorised, these fishes have become popular among aquaculturists in the country.

Fisherman with cultured common carp.

Now one important area for African Catfish farming in Andhra Pradesh is Mahabubnagar District in the vicinity of the Priyadarshini Jurala Project (PJP), which is a major multi-purpose project constructed across the river Krishna. Local fishers have reported stray catches of *C. gariepinus* from the many waterways that lie adjacent to the PJP in the last couple of years. However, in recent years, increasing catches of *C. gariepinus* have been made from the main water body of the project, Srisailam backwaters and PJP canal fed irrigational tanks.

Fisherman with cultured common carp.

Tilapia caught from natural waters.

The author observing pangas harvesting at culture pond.


Harvested Pangas fish packing at pond site.


Fisherman with cultured silver carp.

Among the poplar alien fish species, pangas catfish *(P. hypophthalmus)* was introduced in 2004 from West Bengal illegally. The Government of India permitted this species for aquaculture in 2009. During the period of 2008-2010 pangas culture grew up to 30,000 ha, but has now come down to 120,00 ha in the state. Red-bellied pacu *(P. brachypomus)* is also illegally introduced in 2012 for aquaculture. In some areas of Andhra Pradesh *P. brachypomus* culture is mixed with pangas species and in some other areas culturing separately. Due to low yield problems its culture area is limited in the state of Andhra Pradesh.

Impact of alien species

The use of exotic species for fisheries and aquaculture diversification has been practiced since the middle of the 19th century. Although many such introductions have been


Fisherman with cultured grass carp.

successful, others have resulted in highly publicised failure, generating controversy over protection of native biodiversity, spread of pathogens and disease. However, the introduction and transfer of exotic species and breeds for aquaculture of exotic species and breeds for aquaculture purposes may be done with extreme caution as it can change or impoverish the biodiversity and genetic resources through interbreeding, competition for food, habitat destruction and through transmission of diseases.

The little or no management measures taken by farmers especially in preventing escape of pond reared individuals has now resulted in the species being distributed in many natural water bodies of the state. *C. gariepinus* is now being increasingly caught from PJP, Srisailam backwaters and PJP canal fed irrigational tanks in the state. African Catfish escaped from rearing ponds in the area and became established in the larger village tanks also subsequently wiping out the indigenous species such as snakeheads (murrels), local catfish sp etc.

Over the last five years the State Fisheries Department has been conducting raids, destroying African catfish stocks and filing the cases against farmers. But still some of the farmers doing this illegal activity secretly and exporting their produce to other states. The PJP canal fed irrigational tanks are also getting this and suffering a lot due to declining cultured carp's productivity. Carps culturists are also getting these African cat fish ranging from 2-5 kg each in their tanks at the time of harvesting. However, formers are unaware of the adverse implications of this catfish on the ecology. Its propagation is being discouraged.

Conclusions

Although aquaculture of *C. gariepinus* is banned in Andhra Pradesh, some farmers have taken little consideration for such bans and continue rearing this catfish. It is widely believed that the popularity of African catfish aquaculture is due to the simplicity in their rearing, fast growth and acceptability of cheap feed, such as slaughterhouse and chicken waste. The low operational costs and high profits derived from African catfish farming have led to intensification of production.

Low culture management practice, tolerance of a harsh environment, acceptability of a variety of feed and fast growth mean that farmers have begun to culture it in small pits and cement cisterns as well as in large ponds and reservoirs in India. Considering the threats posed by African catfish, the Ministry of Agriculture, Government of India, ordered the destruction of this alien catfish en masse and has imposed a ban on its culture. However, it is still bred and cultured even today in different parts of the country.

In view of the adverse environmental, socioeconomic and biodiversity impacts, there is an urgent need to regulate the illegal entry of alien species into the state including

Fisherman with cultured African catfish.

Pangas culture pond with pellet feeding.

India. There is a pressing need to follow scientifically sound methods and approaches in the field of risk assessment for alien species so as to pick only safe and profitable species of aquaculture.

Cultured red-bellied pacu.

References

Barua SP, Khan MMH, Ali Reza AHM (2001) The status of alien invasive species in Bangladesh and their impact on the ecosystems. In: Balakrishna P. (ed.) Report of Workshop on Alien Invasive species, pp. 1–8. GBF-SSEA, IUCN Regional Biodiversity Programme, Asia, Colombo.

Gurung TB (2005) Responsible introduction of alien fish and biodiversity in Nepal. Aquaculture Asia 2005: 13–16.

Lakra WS, Singh AK, Ayyappan S (eds) (2008) Fish Introduction in India: Status, Potential and Challenges. Narendra Publishers, New Delhi.

Raghavan R, Prasad G, Anvar-Ali PH, Pereira B (2008) Exotic fish species in a global biodiversity hotspot: observations from River Chalakudy, part of Western Ghats, Kerala, India. Biological Invasions 10 (1): 37–40.

Ramakrishna R, Munichandra Reddy D, Vara Prasad K (2012) Carp culture in Andhra Pradesh. Aqua Tech 11 (5): 79-83.

Singh, A.K & W.S. Lakra (2006). Alien fish species in India: impact and emerging scenario. Journal of Ecophysiology and Occupational Health 6: 165–174.

Sugunan VV (1995) Exotic Fishes and Their Role in Reservoir Fisheries in India. FAO Fisheries Technical Paper 345. FAO, Rome.

Vaughn CC (2010). Biodiversity losses and ecosystem function in freshwaters: Emerging conclusions and research directions. Bioscience 60 (1): 25–35.

Bridging the research-extension-farmer-input and market linkage gap in coastal aquaculture through application of ICT

M. Kumaran, D. Deboral Vimala and M. Alagappan

Central Institute of Brackishwater Aquaculture, Chennai – 600 028, India.

The primary objective of agrarian extension services is to enhance the standard of living of the farming community by enhancing their technical capacity and facilitating their access to information, inputs, services and market. Extension personnel ought to be an enabling family friend of farmers who need to facilitate the farmers not only in farming but in other frontiers such as education and the health of the family. Because of this broader role extension is being known as a means for community/rural development and not an end in itself. In order to achieve this noble objective the extension system has been adopting time-tested approaches to reach and help the end users. However, there is no 'universal one best-fit magical approach' available which can be adopted every where and hence, context specific extension approaches need to be adopted considering the socio-economic, technical, agro-ecological and resources profile of the end users.

In order to be effective extension personnel need to be supported with periodical capacity building to update their technical skill and knowledge, required extension materials, resources and budget. Similarly the extension system is expected to portray the real requirements and scenario at the field level so that demand driven technical practices can be generated, tested and given to the farming community and other end users at different levels. Likewise the extension personnel need to have linkage with input providers to help the farmers to access quality inputs and monitor the input producers for adherence to quality standards. Similarly to understand the market demands, quality expectations and market intelligence a strong linkage with the buyers is also essential. Therefore the research, extension, inputs, farmer and market systems should have a 'give and take' interaction at required intervals to know each other's requirements and attempting to accomplish the demands of each other. This needs a vibrant institutional linkage mechanism involving research, extension, farmer, inputs and market.

In India, aquaculture is a livelihood for more than 14 million people and also an important constituent of major foreign exchange earning, contributing about 1 % of the total GDP and 5.39 % of the GDP from agriculture sector of the country for the year 2010-11 (DAHDF, 2012). Globally, India ranks second in the aquaculture with a production of 4.65 million tonnes with a share of 8.72% (FAO, 2012). Indian coastal aquaculture in the strict sense is synonymous with shrimp culture which is being carried out in about 1,500,000 ha with a production of 2,200,000 tonnes. Most of the shrimp produced are exported and hence quality of the produce is important. Shrimp aquaculture is a knowledge-intensive and high-investment farming enterprise that requires constant communication of information between the research, extension, inputs, market and farmer subsystems to bring out practical solutions to deal with emerging production and farm management related issues.

Studies on the information sources of the aquaculture farmers and extension personnel have clearly indicated that the linkage between the research, extension and farmers are inadequate (Kumaran et al. 2004; 2008 and 2011). The orientation of the fisheries department per se is towards the popular development schemes and hence, efforts towards extension service providing technical support for aquaculture rather inadequate. Further, a formal linkage interface mechanism in the form of research-extension interface meetings, pre-crop and post-crop conferences at the regional level to integrate the research, extension, farmer, inputs and market sectors is non-existent in the Indian fisheries sector and it is unlikely that a mechanism to facilitate such a linkage will be put in place in the near future. In the absence of a vibrant REF linkage for a two way communication and capacity building it is important to look for an alternative strategy. In the era of information revolution, information and communication technology (ICT) aided tools could offer a solution to address this gap and capacity strengthening (ADB, 2003; Richardson, 2003).

ICT Approach for bridging the REFIM Linkage

Information and communications technology is a broader term inclusive of the existing and continually evolving computer and electronic gadgets and software, digital broadcast and telecommunication technologies, television, radio, mobile phones, electronic information repositories such as the World Wide Web and audio-visual content stored in compact discs. It also includes the policies and laws that govern these media, services and devices. The availability of several telecommunication networks and service providers means that the majority of our end users have access to more than one medium and interactive mode. The rapidity and reach of information services at low cost are the unique advantages of ICT. Therefore ICT has the potential to bridge the REFIM linkage gap.

ICT aided initiatives for aquaculture extension in India

Aquaculture is a technology driven farming enterprise and the aqua farmers are looking for quality information in time at an affordable cost. ICT aided tools like e-publications, compact discs, short films, mobile telephony, phone-in programmes, information kiosks, expert systems and decision support systems have been developed and implemented in a limited scale as projects or programmes. Some of the initiatives are detailed below.

1. The ‘Phone- in’ Programme (PiP): PiP is an e-initiative and service facility where farmers/fishermen can call and record their queries on a given telephone number. They would be called back and provided the required information. At the time of live interaction, they can ask further questions to the experts at the station and get replies to their queries immediately. The Central Institute of Brackishwater Aquaculture in collaboration with M.S. Swaminathan Research Foundation have been under-taking PiPs on better management practices of shrimp farming and sea bass culture and its farm management practices to educate the farming community.

2. Farmer-friendly touch screen information kiosk on BMPs in shrimp culture: An information kiosk with touch screen facility on BMPs of shrimp culture in Tamil language was developed and dedicated to the small scale farmers of Nagapattinam district in Tamil Nadu. In addition to the BMPs, the schemes of various fisheries development departments, contact numbers of inputs and buyers were also provided in the kiosk.

3. Technology dissemination through mobile phones: Mobile phones are the most important medium through which short messages on farming and related aspects can be communicated to the farming community as well as extension workers. Based on a detailed information need assessment the subject matter is made as short technical messages and were disseminated via SMS for the officials of Department of Fisheries of states and farmers in vernacular languages. It was proved that the quantity and quality of the services and the speed of services delivery have been improved significantly through mobile phones for extension services (Xiaolan Fu and Shaheen Akter, 2012). MobiAqua of A.A Biotech Pvt. Ltd a Chennai based private entrepreneur has been linking the inputs, farmers and market through mobile phones.

KISAN Call Centre.

4. Village/ Rural knowledge Centre: The Village/ Rural Knowledge Centre is the initiative of M.S. Swaminathan Research Foundationto help ensure food security. The centre provide the rural communities access to a variety of information in fostering agricultural and allied sectors through a hybrid wireless network comprising computers, telephones, VHF duplex radio devices and facilitating both voice and data transfer (Adhiguru and Mruthyunjaya, 2004). It also provides information regarding fish density in the ocean to the fishers.

5. Kisan Call Centre: The Department of Agriculture & Cooperation (DAC), Ministry of Agriculture, Govt. of India has been implementing Kisan Call Centres across the country to deliver extension services to the farming community in 24 x 7 basis. Any farmer using the toll free number can request for technical service on any subject in a local language. Frequently asked questions in aquacul-ture have been developed and given to the hub centre for disseminating them to the farmers.

6. e-Sagu Aqua: e-Sagu Aqua is an ICT based tool for personalised aqua-advisory system (Vimala et al., 2009). It aims to improve farm productivity by delivering high quality personalised (farm-specific) aqua expert advise in

Touch screen information kiosk.

a timely manner to each farm at the farmer's doorstep. A community worker sends the photograph of the crop for advice through e-mail and the advice sent back with in 24 hours. The community workers download the advice and pass it on to the farmer. The aquaculture extension services are extended through ICT tools like database, internet and digital photographs.

7. Aqua-Choupal: The Aqua-Choupal a web supported initiative to provide market and farming related information to enhance farmers' productivity and their farm-gate price realisation (Kumaran et al., 2010). This approach revolved on a network of information units called Aqua-Choupal equipped with a computer connected to the internet, located in villages. Through Aqua-Choupal, farmers could access information on weather, scientific farming practices and market price. Aqua-Choupals also facilitate the supply of farm inputs to the farmers as well as purchase of shrimps at their doorstep. This was the initiative of the Indian Tobacco Company.

8. e-TSA: The extension module on Tiger Shrimp Aquaculture (e-TSA), an expert system for knowledge management and dissemination of Better Management Practices (BMP) of tiger shrimp (Penaeus monodon) (Alagappan and Kumaran, 2012). Information on BMPs has been covered under ten headings, viz., site selection, pond design and construction, pond preparation, seed selection and stocking, feed management, water quality management, health management, waster water management, harvest and post harvest management, and shrimp farm bio-security. The e-TSA also assists the user in identifying a shrimp disease and its management through selection of symptom(s) provided in the system, apart from assisting in calculation of lime, fertiliser, chlorine and daily feed requirement for shrimp farming activity.

9. e-publications: Farmer advisories, success stories, market information and important field related findings which need to be informed to the end users immediately are being uploaded as e-publications in the websites of the institutions concerned. However, the viability of this medium largely hinges on regular updation and continuity. A specific interaction corner for posting questions and sharing of field information would make it more mutual and interactive.

10. Short video-films: Short duration video-film on different aspects of brackishwater aquaculture are being produced especially in local languages and disseminated to the end users. CIBA has produced video films on BMPs of shrimp farming, shrimp seed production, feed production and setting up of aquaclinics, ornamental fish farming, brackishwater aquaculture based livelihood programmes for women self-help groups.

11. Decision Support Systems: Systems that can aid carrying capacity based aquaculture planning in a given creek, multi-criteria based site selection tools for brackishwater aquaculture site selection have been developed by CIBA.

12. Information dissemination through FM radios: Local FM radio channels could be a powerful medium to disseminate technical information in local languages and it can be an interactive one. FM radios can be activated in some mobile phones. The Tamil Nadu Fisheries University is developing a FM radio based advisory for the aquaculture farmers in the Karaikal region of Pondicherry UT and adjoining districts of Tamil Nadu.

13. Social network media - Facebook: Social websites such as Facebook are being used for aquaculture technical information in a big way among the face book users. The aquaculture professionals.com a face book site is quite dynamic and it provides the platform for posting field related issues, new practices and diseases for the benefit of aquaculture professionals who are involved in farming and consultancy services.

ICT tools for REFIM Linkage

Application of appropriate ICT tools for a specific target of audience considering their access and comprehension is very important. ICT medium suitable for communication between

research and extension may not be fit for farmers. Therefore, the ICT medium should be receiver oriented and stakeholders need to use tools accordingly. Based on the field experience a tentative model list of ICT tools which can be used for REFIM linkage is presented in the figure. In order to make the application of ICT tools for extension service successful and effective the following requirements are essential:

- Periodical capacity building for updation of technological content for the extension personnel.
- A dedicated subject matter specialists (SMS) team at the district/regional level.
- Capacity building on selection and use of ICT tools for an appropriate subject.
- Necessary infrastructure like network, hard ware and software.
- Adequate budget.

Conclusion

ICT has the potential to bridge the research- extension-farmer-inputs - market linkage gap in coastal aquaculture. The pilot scale initiatives implemented has shown a positive impact. Though several initiatives have been taken on the application of ICT in fisheries and allied farming sectors in India most of them are taken up in a limited scale. To make the information transfer more efficient, it is high time to apply ICT tools for aquaculture extension service with dedicated technical teams built in each institution exclusively for the purpose. A mission mode ICT programme for extension service integrating research-extension-farmer-inputs and market need to be planned and implemented at the State level for technology dissemination in fisheries sector.

References

Adhiguru, P. and Mruthyunjaya, 2004. Institutional innovations for using information and communication technology. Policy Brief No. 18. National Centre for Agricultural Economics and Policy Research, New Delhi.

Alagappan.M, M.Kumaran, P.Ravichandran. S.V.Alavandi, M.Muralidhar and K.Ambasankar, 2012. e-Extension module on Shrimp Aquaculture (e-TSA), CIBA e-publication series No.13 with a CD, 12p.

Asian Development Bank, 2003. A Strategic Approach to Information and Communities Technology Toward E-Development in Asia and the Pacific. Asian Development Bank.

DAHDF, 2012. Handbook on Fisheries Statistics, 2011. Dept. of Animal Husbandary, Dairying and Fisheries, Min. of Agriculture, Govt. of India, New Delhi. 91 pp.

FAO, 2012. The State of World Fisheries and Aquaculture 2012. Rome. 209 pp.

Kumaran, M., Krishnan, M. and Ravichandran, P. 2007. Extension services in coastal aquaculture: need for a public and private partnership. Indian J. Fish., 54 (1): 75-83.

Kumaran, M., Vimala, D. D., Chandrasekaran, V. S., Alagappan, M. and Raja, S. 2012. Extension Approach for an Effective Fisheries and Aquaculture Extension Services in India. The Journal of Agricultural Education and Extension, 18(3): 249-267.

Richardson, D., 2003. Agricultural Extension Transforming ICTs! Championing Universal Access. CTA's 6th Consultative Expert Meeting of its Observatory on ICTs. CTA, Netherlands.

Vimala, D.D., Ravisankar, T., Mahalakshmi, P., and Kumaran, M., 2009. e-Sagu Aqua: An innovative information and communication technology model for transfer of technology for aquaculture. Aquaculture Asia Magazine, XIV (4): 23-25.

Xiaolan Fu and Shaheen Akter, 2012. Impact of Mobile Telephone on the Quality and Speed of Agricultural Extension Services Delivery: Evidence from the Rural e-services Project in India, Poster prepared for presentation at the International Association of Agricultural Economists (IAAE) 2012 Triennial Conference, Foz do Iguaçu, Brazil 18- 24 August 2012.

Bio-remediation of domestic sewage recycled in aquaculture: A Central Institute of Freshwater Aquaculture model

R. N. Mandal, D. N. Chattopadhyay#, P.P. Chakrabarti, B. K. Pandey and P. Jayasankar*

*Regional Research Center, Central Institute of Freshwater Aquaculture, Rahara, Kolkata -118, India; #Field Station of Central Institute of Freshwater Aquaculture, Kalyani, Nadia, India; *Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar-2, India; Corresponding author: rnmandal2003@yahoo.com*

Freshwater scarcity is imminent in near future. The World Water Report (2009) revealed that nearly half the global population would live in the regions of "high water stress" by 2030. Therefore, such precious resource needs to be managed with utmost care and restraint. Freshwater can influence food security and should always be regarded as a finite natural resource essential for sustenance of human civilisation. A serious concern is already raised worldwide of how to conserve this important resource, utilise it judiciously and prevent it from further exploitation.

A huge amount of sewage of freshwater origin emanating from domestic sources is wasted daily without its rational utilisation. Domestic sewage is of certain benefits: It contains a colossal amount of nutrients which are misplaced, to avoid heavy metals since it is rich in organic content and its contaminants may easily be reduced through treatment. It is therefore pertinent that by application of suitable technology such a valuable resource be utilised for benefit of human beings.

The development of responsible aquaculture practices with addition of treated sewage has been considered to be a viable proposition. In search of effective technology, a biological treatment system has been tested and proven as a tool to render domestic sewage useful for the purpose of aquaculture by harnessing its wealth of nutrients.

Efforts to recycle domestic sewage in the production of quality human food with subsequent reduction of water pollution are relevant to human nutrition, hygiene and water conservation (Chakrabartiet al., 2011). It is estimated that about 20 litres of wastewater in the form of domestic sewage are released per person per day in our towns and cities. Annual discharge domestic sewage contains around 90 million tonnes of nitrogen, 32 million tonnes of phosphorus and 55 million tonnes of potassium valued at around Rs. 60,100,000 (Chakrabartiet al., 2011).

Sewage transport channel.

A view of sewage inlet.

Aquatic weed vegetation comprising Colocasia and Typha bed acting as sink.

Water hyacinth acting as agent for bioremediation.

Domestic sewage after different treatments, and sometimes through ASTP, can be utilised for the production of fish through sustainable aquaculture, livelihood and income generation. Several studies conducted in India and elsewhere have confirmed that the utilisation efficiency of sewage water reuse has been beneficial for production of fish safe for human consumption even during erratic monsoon periods and prolonged rainless days.

With this background, the Regional Research Center (RRC) of the Central Institute of Freshwater Aquaculture (CIFA), located about 18km north of Kolkata city, utilises primary treated domestic sewage and disseminates the technology of sewage-fed aquaculture to the farmers for the purpose of growing fish with low external inputs. Nutrients from sewerage enhance pond fertility and natural food supply, which in turn supports fish production to supply cheap animal protein to the population.

Intervention of CIFA

A study was conducted in a sewage-fed farm of a progressive fish farmer who came in contact with scientists of RRC of CIFA. He had learnt to effectively treat sewage through bio-remediation using different types of aquatic plants. The treated water was utilised in aquaculture without supplementary feeding. Experienced with technology of sewage-fed aquaculture, he has established a fish farm that incorporates sewage in water bodies covering the total area of 7.3 ha. For this purpose, a boundary wall and brick lining on the pond slopes was constructed and he started receiving sewage water released by the Ganga Action Plan project in a controlled manner. His farm supports the livelihood of substantial number of wage labours and also provides affordable food fish to local people.

Infrastructure of the sewage fed farm

The farm consists of:

A long cemented channel carrying domestic sewage.

Available fallow wetlands covered with aquatic vegetation comprising colocasia *(Colocasia esculanta)*, typha *(Typha angustata)* and water hyacinth *(Eichhornia crassipes)*.

System well, connected with pond water.

Discharge of sewage water under controlled manner as and when required.

Our study was conducted in two ponds as below:

Table 1. Pond details.

Items	Particulars
Total no. of ponds	2
Area of each pond	1.0 ha
Duration of experiment	6 months (180 days approx.)
Water depth	1.0m (approx.)
Ratio of freshwater and treated sewage	5:1(approx.)
Frequency of application of sewage	Weekly once/biweekly
Water temperature	28°C-30°C
Fish species stocked	Tilapia, silver carp and mrigal
Stocking density	@20,000/ha
Stocking ratio	2:1:1 tilapia : silver carp : mrigal

Analytical method

Selected water quality parameters were assessed through standard methods mentioned in APHA (2002). Other parameters measured were:

- Plankton population, using Sedgewick Rafter plankton counting cell.
- Pond productivity (gross and net primary productivity) via the black and white bottle method.
- Fish growth and yield through intermediate sampling of fish harvest.
- Microbial load.

Methods followed

The basic production flow on the farm was as follows:

Sewage intake → passing through long channel → bio-remediation → bio-remedied sewagewater → aquaculture pond → fishstocking → harvesting

Methods for bio-remediation of sewerage water

Several natural, innovative, alternate approaches of biological treatment of wastewater have been evaluated over the years for their economic viability, operational ease and system sustainability (Olah et al., 1986; Jana, 1998; Rai and Pandey, 1998; Ayyappan, 2000; Datta et al., 2000 and Jena et al., 2010). Evidently, different stages of biological treatment using aquatic plants are considered to be a viable technology of sewage treatment in perspective of sustainable aquaculture.

Sewage was received from the Ganga Action Plan through long gravity-fed pipeline and then left to fallow for a time in wetlands fed through cemented channel before being drained into culture ponds. The area lying between outlet of the cemented channel and edge of water area was covered with three types of aquatic plants, namely Colocasia *(Colocasia esculanta)*, typha *(Typha angustata)* and water hyacinth *(Eichhornia crassipes)* in that order.

Initially, sewage was introduced to the colocasia dominant zone. This is an emergent plant that grows well in marshy areas and is capable of accumulating contaminants from polluted wetlands. The partially treated sewage was then moved to downland marshy areas covered with typha, an erect plant species known for accumulating pollutants in contaminants laden area. The organic load of the sewage, while traversing through macrophytes covered area, was found to be greatly reduced. Eventually, the ameliorated sewage reached the pipelines and flowed into the culture ponds of which periphery were covered with water hyacinth – a floating plant which is efficient in further reducing the dissolved organic load in water bodies.

Table 2. Certain physico-chemical characteristics of domestic sewage.

Parameters	Sewage water (value)	Pond water (value)	Reduction of value (%)
pH	7.4-8.0	7.0-7.8	2.5-5.4
Temperature (°C)	28°C-30°C	28°C-30°C	-
Total alkalinity (mg/l)	370-450	126-205	54-66
DO(mg/l)	nil	6-12	600-1,200
BOD_5 (mg/l)	240-500	6.0-12	97.5
NH_4-N (mg/l)	25-60	0.1-1.2	98
P_2O_5 (mg/l)	2.8-9.7	0.09-1.8	81-96

Table 3. Showing value of plankton population, water productivity and microbial population.

Parameters	range	Remarks
Phytoplankton (no./l)	65,000-120,000	Green algae dominant
Zooplankton (no./l)	20,000-45,000	Cladoceran dominant
Gross productivity (mg C/m³/h)	650-850	High productive condition
Net productivity (mg C/m³/h)	250-450	Sufficient amount of oxygen
Microbial load	**Sewage (range)**	**Pond water (range)**
SPC (cfu/ml ×103)	45-120	16.0-40.0
Total coliforms (cfu/ml × 103)	07-16.0	03-13.0

Sewage mixing water body via sewage pipe.

The system was operated with three tiers of treatment in the order mentioned above, facilitating the elimination of solids contained in sewage water. Pond water, after receiving bio-remedied sewage, was found to be of a favourable condition for fish farming, with certain parameters conducive to the growth and development of fish. This biological treatment system had been efficient in reducing drastically the levels (%) of physico-chemical parameters of sewage water (table 2).

Cultured species and their growth

Several fish species were successfully tested to grow in sewage fed ponds, with variable sewage concentration tolerable level from species to species. In this sewage culture water bodies, tilapia *(Oreochromis nilotica)*, silver carp *(Hypopthalmichthys molitrix)* and mrigal *(Cirrhinus mrigala)* were reared with stocking density @ 20,000/ha following the ration 2:1:1 for 6 months only. Their growth, biomass increase, survival and total production are mentioned in table 3.

A view of sewage-fed aquaculture farm.

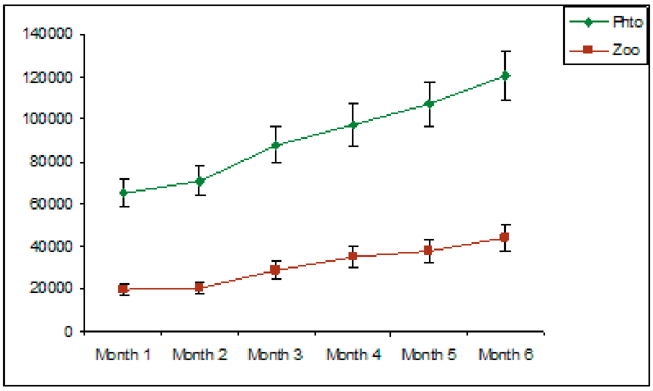
Table 4. Showing growth rate, survival and total production of three species reared in sewage fed ponds.

Species*'	Initial av. wt. (g)	Number stocked	Final av. wt. (g)	Av. net wt. gain (g)	Growth rate (g/day)	Survival (%)	Wt. increase (%)	Total biomass (kg)/ha/6 months	Remark
Tilapia	1.5	10,000	205	203.5	1.13	95	13567	2050	5,575 kg/ ha/6months
Silver carp	5.0	5000	395	390	2.16	86	7800	1975	
Mrigal	4.0	5000	310	306	1.7	81	7650	1550	

Indices used to measure the fish growth were:

- Weight gain (g/pond) = Final weight (g) – initial weight (g).
- Total biomass (g) = Final average weight (g) × number stocked.
- Total biomass (kg)/ha = Harvested fish weight (kg) / unit area (ha).
- Fish survival (%) = (Initial no. of fish – dead fish) / initial no. of fish×100.
- Growth rate (g/day) = Average weight gain (g) / days on culture.
- Weight increase (%) = Final mean weight – initial mean weight / initial mean weight × 100.

Figure 1: Comparative evaluation of both phyto and zooplankton.

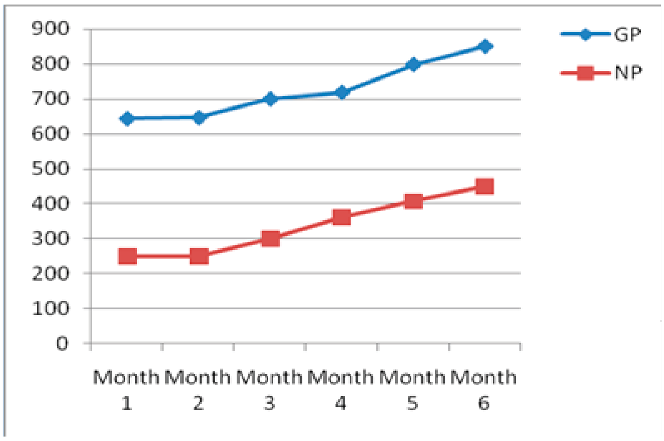


Results and discussion

Incorporation of bio-remedied sewage water in fish culture ponds facilitates an increase in the natural productivity of water body. The autotrophic phytoplankton population increases markedly due to the addition of nutrients contained in sewage.

Phytoplankton play a crucial role in enhancing pond productivity and form the base trophic level of the food chain: Total plankton population constitutes about 80% phytoplankton and 20% zooplankton. The population of phytoplankton determines the productivity of the pond water for higher-trophic level organizing, and can be simply measured by the light and dark bottle method (Odum, 1983). Gross primary productivity (GPP) and net primary productivity (NPP) are two important parameters indicating the condition of pond water in the purpose of aquaculture activity. Estimated GPP in standard phytoplankton dominated ponds was in the range of 650-850 mg c/m^3/h, with NPP ranging between 250 - 450 mg c/m^3/h (Fig. 2). This condition favoured aquaculture production in respect of fish growth and development due to sufficient amount of dissolved oxygen in pond water.

Figure 2: Showing comparative evaluation of gross primary productivity and net primary productivity.



- Increased density of phytoplankton is, in turn, used as food by the zooplankton community. The population of rotifers (*Brachionus* spp.), water fleas (*Daphnia* spp. and *Moina* sp.) and copeopods (*Cyclops* spp.) also increased as they directly feed on phytoplankton. The ability of the system is likely to reach an optimal level for ideal ecosystem functioning when a proper plan in respect to the intake of sewage is operated.
- Research and extension have led fish farmers to understand that fertilisation by sewage facilitates and to maintain the dynamics of the pond environment, which in turn substantially increases the amount of natural foods such as phytoplankton, zooplankton and benthic organisms essential for growth and production of fish reared in this low cost system. To fertilise pond water, the organic load of sewage is the key component as to achieve the following criteria:
- Increased amount of dissolved oxygen, along with transparency of water from minimal level to near normal level conducive to fish growth and development.
- Water temperature remained in the range of 28°- 30°C favourable for fish growth.
- Amount of BOD_5 decreased by about 97.5% through the application of phyto-remediation.
- This remedied water became facilitator for fish survival, growth and development. All these indicated the suitability of pond ecosystem for aquaculture through application of sewage water.

Population of phytoplankton triggered by sewage effluent.

- Pond productivity became congenial as reflected in the high value of gross productivity of pond water, with dynamics of population of fish food organisms favourable for fish growth.

- Gross weight, weight gain and growth rate of cultured fishes increased from initial, with weight enhancement in the range of 7,650-13,567%, total production of yield in the range of 1,550-2,050 kg/ha/6 months and survival in the range of 81-95%.

- From the hygiene and public health perspective, microbial population remained within accepted safe limits.

- Heavy metals analysed from muscle (edible part) of reared fish showed residues below the normal amount (Cu, 2ppm; Cr, 0.2ppm; Pb, 1.0ppm; Zn, 5.0ppm; As, 200ppb and Cd, 400ppb) of recommended levels safe for human consumption.

Endnote

In a rapidly urbanising world where there is increasing concern about a freshwater shortage, the practice of using treated sewage water for aquaculture is essentially required particularly in semi-urban areas in view of abating water pollution. In this context, increasing the productivity of water used for aquaculture has high relevance to provide nutritional as well as livelihood security for farmers. Reuse of treated sewage effluent in aquaculture through effective bio-remediation has been examined as potentially useful method to enhance the productivity of the system. Sewage effluent is a rich source of nutrients and its judicious incorporation in fish rearing systems in a controlled manner has only to be made in order to ensure water quality suitable for fish culture.

Sewage-fed aquaculture is an age-old practice and provides social and environmental benefits via recycling nutrients that may be considered environmental pollutants into food. Such ventures are an effective approach for the conservation of water as well.

Reference

Ayyappan, S. 2000. Duckweed and fish based aquaculture sewage treatment system: status and prospects. In: Wsate recycling and resources management in the developing world by Jana, B. B., Banerjee, R. D., Guterstan, D. and Heeb, J. (eds.), University of Kalyani, India and International Ecological Engineering Society, Switzerland, pp. 59-63.

A view of integrated farming.

Chakrabarti, P.P., Ghosh, P. K., Mukhopadhyay, P. K. and Jayasankar, P. 2011. Urban sewage water recycling through aquaculture. Everything About water, September: 36-39.

Datta, A. K., Roy, A. K. and Saha, P. K. 2000. Comparative evaluation of sewage fed and feed –based aquaculture. In: Wsate recycling and resources management in the developing world by Jana, B. B., Banerjee, R. D., Guterstan, D. and Heeb, J. (eds.), University of Kalyani, India and International Ecological Engineering Society, Switzerland, pp. 97-104.

Jana, B. B. 1998. Sewage-fed aquaculture: The Calcutta model. Ecol. Eng., 11: 73-85.

Jena, J. K., Patro, B., Patri, P., Khuntia, C. P., Tripathy, N. K., Sinha, S., Sarangi, N. and Ayyappan, S. 2010. Biological treatment of domestic sewage through duckweed-cum-fish culture: a pilot-scale study. Indian J. Fish., 57(4):45-51.

Olah, J., Sarangi, N. and Dutta, N. C. 1986.City sewage fish pond in Hungary and India. Aquaculture, 54:129-134.

Rai, S. P. and Pandey, B. K. 1998.Bharat me Apajal Jib Palanki Punarbibechana (written in Hindi). In: (eds. Radheshyam and Ayyappan), Published by Director, CIFA, Bhubaneswar, pp. 22-42.

Cement lining around the edge of pond dyke.

Role of family farming in the marine and coastal ecosystem management in India

J. Stephen Sampath Kumar[1]* and C. Judith Betsy[2]

1. Department of Aquaculture, Fisheries College & Research Institute, Tuticorin, India – 628 008, email jstephenkumar@gmail.com; 2. PhD Scholar, Department of Aquaculture, Fisheries College & Research Institute, Tuticorin, India – 628 008.

India has a coastline that has been recognised for its bio-diversity and ecological significance. There are eleven maritime states in the country that support for the marine fisheries production and coastal aquaculture production. In recent years, production from marine fisheries has been in a declining trend but their slow growth has compensated for by coastal aquaculture production. It is needless to say that management of coastal and marine ecosystems is in the hands of the communities that dwell in them and depend on their resources for their livelihoods.

The United Nations declared 2014 as the "International Year of Family Farming" with an aim to improve the socio-economic status of farmers and to sustainably develop agriculture and allied activities with the involvement of family members. They work with the objectives of eradicating hunger and poverty, providing food security and nutrition, improving livelihoods, managing natural resources, protecting the environment and achieving sustainable development in rural areas.

The family farming initiative was developed with a view to support farming families that have poor access to natural resources, technologies and to promote enabling policies. Family-based farming is a major component of agriculture worldwide and it has been reported that there are as many as 500 million families involved world-wide. The activities in a family farm are typically undertaken primarily through the labour of family members. Family farming is known to improve the livelihood of rural people both in developed and developing countries. In this line, being the farming activity and a livelihood option for the coastal community, the role of such family farming in the marine and coastal ecosystem management can be examined.

Coastal aquaculture and ecosystems

Coastal ecosystems support a great diversity of life. Besides the diversity of marine flora and fauna, a sizable population of human beings and livestock also depend on these ecosystems. Any human activity that affects the balance of the ecosystem can adversely affect resident species and populations. Therefore, coastal aquaculture and its related activities, such as transportation of people and materials and related activities can result in significant changes in coastal ecosystem.

Farm operators therefore have great responsibility for the management of coastal and marine ecosystems. Legislative controls have been put in place to regulate and monitor the discharge from farms and to protect the receiving ecosystems from contamination with biological materials. It is in this context family farming systems have relevance to ecosystem management.

Family farming and coastal ecosystem management

Small scale aquaculture systems in inland areas are often synonymous with family farming systems in many developed and developing countries. Women often innovate or pioneer in small scale family-based farming systems and food security is ensured through equitable participation of the family members. Family labour minimises the cost of production and local market networking through other families engaged in the farming can also lead to the high revenue for the produce. In countries such as China and the Philippines there are large numbers of family-based farming operations involved in seaweed production. In Indonesia and Myanmar, small scale fish hatcheries and trading in fish seed are also done by families. These activities exhibit large scope for the family farming in the coastal aquaculture.

How coastal aquaculture can be a successful family livelihood option?

Simon Funge-Smith of FAO, when discussing small scale aquaculture, pointed out that it can contribute to the diversification of livelihoods and add value to the family farming activities. He further explained that small scale aquaculture in the inland areas can add income and employment opportunities for families. Besides being low capital investment enterprises, they can – under suitable circumstances - also be low risk business for marginal families depending on small piece of land for their livelihood. This is a good fit for countries such as India and other south Asian countries where marginal artisans represent a substantial proportion of production.

Coastal aquaculture enterprises can benefit from the family farming mode in many ways. Firstly, there can be small units instead of large units that can be easily managed by family labour with less investment. Secondly, the cost of production will be under check in the full participation of the whole family ensuring the knowledge pouring in from all family members. Thirdly, learning can be a possibility in the family with the participation of family members. Lastly, there will be sustainability in the business as the family can take it on as an enterprise for its livelihood.

Low technology production systems, gradual introduction of innovation in the production process, ready access to all the needed support materials, easy management options and technical support from technocrats are factors that qualify coastal aquaculture as a suitable option for family farming. Besides the above, better knowledge on local conditions and the need to maintain better surroundings and safety for the environment for the families living in the coastal zone are basic reasons to promote aquaculture as a family enterprise in coastal areas.

Current scenario of the family farming in coastal aquaculture in India

Coastal aquaculture in India is generally considered a business rather than as a farming activity. Although it is essentially a farming activity in many occasions it has been dealt as a business activity there by it loses its agro inclination. Presently only a few instances of family farming can be noticed in the coastal aquaculture in India. Unlike countries such as Vietnam, Indonesia, China, Laos, the Philippines and Australia, where coastal farms commonly produce crustaceans, finfish, oysters, abalones and other molluscs via family farming activities. In India very few families are fully involved in coastal aquaculture farms. Large cages in the bays of Vietnam's coastal waters and the South China Sea are common sights where families reside on the cage farming platform managing the cages. Such a situation cannot be seen in India due to less degree of participation of families in the farming. However in small scale shrimp farming there is tremendous scope for the families to make a big profit through managing farms. Approximately 60% of the farms along the coastline in India employ family labor who can reside inside the farm area and devote their full attention in the farming operation. Here too family labour is fully used for the farming thereby poverty and hunger can be alleviated.

Advantage of family farming in coastal aquaculture

Like small scale aquaculture in inland areas, here too family participation in the farming can make major development in the socio economic status of the families besides the preservation and protection of ecosystems.

As said before woman can be innovators and can make things in an easier and simpler way particularly in feeding and feed preparation. The family labour will always help reducing the cost of production and the sense of ownership can bring in a mature attitude in the minds of youth in the families. Protection of farms and prevention of unlawful activities in the vicinity of the farm area will improve the life status of the families. Economic status of the families can also be improved through additional income. Therefore promotion of family farming in the coastal aquaculture besides providing socio economic improvement for the families can also help in the protection of ecosystem for the country.

Family faming in small scale marine fisheries

Family-based farming can be easily seen in small scale marine fisheries and among artisanal fisherfolk. Most of the activities in marine fishing and marketing involve families or groups of families as communities. For instance owning a country boat or a catamaran by one family is a common sight in east coast of India. The fishing operation in one single craft is managed by family members either closely related or blood related. The erstwhile pearl fisheries in Gulf of Mannar is a popular family fishing activity in which the pearl divers are always assisted by their close blood relatives on the craft. Similarly, marketing of the catch is done by the fisherwomen in the house through retail sales and the unsold catch will be processed further by the members of the family.

A closely knit family enterprise approach can be witnessed in small scale fisheries along the coast of India. This is mainly due to the communal participation strictly restricted to one single community residing along the coast. This is comparable with artisanal agriculture wherein family farming is commonly seen due to small piece of land ownership. Either a family is "engaging" or "engaged" in agri-business under family farming for revenue and preventing poverty and hunger. Participation of entire family in a single agriculture-related activity is an age old practice in small scale marine fisheries that can also be applied to coastal aquaculture and marine farming activities.

References:

http://www.fao.org/family-farming-2014/en/
http://www.agriculturesnetwork.org/

Conservation of fish genetic resources: An introduction to state fishes of India.

Vinay T. N.[1]*, Kapil S.[2], Tanmoy G.[1] and Anutosh P.[1]

1. ICAR-Indian Institute of Agricultural Biotechnology, Ranchi, India, email vinaytn56@gmail.com;
2. ICAR-Central Marine Fisheries Research Institute, Regional Research Centre, Veraval, India

India is estimated to have around 2,500 fish species, some 11.72% of all fish species known world-wide, out of which 2,358 are indigenous and 291 are exotic[1].

Over exploitation, habitat destruction, introduction of exotic species and pollution has led to the loss of native germplasm. Biodiversity conservation is very important to preserve species and also to safeguard the local interest and the cultural attachment of people to certain species. Several species from India are already extinct and many are endangered, threatened or listed in different categories based on their natural presence. The estimated current extinction rate is very high, ranging between 1000-10000 times the natural rate[2]. Hence, appropriate strategies for biodiversity conservation management are required.

Indian Mackerel (Rastrelliger kanagurta), national fish of India.

Murrel (Channa striatus), state fish of Andhra Pradesh.

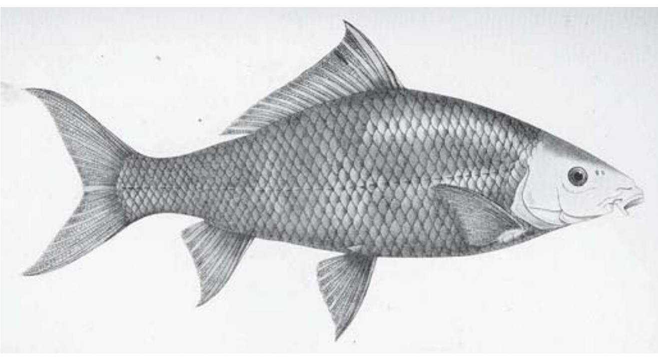
Fish is a very good source of nutrition and has to be preserved for the sake of food security as well. Fisheries has provided food and livelihood to millions of people and in several places livelihoods of local communities are dependent on a particular species, frequently leading to over exploitation. To balance livelihoods and sustainability, it is important to bring awareness among the people to conserve the species. Peacock and the tiger being the national bird and animal respectively, have their own stature in the minds of people and there is always a special interest to preserve these species. Similarly, Indian mackerel is our national fish, found abundantly on the south west coast of India and has a special place in the life of people residing there.

India is a large country with many states and there is considerable cultural variation between them. The varying climatic conditions have led to varied distribution of species among different states of India and the people have different preferences and cultural attachments towards different species. Sensing an opportunity to make use of this, the ICAR-National Bureau of Fish Genetic Resource, Lucknow has conceptualised the "state fish" concept as a method to conserve fish species.

Different states of India have declared their state fish based on the abundance, preference and importance in the day to day life of the people. Out of 30 states, 17 have already declared their state fishes and given importance for their conservation, breeding and culture aspects. This will help in conserving the biodiversity.

Red listing of species

International Union for Conservation of Nature and Natural Resources (IUCN) sets the standard for the conservation effort and species listing based on the threat status on particular species. The IUCN red list conveys the urgency and scale of conservation problems to public and policy makers to bring awareness in people to conserve species from extinction[1].



Kalbasu (Labeo calbasu), state fish of Haryana.

State fishes of India

Out of the 17 states that have declared a state fish, five of them have chosen same species, which indicates the importance of that particular species. It is important that all the states declare their state fish and start contributing towards the conservation of those neglected species, which are in urgent need of conservation. This concept may also be applied elsewhere for biodiversity conservation. This article aims to introduce all the state fishes which are declared at present to the people of the nation to have the awareness on the biodiversity and its conservation.

Channa striatus

Indian state of Andhra Pradesh has adopted Channa striatus (Murrel) as its state fish. It belongs to the family channidae. In Hyderabad, India, some people promote the swallowing of live murrel fish and herbs as an asthma treatment, although it is not legally considered as medicine. This species is very common in the plains of India with no known major threats and is currently assessed as least concern, according to IUCN guidelines[3]. The fish breeds during the rainy season and the female matures at two years, and lays a few hundreds to over a thousand eggs. Young ones are guarded by both parents until they are in fry stage[4].

Tor putitora

Indian states of Arunachal Pradesh, Himachal Pradesh, Jammu Kashmir, Madhya Pradesh and Uttarakhand have adopted Tor putitora (golden mahseer) as their state fish due to its natural occurrence in the region, the affinity of local population towards the fish and mainly due to the conservation status of the fish. It belongs to the family Cyprinidae. It is the most preferred game fish for anglers globally, but unfortunately it is one of the most endangered species of fish in India. The reasons could relate to biological factors, as the fish has a very long hatching period. Further, its migration routes are blocked by construction activities on the rivers. The species is therefore assessed as endangered according to IUCN guidelines and is in need of urgent conservation efforts to save it from becoming locally extinct. Fish lays,

Carnatic Carp (Puntius carnaticus), state fish of Karnataka.

4,000-5,000 eggs/kg body weight. The artificial breeding techniques are standardised but the seed production has to be increased[5].

Clarias batrachus

The Indian state of Bihar has adopted Clarias batrachus (magur) as its state fish. It belongs to the family Clariidae. It is highly threatened by exploitation and threats to breeding grounds. More than 50% of the wild population has declined in the last few years, and the species is assessed as endangered according to IUCN guidelines. Magur spawn for short period from July to August during the rainy season, when water level rises and fish are able to build nests in submerged mud banks and dykes. Significant developments have been made in India in culture techniques for Magur under the All India Coordinated Research Project on Air-breathing Fish Culture. Seed production has to be increased to conserve the species[6].

Labeo calbasu

Haryana has adopted Labeo calbasu (kalbasu) as its state fish. It belongs to the family Cyprinidae. It is mainly present in ponds and in slow moving waters of rivers. Based on wide distribution in India, it is one of the major Indian carps. It is an important food fish and at several places, and is referred as the "black rohu". It is an important game fish in several tanks where it is stocked and is cultured along with other species. Due to its abundance, the species is assessed as least concerned according to IUCN guidelines. The fecundity of this species ranges between 200,000 and 250,000, it does not normally breed in ponds, and hypophysation is required for induced breeeding[7].

Puntius carnaticus

Karnataka has adopted Puntius carnaticus (carnatic carp) as its state fish. It belongs to the family Cyprinidae. The species is abundant in the rivers of Karnataka, Kerala and Tamil Nadu. Carnatic carp forms minor fisheries in several reservoirs located in the Cauvery River basin. It is threatened by a wide range of factors including decline in habitat quality due to destructive fishing practices such as poisoning and dynamiting, altered river flow due to construction of dams, competition with exotic and transplanted carps and aquatic pollution. No proper conservation efforts are in place. However, due to its abundance, the species is assessed as least concern category according to IUCN guidelines. The adults migrate upstream for spawning and breed in the flood waters along rivers during the monsoons. Milt cryopreservation and captive breeding protocols have been developed at National Bureau of Fish Genetic Resources and Central Institute of Freshwater Aquaculture-Regional Research Centre, Bangalore is dedicated to conduct the research, on peninsular carps including carnatic carp[8].

Etroplus suratensis

Kerala has adopted Etroplus suratensis (karimeen) as its state fish). It belongs to the family Cichlidae. Karimeen is a euryhaline species that inhabits mainly brackish water and in river mouths. A major threat is from exotic species like Oreochromis mossambicus and Trichogaster trichopterus. Though the species has high demand, the wild populations have not been given sufficient conservation attention. However, due to abundance the species is assessed as least concern category according to IUCN guidelines. Karimeen breeds in rainy season and several adults care for a single brood that were probably spawned by only a single pair of the adults[9].

Osteobrama belangeri

Manipur has adopted Osteobrama belangeri (Pengba) as its state fish. It belongs to the family Cyprinidae. Pengba has become extinct from the wild in Manipur and the extinction of the species is due to dam construction and other threats. This indicates that the species is very sensitive to changing environments. Since no threats are known for the species' distribution range, it is assessed as near threatened category according to IUCN guidelines. More research is needed to investigate the possibility of natural population in India. It is commercially used as food from captive breeding in Manipur. Artificial breeding techniques are available and seed production has to be increased for stocking in natural water bodies[10].

Semiplotus modestus

Mizoram has adopted Semiplotus modestus (nghavang) as its state fish. It belongs to the family Cyprinidae. This is a very rare species and it inhabits moderate to fast flowing mountain streams and rivers with rocky bed. The hill streams are now threatened by sedimentation due to deforestation and agricultural practices resulting in habitat destruction of the species. Research on distribution, biology, habitat and threats are very necessary. The species is at present assessed as data deficient category according to IUCN guidelines. Further survey work is needed to determine whether or not this species is experiencing a decline, or is undergoing extreme population fluctuations[11].

Karimeen (Etroplus suratensis), state fish of Kerala.

Pengba (Osteobrama belangeri), state fish of Manipur.

Neolissocheilus hexagonolepis

Nagaland has adopted Neolissocheilus hexagonolepis (chocolate mahseer) as its state fish. It belongs to the family cyprinidae. It is endemic to northeastern states of India, particularly to the Brahmaputra River basin. It is a very popular fish for both food and sport and also a rich protein source for remote villagers of Arunachal Pradesh, Assam and Meghalaya. But it is reported to be declining in the wild and presently assessed as near threatened species category according to IUCN guidelines. Its propagation by artificial breeding is been attempted as a measure of conservation by several research and educational Institutions[12].

Tor mahanadicus

Indian state of Orissa has adopted Tor mahanadicus (mahanadi mahseer) as its state fish. It belongs to the family Cyprinidae. It is commonly known as the tor mahseer or tor barb. It is found in fast flowing rivers and streams with rocky bottoms and is a commercially important food and game fish. Its population is rapidly declining in its native range due to overfishing. It is a large fish, reaching 36 cm at maturity. In conservation terms it is assessed as near threatened category according to IUCN guidelines[13].

Ompak bimaculatus

Tripura has adopted Ompak bimaculatus (pabda) as its state fish. It belongs to the family Siluridae. Pabda is also known as butter catfish, it is a species of sheat fishes native to India, Bangladesh, Pakistan, and Sri Lanka, but recently identified in Myanmar. In conservation terms it is in near threatened category according to IUCN guidelines. Breeding techniques for this species are standardised in the state of Tripura and seed production needs to be given more importance[14].

Chitala chitala

Indian state of Uttar Pradesh has adopted Chitala chitala (chitala) as its state fish. It belongs to the family Notopteridae. Chitala is mostly restricted to the Indian subcontinent and the stock has declined considerably. However, limited data is available on the population status and it has been difficult to estimate the period over which the suspected decline has occurred. The species congregates, making it very easy to catch where it is present. The catches of this species are fast declining in India. In conservation terms it is assessed as near threatened category according to IUCN guidelines.

Nghavang (Semiplotus modestus), state fish of Mizoram.

Chocolate Mahaseer (Neolissocheilus hexagonolepis), state fish of Nagaland.

Breeding has been successfully demonstrated and captive breeding of the species is being undertaken in parts of India to provide food fish[15].

Tenualosa ilisha

Indian state of West Bengal has adopted Tenualosa ilisha (hilsa) as its state fish. It belongs to the family Clupeidae. There is not a single Bengali that doesn't like hilsa. It has become an integral part of everyday life and diet of Bengali culture. The species is widespread, but there have been serious declines in some major populations of the species due to over-exploration by commercial fisheries. There are no known, species-specific conservation measures in place. In conservation terms it is assessed as least concern category according to IUCN guidelines. This species has the ability to spawn multiple times during its spawning season from May to August. Its absolute fecundity ranges from 450,000 to 1,600,000 eggs per female, but may reach 2,000,000 depending on the size of the fish[16].

Conclusion

Out of the 13 species adopted by 17 states, 2 are endangered and 5 are near threatened and if proper care is not taken, there is every chance of losing these species. The conservation of aquatic organisms has to be taken very seriously as more and more organisms are approaching a threat of extinction. The state fish concept is an innovative step to make people understand and take care of species that are related to the everyday life of the people. It leads to the conservation of the local germplasm and helps to maintain sustainability in fisheries activities. It is the responsibility of every person to contribute to conservation of biodiversity, and not just the states who have declared their state fishes. It is "easy to lose a species but impossible to create one". This concept of encouraging region specific conservation method will bring more awareness in people for biodiversity conservation and sustainable livelihoods.

Pabda (Ompak bimaculatus), state fish of Tripura.

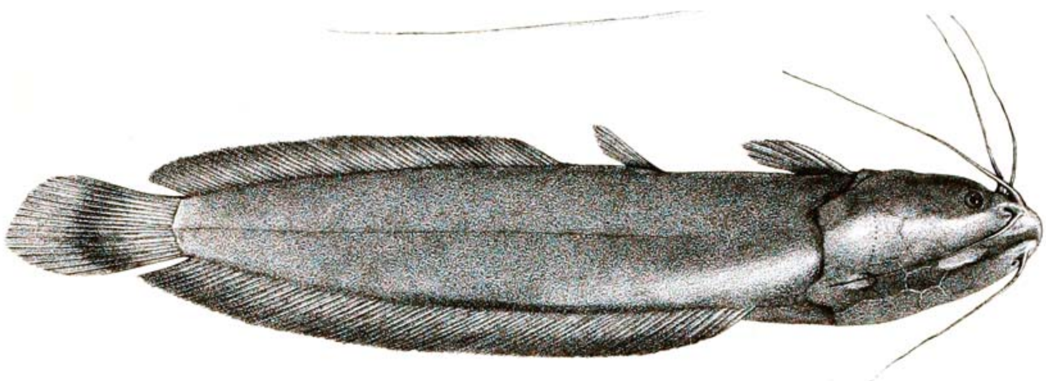
Chitala (Chitala chitala), state fish of Uttar Pradesh.

References

1. Lakra, W.S., U.K. Sarkar, A. Gopalkrishnan, A. Kathirvelpandian. 2010. Threatened fresh water fishes of India. NBFGR Publication. ISBN: 978-81-905540-5-3.
2. Kumar, A and V. Khanna. 2006. Globally threatened Indian Fauna Status, Issues and Prospects: Zoological Survey of India, Kolkata. ISBN: 81-8171-122-X.
3. IUCN, 2014. IUCN Redlist of threatened fishes. www.iucnredlist.org.
4. Chaudhry, S. 2010. *Channa striata*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved 02 May 2016.
5. Jha, B.R. & A. Rayamajhi, 2010. *Tor putitora*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved 02 May 2016.
6. Vishwanath, W. 2010. *Clarias magur*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved 02 May 2016.
7. Dahanukar, N. 2010. *Labeo calbasu*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved 02 May 2016.
8. Ali, A & R. Raghavan. 2013. *Barbodes carnaticus*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved 02 May 2016.
9. Abraham, R. 2013. *Etroplus suratensis*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved 02 May 2016.

Hilsa Fish

10. Vishwanath, W. 2010. *Osteobrama belangeri*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved 02 May 2016.
11. Singh, L. 2010. *Semiplotus modestus*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved 02 May 2016.
12. Mahapatra, B.K and K. Vinod. 2011. Reproductive biology and artificial propagation of chocolate mahseer *Neolissocheilus hexagonolepis* (Mc Clelland) in Meghalaya, India. Indian Journal of Fisheries 58(2): 35-40.
13. Rayamajhi, A., B.R. Jha, and C.M. Sharma. 2010. *Tor tor*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved 02 May 2016.
14. Froese, Rainer and Pauly, Daniel, eds. (2013). *"Ompok bimaculatus"* in FishBase. April 2013 version.
15. Chaudhry, S. 2010. *Chitala chitala*. IUCN Red List of Threatened Species. Version 3.1. International Union for Conservation of Nature. Retrieved June 02 May 2016.
16. Freyhof, J. 2014. *Tenualosa ilisha*. IUCN Red List of Threatened Species. Version 3.1. Internation.



Magur.

NACA Newsletter

ISSN 0115-8503

Published by the Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand

Volume XXX, No. 3
July-September 2015

26th NACA Governing Council Meeting, Bali, Indonesia

The 26th meeting of the NACA Governing Council was hosted by the Government of Indonesia in Bali, from 5-7 May in the Inna Grand Bali Beach Hotel. Sixteen member governments attended, as well as representatives from four NACA Regional Lead Centres, the Food and Agriculture Organization of the United Nations, the Southeast Asian Fisheries Development Center and the Secretariat of the Pacific Community. A welcome address and opening remarks were given by Dr Slamet Soebjakto, Director General of Aquaculture, on behalf of the Indonesian Ministry for Marine Affairs and Fisheries. A keynote address on the foundation of NACA and its achievements over the past 25 years and looking forward was given by H.E. Dr Plodprasop Suraswadi, the founder of NACA and Chair of the NACA Task Force.

Dr Soebjakto was elected as the Chair of the Governing Council for 2015, and Dr Waraporn Prompoj, Thailand, was elected as Vice Chair. The Secretariat would like to thank the outgoing Chair, Mr Bounthong Saphakdy, Lao PDR, for shepherding the organisation during 2014.

The key issue for this meeting was setting a new direction for the organisation. In 2015 the Governing Council established the "NACA Task Force", a group of eminent persons with broad experience in aquaculture development in the region, to review NACA's role, structure, funding and operation with respect to the present needs of member governments. The Task Force was created in recognition of that fact that, in the twenty-five years since NACA had been established, the technical capacity and economic status of most member states had substantially improved, donor funding for the region was in decline and the organisation needed to be reoriented with respect to the contemporary operating environment. Twenty-five years ago aquaculture was just emerging as a new branch of science and there were very few technical personnel in the region, and for most countries food security, poverty alleviation and capacity building were the most pressing issues. For some member governments these are still the major concerns, while others now have relatively mature aquaculture industries and significant internal technical capacity and expertise.

The Task Force was chaired by H.E. Dr Plodprasop Suraswadi, with four members being Prof. Sena De Silva (former Director General of NACA), Dr Meryl Williams (former Director General of the WorldFish Center), Dr Brian Davy (formerly of Canada's International Development Research Centre) and Dr Pongpat Boonchuwong (Advisor to the Thai Department of Fisheries).

The Task Force, represented by Prof. De Silva, delivered recommendations on a wide range of issues, but with respect to the work programme, was essentially was of the view that given the decline in donor funding for the region member governments would increasingly needed to fund and execute joint development activities from their own resources. The Task Force therefore recommended that the member governments increase their financial contributions to the organisation and that the Secretariat strengthen collaboration in project development, implementation and information sharing across the network, with renewed emphasis on the regional lead centres.

The Task Force also indicated that NACA needed to move beyond basic capacity building and poverty reduction activities to accommodate, in addition to these core functions, an additional emphasis on building capacity in social issues, in particular in gender and in aquatic resource management with regards to inland waters. The Task Force also noted the need for an additional focus on more technical aspects of aquaculture such as food safety and trade, aquatic animal health, genetics and biodiversity and development of better management practices with a view to improving the sustainability of aquaculture as a livelihood and an industry.

Member governments outlined their current needs and priorities. Issues of broad common interest included food security, broodstock management and seed quality, aquatic animal health, climate change impacts, trade and gender. Labour rights were emerging as a significant regional issue, both from a social responsibility and trade perspective. Accordingly, traceability mechanisms to create transparency in the supply chain, and also to farmed products to be distinguished from fished products, were seen as a high priority. The Governing Council also requested the Secretariat to consult the Government of Nepal concerning a possible recovery assistance programme in the wake of the recent devastating earthquake.

The Governing Council also endorsed the NACA Work Plan 2015+ (PDF, 1.29 MB), the most recent iteration of the rolling work plan, which was developed by the 12th Technical Advisory Committee meeting, held in Cha-am, Thailand.

The 27th NACA Governing Council will be held in Thailand in 2015, in conjunction with the 11th Asian Fisheries and Aquaculture Forum.

Regional Workshop on the Status of Aquatic Genetic Resources

FAO and NACA organised the Regional Workshop on the Status of Aquatic Genetic Resources in Asia-Pacific at Hotel Centara Grand Ladprao, Bangkok from 23-26 March 2015. This was the first workshop in the series of four to be conducted globally by FAO. The workshop was intended to enhance the capacity of national focal Points on Aquatic Genetic Resources within Asia-Pacific Region regarding the preparation of national reports on the current status of aquatic genetic resources for food and agriculture (use, conservation and management). These will be used as the major source of information for the first State of the World's Aquatic Genetic Resources for Food and Agriculture report, under the umbrella of the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA).

The national focal points from fifteen countries in Asia; Thailand, Cambodia, Lao PDR, Vietnam, Indonesia, Malaysia, Philippines, India, Pakistan, Nepal, Myanmar, Japan, South Korea and the Pacific participated in the workshop, along with Fiji and global experts. FAO staff including Dr Devin Bartley, Dr Halwart Matthias and NACA staff Dr Kuldeep K. Lal facilitated the process of workshop with expert input

from Dr Graham Mair (Australia), Dr Tim Pickering (SPC), Dr Clemens Fieseler (Germany) and Dr Ruth Garcia Gomez (FAO consultant).

The workshop started with the welcome address from Dr Cherdsak Veerapat, Director General of NACA and opening remarks by Dr Devin Bartley. The workshop was opened by Dr Miao Weimen, FAORAP, Bangkok on behalf of Dr H. Konuma, ADG, FAO Office for Asia pacific, Bangkok. The participants were given an appraisal on the theme and concept of this workshop through four expert presentations on workshop content, process, expected outcomes and outputs and introduction to the CGRFA by Devin Bartley. The Aquatic Genetic Resources Component of CGRFA and the steps towards the State of the World's Aquatic Genetic Resources report were addressed by Matthias Halwart; the German National Technical Programme on the conservation and sustainable use of aquatic genetic resources by Clemens Fieseler and perspectives on aquatic genetic resources management and conservation in Asia-Pacific by Kuldeep K. Lal.

The national focal points and experts discussed each chapter of the report in the respective groups. The groups also prepared each chapter as an exercise with information from one member country as an example followed by a presentation on the chapter by respective group.

This exercise was found useful by the national focal points as this not only provided them first hand feel of the whole questionnaire but also served as useful feedback for FAO colleagues to incorporate suggested modifications in the report format.

A one day field visit was organised by NACA for the delegates to see the activities related to aquatic genetic resources in Thailand. The forenoon session was devoted to observing activities at the Thai Department of Fisheries Inland Fisheries Research Station at Bangsai. In addition to various aquaculture activities, an interesting feature was on farm conservation of the Mekong giant catfish Pangasianodon gigas, a near extinct species conserved through a dedicated breeding program. In the afternoon delegates visited National Centre for Genetic Engineering and Biotechnology (BIOTEC) at Thailand Science Park. Here delegates were exposed to the activities through presentations about BIOTEC and its shrimp biotechnology program by Dr Sirawut Klingbunga, Director of the Animal Biotechnology Research Unit. The delegates visited the laboratories and also the pilot testing plant.

The technical session resumed on March 26, 2015 with the exercise on chapters. The exercise on drafting eight chapters of the State of the World's Aquatic Genetic Resources report were completed during the stipulated time. The delegates found the training useful and will help them to facilitate the process of preparing country reports for submission the FAO's Fisheries and Aquaculture Department and this accomplished the objective of this workshop.

Developing an environmental monitoring system to strengthen fisheries and aquaculture in the Lower Mekong Basin

FAO and NACA convened a stakeholder consultation in Bangkok 25-27 March 2015 to discuss development of an environmental monitoring system for the lower Mekong Basin. The objective of the system is to strengthen the resilience of fisheries and aquaculture and to improve early warning for fishers and farmers.

The workshop was preceded by baseline assessments of existing environmental monitoring and early warning systems relevant to fisheries and aquaculture in the target area, which covers Vietnam, Cambodia and Thailand. The assessments also reached out to relevant agencies in the target countries to gather feedback on what environmental issues they considered important and what parameters should be monitored to meet these ends. While the main goal of the system is to serve the daily needs of farmers and fishers – providing information and warnings important to their livelihoods - a secondary objective is to facilitate long-term monitoring of the impacts of climate change over the long term.

The state of environmental monitoring was observed to vary between countries. Some such as Thailand, for example, have very good monitoring systems in place for meteorological and water management. Vietnam's meteorological bureau monitors also river levels and publishes flow and height forecasts. Cambodia has strong programmes to monitor water quality and biodiversity aspects, such as surveys of fish larvae and fish diversity and abundance in deep pools. However, these diverse systems are owned and operated by a raft of different agencies, as they have been developed to serve different purposes, and are not necessarily connected or sharing data. The workshop identified a need to try and integrate the available data produced by existing sources and to build on it, where required, to provide a unified environmental monitoring system capable of sharing data and reporting over different geographic scales, from the wider basin level (ie. between countries) to the local-level advisories of interest to farmers and fishers.

Another crucial issue is connecting the reports generated by the system to fishers and farmers using appropriate communication channels, to ensure that they actually receive the kind of information they need in a timely manner and can benefit from it. As accessibility to different forms of media, language and literacy skills are all substantial issues for often remote communities, communication channels must be chosen very carefully, and in line with the access, skills and convenience of fishers and farmers.

The consultation spent some time discussing recent technological developments. The dramatic increase in the penetration of mobile phones (especially smart phones) and coverage of mobile networks offers a way to directly deliver area-specific information services to farmers and fishers as well as the opportunity to involve them in data collection through custom applications. The 'internet of things' also offers new opportunities for low-cost data gathering. Cheap programmable micro-controllers - essentially the tiny computer you might find operating a hotel door lock - are now widely available even as hobbyist kits, excellent documentation and can be fitted with a surprisingly wide array of off the shelf environmental sensors to monitor anything from light, temperature and humidity to gas and radiation levels.

The findings of the consultation will be used to develop a pilot project, to be implemented on a regional basis. Due to the nature of the project, implementation is expected to proceed over an extended, ongoing basis.

Regional workshop documents sustainable intensification practices in aquaculture

Due to the world's rapidly growing population, which is expected to peak somewhere around 9.5 billion, food production will need to be massively increased over the next few decades. This increase must be achieved without further degrading the environment. The unit environmental footprint of food production must be significantly reduced from where it is today. This concept, termed sustainable intensification, applies as much to aquaculture as it does to other agricultural sectors.

As a step towards this goal FAO and NACA convened a Regional Workshop on Documentation and Dissemination of Successful Practices of Sustainable Intensification of Aquaculture in Asia-Pacific, from 16-18 June 2015 in Bangkok, Thailand. The workshop was attended by 29 experts from 17 states in the region and regional development organisations. It was opened by Mr Hiroyuki Konuma, FAO Assistant Director General and Regional Representative for Asia and the Pacific.

The purpose of the workshop was to identify and document successful farming practices and technologies that had contributed to the intensification of aquaculture in a sustainable way. That is to say that they had provided demonstrable benefits to farmers and farming communities without adding to the environmental impact of aquaculture production, or by reducing it. By documenting these practices, it is hoped that awareness of them will be raised and that they will be adopted in other countries in the region.

The workshop participants reviewed twelve case studies shortlisted for consideration:

- Development of an improved common carp strain and its dissemination in China.
- Development and dissemination of genetically improved "Jayanti" rohu (*Labeo rohita*), India.

- Development and dissemination of specific pathogen free shrimp seed (*Penaeus monodon*), Thailand.
- Successful development and dissemination of the mass grouper seed production technology in Indonesia.
- Development and dissemination of low cost farm-made formulated feed for improved production efficiency in polyculture, India.
- Increased resilience and empowerment of small-scale farmers through cooperatives, China.
- Development of bivalve farming as a source of income generation for women self-help groups in coastal India.
- Integrated rural livelihood development through trout farming and related business in hill areas of Nepal.
- A science-based management approach for sustainable marine cage culture, Hong Kong SAR.
- Integrated multi-trophic aquaculture of fish, bivalves and seaweeds in Sanggou Bay, China.
- Sustainable milkfish production in marine cages in the Philippines through strong government support and effective public-private partnerships, Philippines.
- Development and dissemination of closed and semi-closed intensive shrimp production systems, Thailand.

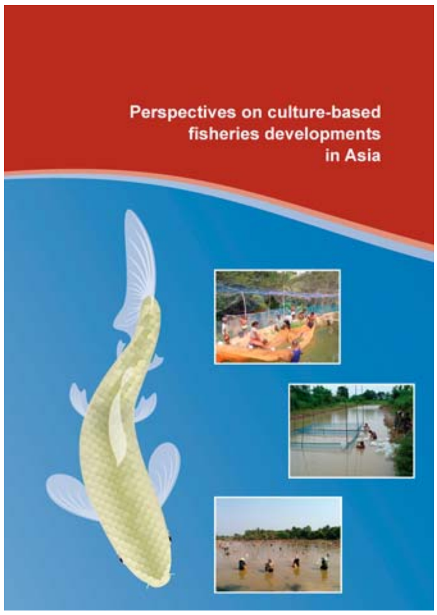
Case studies that meet the grade for sustainable intensification will be written up in a forthcoming publication to be released jointly by FAO and NACA, which will be released for free download in due course. For more information please contact kuldeep.lal@enaca.org.

Perspectives on culture-based fisheries developments in Asia

This book is the proceedings of the Regional Consultation on Culture-Based Fisheries Development in Asia, held in Siem Reap, Cambodia, 21-23rd of October 2014, under the auspices of the Australian Centre for International Agricultural Research (ACIAR), the Mekong River Commission (MRC) and the Network of Aquaculture Centres in Asia-Pacific (NACA). The consultation was jointly organised by NACA and the Fisheries Administration of the Royal Government of Cambodia.

Food and nutritional security remains problematic in many developing countries. There are many initiatives underway which are designed to increase food supply, employment and income opportunities, most of which require considerable capital inputs (for instance cropping, livestock production and aquaculture). Often overlooked, are the opportunities to produce more food from the natural productive ecology of lakes and forests. Culture-based fisheries are one example of a relatively simple and low cost technology which can deliver nutritional and economic benefits to communities which often have few livelihood options.

Culture-based fisheries are based in lakes and reservoirs, where fish populations are supplemented by hatchery-produced fingerlings. The stocked fish may breed naturally in the lakes, or they may be species which are desirable but which do not breed in the still-water environments. Fish growth is driven by the natural productivity of the water bodies. Generally, local



communities have ownership of the fish, with the benefits shared or used for communal purposes. However, there are other options for management and ownership depending on local needs, cultural arrangements and other uses of the water.

Research and development of culture-based fisheries has been a major endeavour for NACA and ACIAR since the mid-1990s. This has involved projects in Sri Lanka, Indonesia, Vietnam, Lao PDR and Cambodia, the results of which have been reported in previous publications, as noted below.

In this volume, we bring together an update from research conducted in those countries and others. We trust the information will foster further development and spread of culture-based fisheries in Asia and beyond, and in doing so, bring livelihood and nutritional benefits to otherwise resource-poor communities.

http://www.enaca.org/modules/library/publication.php?publication_id=1150

Network of Aquaculture Centres in Asia-Pacific

Mailing address:
P.O. Box 1040,
Kasetsart University
Post Office,
Ladyao, Jatujak,
Bangkok 10903,
Thailand

Phone +66 (2) 561 1728
Fax +66 (2) 561 1727
Email: info@enaca.org
Website: www.enaca.org

NACA is a network composed of 19 member governments in the Asia-Pacific Region.

SUPERSEAS PhD opportunities

SUPERSEAS is a major research programme funded by the NWO Food and Business Global Challenges Program. The objective of SUPERSEAS is to study area-based management and certification as an alternative governance and risk-sharing model for sustainable aquaculture and to explore how vulnerable producers and consumers can benefit from reduced risk of aquaculture production and more secure supply both directly and through markets. The SUPERSEAS program includes three PhD-projects. The full proposal can downloaded here and the individual advertisements here.

Position 1 Design of area-based aquaculture management and certification models

Based at the Environmental Policy Group (ENP) and Business economics Group (BEC) at Wageningen University in the Netherlands and the WorldFish Centre in Penang Malaysia, you will conduct independent research on the design of area-based management (ABM) and certification models for aquaculture in Southeast Asia. You will develop your PhD project in line with questions on the principles of effective ABM, the applicability and design of sustainability certification. You will answer these questions by undertaking an assessment of existing collective production systems and sustainability certification schemes. You will be based at Wageningen University, but with extended periods of field work in Bangladesh, Thailand and Vietnam.

Position 2: PhD position: Inclusive value chain models for area based aquaculture certification

Based at the Environmental Policy Group (ENP) at Wageningen University in the Netherlands and Prince of Songkla University in Thailand, you will conduct independent research on the potential for inclusive area-based business models for sustainable aquaculture in Thailand, Vietnam and Bangladesh. You will develop your research around questions related to how the contract conditions and value chain arrangements controlled by retailers in Europe and Southeast Asia, and regional trade policies under ASEAN, can lead to greater inclusion of vulnerable households through area-based aquaculture management and certification. Your scholarship is a 'sandwich' construction, meaning you will spend half your time at Wageningen University and the University of Prince of Songkla.

Position 3: Opportunities and impact of area-based aquaculture on access to finance and risk transfer

Attached to the Business economics Group (BEC) at Wageningen University in the Netherlands and Can Tho University in Vietnam. You will conduct independent research on the financial consequences of area-based aquaculture systems and related opportunities for finance and risk transfer. You will develop your PhD project in line with questions on what risk financing lessons can be transferred from other area-based systems in the world, what cost implications can be expected at specific sites in Southeast Asia, how design and access to risk financing is affected, and what implications for food security for Southeast Asian smallholders can be derived. The post will be based in Wageningen but expected to spend extended periods of time at Can Tho, University.

Applications

For more details on the minimum requirements of prospective candidates and application procedure please visit the following website:

http://www.wageningenur.nl/en/Expertise-Services/Chair-groups/Social-Sciences/Environmental-Policy-Group/Show/PhD-vacancies-on-areabased-aquaculture-management-in-Southeast-Asia-.htm

Applications should be submitted by email to simon.bush@wur.nl before **1 September 2015**.