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Rural aquaculture – Now and Then

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Abstract

Rural aquaculture as a weapon to fight poverty and reduce inequality has received renewed attention in recent years. It contributes to poverty alleviation and provides employment to millions of people, both in the sector itself as well as in support services. Rural aquaculture pertains to the farming of aquatic organisms by small-scale farming household or communities, usually by extensive or semi-intensive low-cost production technology appropriate to their resource base. In rural aquaculture there is low level of fish production for household use and family income. Its production and income potential has largely remained undocumented. Development of rural aquaculture can be accomplished in two ways - by increasing the area devoted to aquaculture and by intensifying production in existing aquaculture areas. Recent discourses on small-scale rural aquaculture concluded that aquaculture should not be viewed as an isolated technology but be considered as one aspect of rural development and form part of a holistic approach to development. The institutional mechanisms by which the rural poor can access and benefit from aquaculture are being duly emphasized. Researchers in India and elsewhere have demonstrated the impact of rural aquaculture on the lives of poor. In terms of providing nutritious food (fish being the cheapest animal protein) and creating employment opportunities aquaculture interventions have proved to be quite useful. Changing perspectives of rural aquaculture; shift in focus from productivity to profitability; aqua farmers turning into aqua innovators and several other aspects are discussed in the paper.

Keywords: Aquaculture field school, gender mainstreaming, ornamental fish village, rural aquaculture

Historical perspectives of rural aquaculture

Kautilya's Arthasastra – one of the oldest Indian epics indicates that fish culture activity in India dates back to 2000 years. Perhaps it started when the human settlement moved away from the riverbanks to the hinterland. Paddy fields and low lying areas in flood plains and those connected to the estuaries and estuarine creeks became the cradle of aquaculture where inundation, caused either by monsoon rain or by tidal water, brought the natural seed of finfish and shellfish which got automatically trapped after the water receded. That eventually gave rise to the operation of "trapping and holding" of fish seed and raising them to table size and thus this marked the beginning of aquaculture in India (Sinha,1999). Ponds (in some part of India it is called tanks) are an essential component or rural setting. Similarly, any religious place, whether it is Hindu temple or Muslim mosque or Sikh gurudwara invariably has ponds or tanks with fish. The value of such ponds and of the fish as purifying agent of water was well known to Indians since time immemorial. Thus ponds became an integral part of Indian tradition, culture and religion (Sinha, 1999).

Although aquaculture has been in vogue, its important role in rural development has been rediscovered recently. Soon after the independence in 1947 from the British Empire, India pursued the policy of increasing food production and community development. It embarked on programs such as "Grow More Food" and made considerable investment in irrigation infrastructure and institutions building (Sinha, 1999).

Scope of Rural aquaculture

Rural aquaculture pertains to the farming of aquatic organisms by small-scale farming household or communities, usually by extensive or semi-intensive low-cost production technology appropriate to their resource base. In rural aquaculture there is low level of fish production for household use and family income (Choudhury, 1997). It's production and income potential has largely remained undocumented. The resource-poor base of most farms requires off-farm agro industries inputs to intensify production. This implies use of mainly inorganic fertilizers rather than formulated feed to provide low market value produce affordable to poor consumers. Aquaculture growth can be accelerated in two ways - by increasing the area devoted to aquaculture and by intensifying production in existing aquaculture areas. According to an estimate potential of vast freshwater resources covering 6.7 million hactare is yet to be fully utilized. Aquaculture may use swamps, saline soils mangroves that are otherwise unsuitable for agriculture. It may also use inland aquatic resources such as natural and man made lakes, reservoirs, rivers etc. (Choudhury, 1997).

Aquaculture is a sunrise sector and a lion's share of total fish requirement of the country is going to be contributed by this sector. Fish Farmers Development Agency (FFDA), one of the flagship schemes of DAHDF, Ministry of Agriculture, Govt. of India has made good contributions in improving the average yield level (3000 Kg/ha/yr in 2011-12). However, yield levels of ponds not covered under FFDA are still very low. Promotion of scientific fish farming in such areas is highly recommended. Recently various new aquaculture resources are developed including water harvest structures (NWDPRA), farm ponds (NREGA), water bodies renovated under the Ministry of Water Resources funded project "Repair, Renovation and Restoration (RRR) of water bodies". These are untapped potentials for enhancing fish production. Technological package developed for perennial water bodies will have to be suitably modified to

Table 1. Time line of major breakthroughs and its impact on rural aquaculture

Year	Major research breakthrough/ Landmark achievements	Remarks
1957	Induced breeding of carps	Induced breeding, i.e., hypophysation, has paved the way for obtaining adequate numbers of fry for stocking purposes. This discovery has revolutionized fish farming sector.
1970	Carp fry and fingerling production	Rearing of spawn to fry (15-20 mm) and fingerling (50-60 mm) is considered to be a significant step in successful fish farming. Production of carp fingerlings normally takes place in semi-intensive ponds, based on manure/fertilizer-generated natural food and supplementary feeding.
1971	Composite carp culture	More than one type of compatible fishes are cultured simultaneously. It enables maximum fish production from a pond or a tank through utilization of available fish food organisms in all the natural niches, supplemented by artificial feeding.
1975	Integrated fish farming	The principle of integrated fish farming involves farming of fish along with livestock or/and agricultural crops. This type of farming offers great efficiency in resource utilization, as waste or byproduct from one system is effectively recycled. It also enables effective utilization of available farming space for maximizing production.
1970	Cage and pen culture	Both cage and pen culture are types of enclosure culture, and involve holding organisms captive within an enclosed space whilst maintaining a free exchange of water. A cage is totally enclosed on all, or all but the top, sides by mesh or netting, whereas in pen culture the bottom of the enclosure is formed by the lake or sea bottom.
1984	Monosex tilapia	Application for 21 days of feed treated with 17-Î± methyl testosterone ensured consistently high (~99%) levels of male fish. Culture of monosex tilapia has become very popular.

1988	Ovaprim	Ovaprim, an alternative to Pituitary gland extract, is a sterile injectible liquid that contains Syndel's patented sGnRHa and a dopamine inhibitor. Ovaprim is injected into the fish during the spawning season to promote and facilitate reproduction of many species of fish.
1993	Stunted yearling stocking	Since carps are known to grow faster during their second year, now a days ponds are stocked with 8-12 month-old stunted fishes of 100 -150 g, instead of fry or fingerlings as practiced in the traditional system.
1997	Improved rohu 'Jayanti'	Jayanti developed through selective breeding with selection response of 17% per generation.
1998	CIFAX	The formulation CIFAX has proved to be very effective for prevention and control of Epizootic ulcerative syndrome.
2004	Pellet feeding	Carp feed pellets are a complete nutrition for carp and other cyprinids. These pellets are based on very palatable ingredients like fish meal, fish oil and several grains.
2006	FRP hatchery	Fiberglass reinforced plastic hatchery, is an alternative to concrete hatchery, for production of healthy carp seed. The system consists of one breeding pool; one hatching pool; and egg collection chamber and an overhead storage tank. It can produce 10 lakh carp spawn per operation.
2006	*Pangasiussutchi* introduced	Catfish (Pangasius) introduced as an alternative species in the brackish water shrimp ponds due to its survival and fast growing nature in the harsh pond environmental conditions.
2008	Invasion of alien fish species (Pacu; C. gariepenus, Chinese black carp)	*Piaractusmesopotamicus*, *Clariasgariepenus*, *Mylopharyngodonpiceus*have made illegal entry.

suit the culture environment prevailing in the seasonal tanks, which are essentially rain-fed. Appropriate technological packages also need to be developed for remote and inaccessible terrains.

Two landmark achievements that have revolutionized fish farming in this country are – (i) Induced breeding of carps and (ii) Composite carp culture technology. As it is evident from the timeline several technologies are developed and transferred to farming community subsequently. However, large scale adoption of such technologies has not taken place. Is the technology a failure? Surely not. So where lies the problem? There is no denying that acceptance by the farming community should be the litmus test for a successful technology. Simply put the new technology must be more profitable than the one it seeks to replace. Probably several technologies fare poorly on this count and as a consequence their adoption is limited to few farmers only. On the other hand the traders (unscrupulous?) influence the farmers decision greatly and facilitate introduction of alien species e.g., *Pacu, C. gariepenus*, Chinese black carp etc. Changing consumer preferences, market demand etc. fuel such shifts in production systems.

Aquaculture and rural development

Researchers in India and elsewhere have demonstrated the impact of rural aquaculture on the lives of poor. In terms of providing nutritious food (fish being the cheapest animal protein) and creating employment opportunities aquaculture interventions have proved to be quite useful. A series of consultations on small-scale rural aquaculture concluded that aquaculture should not be viewed as an isolated technology but be considered as one aspect of rural development and form part of a holistic approach to development (Martinez-Espinosa 1995, APFIC 2000). Bhaumik *et al* (1992) reported that Composite fish culture has brought new hopes for the fish farmers of West Bengal, where 90% of the population are fish eaters. Investigations carried out in 5 districts of West Bengal to study the adoption behaviors of fish farmers towards composite fish culture revealed adoption of the technology by 61% of the farmers.

Roy (2003) reported that a fish poly culture trial with different combination of large Indian major and Chinese carps with small indigenous fish species mola (*Amblyphayngodon mola*) was carried out in

the farmers' pond at Boilor-Dhanikhola village under Mymensing district, Bangladesh. He further emphasizes that mola may be considered as a viable proposition of rural aquaculture technology for Bangladesh in terms of nutritional and socio-economic benefits of the rural households. The woman in aquaculture have contributed significant role for improving their income of the family. Rural women in coastal areas of south 24 Parganas perform many fishery activities including fish seed collection, net weaving, fish marketing and fish harvesting. Women of lower economic class give a helping hand to men (Goswami, 2009). They take part in decision making related to fishery activities which is fairly good indicator of their status. Amount of net weaving was positively and significantly correlated with annual income, utilization of information sources and decision making process.

Kaliba *et al.* (2007) suggested that aquaculture expansion has the potential to create new jobs and improve food security among poor households. Three computable general equilibrium models were used to estimate the effects of aquaculture expansion and increased input productivity on poverty reduction in Ghana, Kenya and Tanzania. The results suggest that there will be positive effects on per capita income for all households in Ghana and Kenya. In southeast Vietnam rural aquaculture is reported to be a good option for rural development, making an important contribution to farm income with a high adoption rate among poor farmers. Fish farmers have gained an increased level of satisfaction by means of fish culture production growth along with corresponding economic gain. This enterprise continues to play an increasing important role in their livelihoods and has potential to develop further in the area (Nguyen Minh Duc, 2009).

Ponnusamy and Gupta (2009) described that integrating different enterprises for maximizing farm productivity is the tradition of Indian farmers. Aquaculture in combination with other farm enterprise in the coastal regions of the country significantly contributes to the livelihood security of farm families in a system's perspective. They also suggested that future challenges to Farming System Research and Extension (FSRE) will be in rehabilitation and renewal of degraded environment, livelihood enrichment through diversification and common property resource utilization and conservation of nature as well as bio-diversity. The diffusion and maintenance aquaculture-agriculture-livestock system depends on development of good policy, infrastructure and goods and services to sustain IFS.

De *et al.*, (2013) reported that mean production from the adopted pond was 1028.57 kg/ hain 6 months culture period as against the pre-adoption production level of 195.42 kg/haduring same culture period. The average production cost was worked out to be ₹ 31697.28/ ha. The production package practiced by the farmers enabled them to earn net income of ₹ 65674.14/ ha. Each women member of the M. D. T. Samity got 8.0 kg fish (@2 kg/member every time partial harvesting was done) for their household consumption. The group kept aside ₹63000.00 of the net income in the bank to meet next year's expenditure. This leaves an amount of ₹ 51929.75 which was equally distributed among the members as profit. The women benefitted in two ways (i) they got quality fish (8.0 kg/ family) for home consumption and (ii) additional money (₹ 4327.50) they brought to the family has improved their status.

Rural aquaculture has been contributing immensely towards rural livelihood. However, there are lots of changes taking place today as compared to rural aquaculture practices in yester years. Species combination has undergone sea changes. Composite carp culture in its strict sense has probably ceased to exist. What is common today is single (Rohu) or two species culture (90% rohu and 10% catla). Farmers in several parts in West Bengal are culturing Pangas; Pacu; Black carp; Chitala etc. Sri Susanta Khan a farmer from Bankura says "I stocked few Chitala fingerlings which grew to an average size of 2.5 Kg in a years time. Each fish fetched me ₹ 750.00 (average sale price of Chitala is ₹ 300/kg). Why should I rear 8 Kg rohu that brings me same return?" Consumer preferences too are shifting towards non-conventional species which probably driving farmers to introduce diversified species. It's the market and profit consideration which is determining species combination and thereby bringing sweeping changes in rural aquaculture practices.

Paradigm shift in Rural Aquaculture

There has been a marked departure in priorities of rural aquaculture. From food security and enhancing

productivity the focus is shifted to improving farmers' income and profit. Multiple stakeholders both government and non-government agencies are working towards fisheries development as compared to department of fisheries alone. Hapa breeding, composite carp culture etc. have given way to Circular/FRP hatchery, Mixed carp culture, culture in seasonal water bodies, ornamental fish, value addition, organic aqua farming, species diversification etc. Farmers are being recognized as innovators and not merely seen as passive recipient of technologies. Average yield in FFDA adopted ponds have risen to 3000 Kg/ha in 2011-12.Extension approach has shifted to become more knowledge intensive with provision of location specific modules for farmers and more proactive role for farmers. Mainstreaming gender has also started receiving required attention.

Rural aquaculture - changing perspectives

Aqua farmers turning into aqua innovators

Farmers are known to experiment with their limited resources and available technologies for maximizing returns. Through years of trial and error, they come up with locally tested and appropriate package of practices that in turn become popular among the farming community in similar agro-climatic zones. These innovations often remain unnoticed and the talents of the farmers remain underutilized. Such innovations developed within resource constraints at the grass roots level have the potentials of wider scale dissemination through up-scaling. These innovations need to be nurtured, promoted and popularized as they can make significant contribution in planning and implementing research and development work. Research institutes under the administrative control

Table 2.

Components	Rural aquaculture – then	Rural aquaculture - now
Aim	Food security	Improving farmers' income level
Focus	Enhancing productivity	Profitability
Major players	State department of fisheries	Multiple stakeholders – public as well private
Transfer of technology	Input intensive Blanket recommendation of practices	Knowledge intensive Location specific technology modules/ Business plan
Major features of technology		
Seed	Wild collection from river, mixed seed, bundh breeding	Hatchery produced seeds, SIFFS, off-season availability
Size at stocking	Spawn/Fry	Advanced fingerling/ stunted yearling
Culture	Traditional/Extensive culture	Semi-intensive culture
Feeding	Broad casting/ball feeding	Bag / pellet feeding
Avg. Yield	400-500 Kg/ha/year	3000 Kg/ha/year
Types of aquaculture technologies	Hapa breeding, Fish seed rearing, polyculture/ composite fish culture, integrated farming	Circulatory/FRP hatchery, Mixed carp culture, culture in seasonal water bodies, ornamental, value addition, organic aquafarming, Sp. diversification
Role of farmers	Farmers are seen as passive recipients of technology	Farmers are seen as innovators and entrepreneurs
Outreach	Focused on men	Emphasis on mainstreaming women
Dissemination of technology	Poor participation of stakeholders	Active Stakeholder participation
Resources	2.254 million ha ponds and tanks	New resources created under MNREGA and other schemes

of ICAR are organizing 'Innovators meet' with the objective of documenting such innovations as well as recognizing the farmers. The endeavour in this direction should not end with only documentation. The stakeholders should come forward and strive for fostering linkage between R and D institutions, line departments and innovators for up-scaling.

Aquaculture Field School (AFS) for farmer to farmer extension

Aquaculture Field School (AFS) is a school without walls for improving decision making capacity of fish farming community. AFS is composed of a group of farmers who regularly have a gathering for problem solving interaction. Typical group strength should have 20-25 aqua-farmers. The five basic tenets of AFS are fish farmers are experts, their fish farm is a learning place, aquaculture extension worker serves as facilitator but not as teacher, scientists/subject matter specialist work with rather than lecture them and learning materials are learner centered. The principle of AFS is similar to that of Farmers Field School (FFS) implemented in agriculture. Central Institute of Freshwater Aquaculture (CIFA) has established two field schools in the state of Orissa. One field school is established at Bhatpadagarh, Odihsa in the farm of Shri Manabendra Maharatha. He owns a farm of 10 ha water body spread over 27 fishponds of different size. He also has one commercial carp hatchery. He has been in this commercial carp seed business since 2003. Mr. Moharatha who is technically supported by CIFA now produces around 10-15 crores carp spawn, 1-2 crores carp fry, 8-10 lakh fingerlings and 3-5 tones yearlings per year. The other field school is established at Sarakana, Odisha in the farm of Shri Batakrishna Sahoo and Shri Nrusingh Charan Panda. They jointly own a fish farm of 6 ha with 23 ponds. There are 2 commercial carp hatcheries and one freshwater prawn hatchery. Besides, they also have one ornamental fish breeding unit. Pond embankments are used for horticultural crop production including floriculture. Shri Sahoo and Shri Panda are engaged in fish seed production business since 1986 (De *et al.,* 2012). Both the AFSs are becoming popular among the fish farmers. Even state department of fisheries is sponsoring farmers to be trained in selection of brood fish, hormone injection, hatchery operation, pond management, seed rearing, feeding and also various steps of carp poly culture operations at the AFS. Students from nearby colleges have also learnt fish breeding techniques from the AFS.

Ornamental Fish Village

Ornamental Fish village as an innovative approach of promoting rural aquaculture is becoming popular. CIFA played an instrumental role in developing two ornamental fish villages in 2011. Ornamental fish rearing (Black molly, Red molly, Angel fish, Gold fish etc.) in the backyard has caught up with the women in Landijhari (Deogarh district) with as many as 60 cement tanks being used for this purpose (Nath *et al.,* 2012). The local fishery officer initiated this new way of income generation among the women. The Agricultural Technology Management Agency (ATMA) also pitched in by providing financial assistance for construction of rearing tanks. Capacity building training and exposure was provided by the CIFA, Bhubaneswar. The scientists of Krishi Vigyan Kendra, Deogarh popularised the new vocation in the village by organizing awareness camps. With all the families engaged in rearing ornamental fish the village came to be known as *'ornamental fish village'* (De *et al.,* 2012). Another ornamental fish village has also been developed recently at Sarouli in the same district with the partnership of CIFA, ATMA and State Fisheries Department to promote livelihood development of women SHGs.

Gender mainstreaming in aquaculture

Involvement of rural women in aquaculture production activities including composite carp culture, seed rearing and integrated fish farming has been advocated for their socio-economic upliftment (Bhanot *et al.,* 1999) and generation of self employment (Sharma *et al.,* 1988, Thakur *et al.,* 1988). However, lack of focus coupled with cultural and social constraints limit participation of women in training and empowerment. Women are in subsistence aquaculture in India, taking care of fish after stocking (Nandeesha, 2007). Appropriate methods in aquaculture extension coupled with appropriate technologies can draw rural women towards aquaculture practice in a sustainable way. Women can easily manage small backyard ponds (0.01 – 0.1 ha) for raising of fish seed within a short period (Goswami and Ojha, 1997; Radheyshyam, 2002). Besides, they can undertake common carp

breeding including collection of brood fish, breeder maintenance and egg hatching for production of fish seed and also their nursing (Radheyshyam *et al.*, 1999; De *et al.*, 2005).

Aquaculture is increasingly being recognized as a tool for empowering women even in most difficult areas. The initiatives by government as well as non-government also helped bringing them closer to Govt. establishments, Banks etc. Office bearers of SHGs have to deal with management and financial aspects of pond management viz., purchase of inputs – fingerling, lime, feed, fertilizers etc. and selling table fish. Additional income accruing from fish culture has also resulted in improved social status of women.

Farmer led research to gain momentum

It is being increasingly realized that the existing extension system is not adequately responding to the emerging demand of the farmers. On the other hand researchers do have their woes. Often research system does not get proper feedback to carry out demand driven research. This results in mismatch between the need for research solutions at the farm level and its supply. The Indian Council of Agricultural Research (ICAR) is formulating 'Farmers first' project that seeks to bridge this disconnect and would enable farmer-led research which in the long run would help empower farming community. It is time that the formal research system learns from the successful cases and tries to improvise the grassroot level innovations. It is also required to understand the constraints being encountered by the innovators and provide solutions. 'Farmers First' seeks to strengthen Farmer-Scientist linkage with focus on innovation, feedback, stakeholder participation and new institutional configuration. The premise of Farmer First is that farmer should be at the driver's seat in matters related to agricultural development.

Conclusion

In the back drop of reclining land and water resources, exploding population and stagnancy in production from capture fisheries sources, the importance of aquaculture has become crucial in the national perspective. There are great expectations from freshwater aquaculture sector and its present production level of 3.9 million tonnes (2008-09) will be targeted to rise in a sustainable manner to about 8.0 million tonnes by 2030 (CIFA Vision 2030). It is a fact that sweeping changes are taking place in few pockets e.g., Andhra Pradesh, West Bengal , Punjab etc. in terms of production as well as species diversification. However, in vast part of rural India freshwater aquaculture resources remain underutilized. According to an estimate potential of vast freshwater resources covering 6.7 million ha. is yet to be fully utilized. Both horizontal and vertical expansion of aquaculture is required to meet the targeted production. It is worth understanding the dynamics of aquaculture and bring the pertinent issues for redressal by the R and D system. Rural aquaculture will continue to play a significant role both in terms of quantum of fish produced and as weapon to fight poverty and malnutrition.

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