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Sustainable Aquaculture

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COVER PHOTO

Harvesting fishes from rice fish terraces in Arunachal Pradesh.
(Photo: Deepjyoti Baruah)

The AgriCultures Network

LEISA India is a member of the global Agricultures Network. Seven organisations that provide information on small-scale, sustainable agriculture worldwide, and that publish:

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Dear Readers

Asian countries are now the world leaders in fisheries – production as well as exports. The rising demand owing to rising populations and higher fish consumption is being met by a rapid growth in production and increased global trade in fish. However, most of the current innovations in fisheries focus on relatively high-value species, resource intensive production technologies, and expensive operations, making poor fish farmers vulnerable. Moreover, small-scale fish farmers face threats from resource degradation, weak public support and investment, and inequities in access to resources, infrastructure and markets.

Productivity enhancement in the non-intensive small scale sector will result in protecting the livelihoods of small scale fishermen, while meeting growing demand for fish. This calls for local innovations, better extension service and technical support, investments in small scale fisheries and better policy support. Establishing community organizations for managing common areas is one of the promising means of delivering benefits to the poor, particularly for areas with sizable inland fisheries and large reservoir areas.

We are grateful to those who shared their perspectives with practical experiences on the theme. We are for ever thankful to the readers, the contributors and all those who have been instrumental in knowledge sharing and exchange on safe, inexpensive, simple and practical alternatives based on adaptation and innovation.

The Editors

LEISA is about Low-External-Input and Sustainable Agriculture. It is about the technical and social options open to farmers who seek to improve productivity and income in an ecologically sound way. LEISA is about the optimal use of local resources and natural processes and, if necessary, the safe and efficient use of external inputs. It is about the empowerment of male and female farmers and the communities who seek to build their future on the bases of their own knowledge, skills, values, culture and institutions. LEISA is also about participatory methodologies to strengthen the capacity of farmers and other actors, to improve agriculture and adapt it to changing needs and conditions. LEISA seeks to combine indigenous and scientific knowledge and to influence policy formulation to create a conducive environment for its further development. LEISA is a concept, an approach and a political message.

AMEF is a member of AgriCultures Network, which is involved in co-creation and sharing of knowledge on family farming and agro ecology. The network is **locally rooted and globally connected**. Besides magazines, the network is involved in multi stake holders' engagement and policy advocacy for promotion of small holder family farming and agroecology. The network consists of members from Brazil, Ethiopia, India, Netherlands, Peru and Senegal. The secretariat of the network is located in IED Afrique, Dakar, Senegal.

MISEREOR founded in 1958 is the German Catholic Bishops' Organisation for Development Cooperation. For over 50 years MISEREOR has been committed to fighting poverty in Africa, Asia and Latin America. MISEREOR's support is available to any human being in need – regardless of their religion, ethnicity or gender. MISEREOR believes in supporting initiatives driven and owned by the poor and the disadvantaged. It prefers to work in partnership with its local partners. Together with the beneficiaries, the partners involved help shape local development processes and implement the projects. This is how MISEREOR, together with its partners, responds to constantly changing challenges. (www.misereor.de; www.misereor.org)

AME Foundation promotes sustainable livelihoods through combining indigenous knowledge and innovative technologies for Low-External-Input natural resource management. Towards this objective, AME Foundation works with small and marginal farmers in the Deccan Plateau region by generating farming alternatives, enriching the knowledge base, training, linking development agencies and sharing experience.

AMEF is working closely with interested groups of farmers in clusters of villages, to enable them to generate and adopt alternative farming practices. These locations with enhanced visibility are utilised as learning situations for practitioners and promoters of eco-farming systems, which includes NGOs and NGO networks. **www.amefound.org**

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Sustainable Aquaculture

Farmers and fisher folk in India have practiced aquaculture since time immemorial. Traditional fish culture carried out in small ponds in eastern India, indicates that aquaculture was a major vocation for local communities. Even today, it is hard to find a household in rural Bengal that does not have a fishpond.

Aquaculture in India which largely remained at subsistence level till 1980s, dramatically changed into commercial activity with rise in demand from the western markets. With success of green revolution, the focus was now on blue revolution, transforming a environmentally sound and traditional livelihood option into a semi-intensive or highly-intensive industry. Thousands of hectares were earmarked for intensive shrimp aquaculture. Mangroves were cleared, wetlands were encroached upon and drained, and aquaculture tanks were built into fresh-water lakes. Intensifying aquaculture resulted in greater economic benefits in terms of returns and employment while the people found a valuable source of cheap protein in aquaculture products. Nevertheless, there were also serious environmental and socioeconomic impacts. The entry of private actors and large scale exploitation of the natural resources resulted in human and ecological devastation at various levels.

Despite the changes that took over the sector in the last two decades, we find that much of the aquaculture practised in countries like India is still at a small scale, addressing family-level subsistence and livelihood needs. This issue brings out the experiences of small scale farmers and fisherfolk in making aquaculture productive and sustainable.

Small scale sustainable aquaculture

Productivity enhancements in such small scale production systems is possible by adopting good husbandry practices, that are environmentally sound too. Improvements in husbandry skills have resulted in higher levels of production. For instance, understanding feeding behavior of aquaculture species is necessary to establish an optimal feeding regime leading to homogeneity in growth and savings in feed costs. Feeding practices should also be in tune with biological rhythm of the fish species, for example, catfishes generally show better feeding activity in the dark, while carp feeds in the day time. The form of the feed has an impact not only on the acceptance of the feed but also on the aquatic environment. (Pratap Mukhopdhyay, p.6). Also, nourishing the broodstock is critical for successful reproduction, higher fertilization rate and resultant spawn viability. Provision of adequate nourishment supplying essential amino acid and fatty acid sources during pre-spawning phase may ensure quality egg production.

Aquaculture production is often integrated with other forms of agriculture. Integrated farming system is seen as a way to enhance the productivity of water, land and associated resources while contributing to increased food fish production.

Traditionally, integration of rice and fish has been considered as a low-cost sustainable practice providing nutrition and income security to farmer households. Such traditional systems which have proved to be economically viable and ecologically safe have been practiced over centuries by traditional communities, like the Apatani

tribes in Arunachal Pradesh (Deepjyoti Baruah, p. 17). It has been found that there were several benefits by growing fish in rice terraces. For example, fishes by feeding on small insects like water beetle and larvae, which are harmful to the paddy, protect the crop. The waste material of fish serves as manure to the rice plant and also fish by its browsing habit helps in release of fixed nutrients from soil for rice plants.

Many models of integrated models are being practiced. Of them, the rice-fish integration is the most widely practised farming system. For example, farmers of Malda, east Midnapore, Hooghly and South 24 parganas in West Bengal adopt rice-fish integration during kharif season every year (Pratap Mukhopdhyay, p.6). They have reported that rice yields increase when integrated with fish than without integration of fish. There are also other benefits like reduction in rodent infestations in the rice field and while rice plant serves as essential food for fish.

Duck-fish farming is yet another integrated system found in rural West Bengal. Presence of ducks helped in eradicating many insect pests, tadpoles and help in creating a conducive ambience for fish to thrive and grow. Nitrogen rich duck droppings enhanced production of natural food organisms (Pratap Mukhopdhyay, p.6). Communities in hilly regions of Uttarakhand found it remunerative to integrate fish rearing with poultry and vegetable cultivation. Besides income, the integrated model helped to improve the nutrition levels of household members.(Deepa Bisht and Sundriyal, p.10)

Aquatic plants are important in maintaining the habitat for growth of fish and for natural food availability. Promotion of monoculture of fish species has contributed to depletion of biodiversity, thereby reducing productivity, further leading to livelihood challenges for the dependent communities. By extracting Ipomea from the tanks and with better tank management practices, the Dhivar fishing communities in Maharashtra could restore the aquatic biodiversity. (Manish Rajankar, p. 25)

Community-based management approaches are being tried to use common property resources for fishing purposes. For instance, communities in Bhandara and Gondia districts in Maharashtra, have taken up aquatic habitat development in 11 tanks covering 281 hectares. Habitat development has been carried out involving all the stakeholders like the members of local fishing cooperative society, the expert from local community and team member from organization. (Manish Rajankar, p.25)

Aquaculture has the potential to generate income and create jobs, especially to the local youth. Being small and less risky, small-scale aquaculture can be adopted easily by resource-poor farmers. The government and the community level organisations are adopting various approaches to promote sustainable aquaculture. For example, Odisha Skill Development Authority (OSDA) in collaboration with ICAR-CIFA organized Aquaculture Field Schools to train farmers in Orissa on small scale aquaculture. ICAR-DCFR, Bhimtal in association with the Department of Fisheries, established a fish hatchery unit at Hari village in Arunachal Pradesh during 2018. In Jharkhand, the State Fisheries Department has been actively promoting fish farming by extending trainings, subsidies on fishing nets, supplying free seeds and feed besides offering monthly mobile recharges and life insurance covers to fish farmers. *(*Manu Moudgil, p.32)

Aquaculture is changing the lives of farmers by offering a good alternative to land-based agriculture. With its potential to provide nutrition, income and employment, small scale aquaculture has the potential to contribute to most of the relevant SDGs. It is also environmentally efficient, especially when integrated into other farming activities. It offers a great scope for women to take an active role and it can make households and communities more resilient to economic or environmental shocks.

Sustainable Aquaculture

It's all about better management practices

Pratap Mukhopadhyay

Aquaculture has a major role to play in contributing towards better human health and better ecosystem. The thrust needs to be on enhancing fish production in an environmentally sound manner. The emphasis has to be on good husbandry practices.

Duck-fish integrated farming

The role of aquaculture in providing nutrition and income to farming communities hardly needs any emphasis. To meet the ever growing demand for fish and fish products, the focus unfortunately has been on intensive rearing systems, resulting in over exploitation involving fish stocking densities much beyond the carrying capacity, frequent water exchange, inconsiderate application of feed, fertilizer and even scheduled chemo-therapeutic drugs like antibiotics. This has very often led to the generation of detrimental waste that has negative impact on the growth of aquatic life and biodiversity.

While bringing more area under rearing large fish, natural habitats of indigenous small fishes and prawns that contribute significantly towards rural household food basket, are being encroached. Also, while we claim to be the connoisseurs of fish and grow most of the fishes in the country, on the other side, the under-nourishment among school children is among the highest in the country. In rural Bengal, micronutrient deficiency is now a common sight among school children and womenfolk. Such nutritional deficiencies cause enormous national loss and need to be addressed before it is too late. Micronutrient deficiencies impair cognitive development and impair immunity as well as increase susceptibility towards infection. While fortification of food items of daily diet may be a recommended intervention strategy, but food based approach of increasing micronutrient status by increasing fish availability is a very simple and sustainable approach. In this context, the thrust need to be given towards enhanced fish production through inland freshwater aquaculture in an environmentally sound manner. The emphasis has to be on good husbandry practices.

Semi-intensive pond culture of Indian major carps (IMC) relies upon natural productivity (fish feeding on various planktonic food organisms naturally grown in the ambient water under the influence of sunlight) to a large extent. The major function of phytoplankton which include green, blue-green algae also called microalgae, is to supply dissolved oxygen during photosynthesis. Eventually they form food for zooplankton species, which again serve as most desired food source for younger fish species. The ability to support the growth of natural fish food organisms in the ecosystem is the result and effect of abiotic and biotic factors. Release of inorganic nutrients from pond soil in presence of sunlight enhances phytoplankton growth on which again the growth of zooplankton depends. Maintaining a balance of both these kinds of plankton population throughout the culture period, will therefore be of help in enhancing the survival and growth of fish like carps.

Environmental factors such as water temperature, light intensity, soil/water quality and their interactions determine the carrying capacity of a pond and thus influence the fish production. Also, there is ample scope for increasing the production by adopting better management practices and through supplementary feeding. Therefore, there is a strong need for optimum resource utilization to efficiently produce fish through adoption of simple management measures, relying on natural food in the ecosystem.

Adoption of better feeding methods

Semi-intensive farming of six cyprinid species (based mainly on the polyculture) is generally practised in freshwater aquaculture in India. Relying on natural food (zooplankton population) during early stages and delayed feeding with exogenous feed until later stages of growth, is a common practice among fish farmers. The young ones feed on the natural food - the mixed zooplankton including rotifers produced through pre-stocking pond manuring. 'Critical standing crop' (CSC), is a condition during which fish growth starts to decline from its maximum rate, soon after the food organisms decline. Beyond the CSC, the fish growth continues at an extremely slow pace because the supply of natural food becomes insufficient to meet fish requirements. This is the time when supply of acceptable quality of feed must begin to sustain its normal growth. A general survey indicated that farmers use nine major ingredients and five feed types. Ingredients are rice bran, groundnut oil cake, cotton seed meal, sunflower meal, soybean meal, mustard oil cake, sesame oil cake, wheat bran and maize meal. The feed types are rice bran only, rice bran and cotton seed meal, rice bran and groundnut oil cake; rice bran and sunflower meal and rice bran and mustard oil cake.

The form of the feed has an impact not only on the acceptance of the feed but also on the aquatic environment. Selecting proper time and fish size to start feed application should be a key factor in aquaculture.

Providing feed when fish is below the CSC might lead to a waste of feed resources and an unnecessary increase in operational cost. Delaying the supply of feed will cause reduction in fish growth and yield. The frequency of feeding depends on body weight and water temperature. For instance, in case of larvae/spawn, the frequency of feeding may be several times an hour, while in case of juveniles, feeding twice a day may be considered sufficient. Optimal feed supply decreases competition for feed and hence size heterogeneity. Protein and energy concentration should remain balanced for maximum expression of the growth potential. Feeding practices should also be in tune with biological rhythm of the fish species, for example, catfishes generally show better feeding activity in the dark, while carp feeds in the day time. Understanding feeding behavior of aquaculture species is therefore necessary to establish an optimal feeding regime leading to homogeneity in growth and savings in feed costs.

Use of various substrata hiding in water can potentially contribute to the growth and production of different carp species through development of periphyton colonization on the substrata. Sugarcane bagasse, palm leaf, coconut leaves, bamboo poles in ponds provided with organic manure are some of the examples. The attached algae are stable leading to better accessibility to the grazing fish and also quantitatively more per unit water surface area. Increased availability of natural food organisms is also accompanied by positive impact on water quality.

Enhancing nutritional diversity

Small fishes can enormously contribute to micronutrient availability without having any adverse effects on the aquatic ecosystem and carp production. The small local freshwater species including minor carps, catfishes, murrels, perch, eels, feather backs and cichlids, for example, are self recruiting in nature and are able to provide enormous nutrition benefits. Fortunately, several non government development organizations and even Directorate of Fisheries have recently started polyculture of small local fish species and some kind of fish sanctuary has been proposed at several panchayats/villages. One such is located at Laxmikantapur in South 24 Parganas district.

Raising ducks on fish ponds promotes fish growth, fish yields, nutrient recycling, and enhances aeration in ponds.

Quality fish seed production

Farmers seldom take care of the parental nutrition component, which may result in low quality egg production, poor survival and slow growth. Since fish has high fecundity it hardly matters to the farmer or the field practitioner. A *rohu* for example, can have one lakh egg and even if more than 50% dies, the farmer will still have 50,000 spawn produced from a single fish.

Nutrition and feeding the broodstock remains the fundamental tool for successful reproduction, higher fertilization rate and resultant spawn viability. Provision of adequate nourishment supplying essential amino acid and fatty acid sources during pre-spawning phase (April to June) may ensure quality egg production.

Small scale Integrated Farming System

Integrated farming system is promoted with an objective to increase the productivity of water, land and associated

Fish rearing provides nutrition and income to farming communities

resources while contributing to increased food fish production. Agriculture/ horticulture and aquaculture; duck, poultry and aquaculture; treated waste water –fed fish culture are certain examples.

Duck-fish farming is common throughout rural West Bengal. Duck-cum-fish culture involving low stocking density relies primarily on natural food produced in water as source of nutrients. Generally, the variety of duck - 'Indian Runners' is preferred. Presence of ducks help in eradicating many insect pests, tadpoles and help in creating a conducive ambience for fish to thrive and grow. Nitrogen rich duck droppings enhance production of natural food organisms. Duck droppings go directly into the pond, providing Carbon, Nitrogen and Phosphorus, stimulating the growth of natural food organisms. For these simple reasons, raising ducks on fish ponds promotes fish growth, increase fish yields and eliminates pollution problems. The stocking rate of ducks is generally 300-500 ducks/ha and each duck produces about 7 kg of dropping during the 36 day fattening period. If 500 ducks are raised, 3500 kg of excreta would be produced in this period. Ducks help in releasing nutrients from pond bottom also. Fish-duck integration also promotes the recycling of nutrients in the pond ecosystem. In shallow areas, a duck dips its head to the pond bottom and turns the silt to search for its food. By virtue of this digging action, nutritional elements locked in the pond humus get released. Ducks also act as pond aerators. Their swimming, playing and chasing disturbs the surface of the pond and aerates the water.

Rice-fish farming system is generally found in the districts of Malda, east Midnapore, Hooghly and South 24 Parganas in West Bengal, during kharif season every year. Prior to initiating fish culture, land preparation /land shaping is essentially undertaken. Initially, peripheral trenches with 1 m wide x 1m deep and 25 cms high are dug by placing bamboo pipes and screens at inlet and outlet. These trenches serve as refuge for the fish and pass way for their easy movement around the paddy field. In such rice field areas, the water depth is favourable for fish in comparison to other rice ecosystem. There are several benefits owing to rice fish culture. It is reported that rice yields increase when integrated with fish than without integration. There is a reduction in rodent infestations in the rice field because of continuous submergence; the submerged part of the rice plant serves as essential food for fish.

End note

Aquaculture and its management in general has a major role to play in contributing towards better human health. It is important therefore that available water bodies under all panchayats/talukas be utilized for aquaculture. The vast array of agro based by-products available in rural India for potential application in fish culture practices need to be tapped to attain the maximum genetic potential. This can truly make major carp culture remunerative and help improve the livelihood support of rural population. Social aquaculture in the line of social forestry be introduced wherever possible utilizing the small indigenous fish species. This may serve the dual purpose of conservation of these species some of which are becoming endangered as well as production of cheap and best edible animal product for better human health.

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Integrated Fish Farming

A tri-commodity approach

Deepa Bisht and R C Sundriyal

With ample water resources, the communities in hilly regions of Uttarakhand found an alternative livelihood supplementing agriculture. Village communities found it remunerative to integrate fish rearing with poultry and vegetable cultivation. Besides income, the integrated model helped to improve the nutrition levels of household members.

Demonstrations were conducted in farmers fields to promote fish farming

Uttarakhand, is a state rich in natural resources. Agriculture remains the basic livelihood for the majority of the rural population. Plain region of the state is rich in agriculture and produces enough food. However, in mountainous region, farming is constrained by small and scattered farm holdings, poor soils and lack of irrigation facility. Besides uncertainties of weather, damage by wild animals (monkeys and wild boar) has adversely affected crop production. The prevailing situation has been discouraging farmers to grow crops.

Considering that horizontal expansion of land based enterprises is not possible, options for vertical expansion within the existing farming system need to be explored. The region is endowed with fresh water resources, which have great potential for aquaculture and integrated fish farming (IFF). With the aim to make farming a profitable venture through optimum utilization of water resources and land resources; generate employment and income and to provide nutritional security to the rural people, G. B. Pant National Institute of Himalayan Environment and Sustainable Development (GBPNIHESD), Kosi-Katarmal, Almora, promoted Integrated Fish Farming. Demonstrations were carried out in farmers' fields in Basoli and Manan in Almora district, by integrating fishery with livestock, poultry and vegetable cultivation, through participatory approach, during 2004-07.

Development of technology centric model for livelihood security

Farmers of the region practice agricultural and allied activities on traditional basis. Most of them grow three crops in two years in cereals-millet rotation. Crops like wheat, barley, paddy, finger millet, barnyard millet, soya bean, horse gram, and a few vegetables are grown in almost fixed rotation. Dairy and vegetable production are potential livelihood options for small farmers. Fish farming has not been a common practice in hilly areas of Uttarakhand, though some of them have water bodies on their farm.

Participatory Rural Appraisal (PRA) was conducted with the villagers during 2004-05 to get to know about the prevailing situation in the villages. Elderly people, women and members of gram panchayat participated in PRA exercise. Following PRA, several farmers of these villages showed interest to experiment Integrated Fish Farming alongside their traditional cropping system. Farmers were selected on the basis of common community agreement and voluntary basis depending on available resources, farmers' need and their interest. All the selected farmers had a water body near their farm.

Poultry integrated with fish farming

Initially, awareness and skill-oriented training programmes and demonstrations were organized at their villages and at Rural Technology Centre, GBPNIHESD. They were given training on various aspects of integrated fish farming through lectures, audio-visuals and field visits. A total of 9 models of IFF were established on farmers' fields, involving farmers at all stages of development.

Fish pond and poultry/duck house at dyke of the pond were constructed at Basoli and Manan villages in Almora district. A combination of compatible fish species with complementary feeding habits, occupying different ecological niches were stocked to make better use of the natural food available in the pond. Fingerlings of exotic

Table 1. Fish yield in small ponds at two sites

Year	Basoli (100 m^2)		Manan (264 m^2)	
	Production (Kg)	Yield (Kg/ha)	Production (Kg)	Yield (Kg/ha)
First Year	56.5	5650	122.0	4621
Second Year	60.3	6030	127.4	4825
Third Year	57.9	5790	112.7	4269
Average		5823		4572

Fish production was higher in integrated model

carp species (5.5-10.0 cm) viz., silver carp (*Hypophthalmichthys molitrix*) (45%), grass carp (*Ctenopharyngodon idellus*) (35%) and common carp (*Cyprinus carpio*) (20%) at a density of 3/m^3 were released into the pond during first week of March when water temperature was >16^{0}C. To reduce the production cost and to ensure availability of food and manure for fish production, chicken (3000 birds/ha) of hybrid layer species of chick bird (Kurioler) were stocked at Basoli. For comparison of fish growth, yield and economic viability, ducklings (300/ha) of the most potential egg laying species, Khaki Campbell (*Anas platyrhchos*) were introduced in 1 male: 5 female ratio at Manan during first year. Owing to less return from fish integrated with ducks, from second year onwards, ducks were replaced with chick birds at Manan.

Vegetable cultivation was also integrated with fish culture at both the sites. Earlier, farmers were engaged in agricultural and allied activities, dominated by traditional subsistence cereal-millet farming. Besides, local cultivars of a few vegetable crops such as cucurbits, french bean, okra, tomato etc., were also grown on traditional basis during kharif season. Vegetables were now promoted on 600 sq.m area with improved varieties of different vegetables suitable for the region. Farmers were also imparted technical know-how for vegetable cultivation.

Results

Composite carp culture in fish cum duck integrated system has yielded 4621 kg/ha/yr, 900 eggs and 14 kg of duck from 264 m^2 pond at Manan. Further, the market demand of the hills is very limited for the duck eggs and meat.

The yield of fish raised with chick birds have yielded 4269 to 4825 kg of fish/ha/yr (Table 1), 120 to 130 kg of chicken (live weight) and 4200-4400 eggs at Manan. Around 5650 to 6030 kg of fish/ha/yr, 55 to 65 kg of chicken and 2500-3000 eggs were produced at Basoli. These fish yields are comparable to the fish yields reported under fish-duck/poultry integration in India and several other Asian countries. Still higher yields could be achieved through intensive supplementary feeding at initial stages of growth and recycling of manure obtained from integration of poultry thereafter.

Kurioler chick birds started egg laying after 18 weeks while ducks after 22 weeks. Besides, the year round

vegetable cultivation on the pond dyke and associated fields was possible using the overflow of pond, for irrigation. Around 1200-1400 kg and 1900-2300 kg of different vegetables were produced annually at Basoli and Manan, respectively. Enhanced vegetable production led to higher remuneration and generated additional income and adequate employment opportunities. On an average, net gain of Rs 21,829 and Rs. 36,823 was obtained annually from IFF with investment of Rs 8,109 and Rs 11,925 by the families at Basoli and Manan, respectively. Besides substantial monetary gain, farmer's family got fresh vegetables and good quality animal protein, which has helped to reduce malnutrition, particularly in children and women.

Rearing of ducks in integrated system was found less productive and uneconomical

It is evident from the results that the integrated fish-poultry farming is functionally and economically feasible in the hilly region. However, the rearing of ducks in integrated system was less productive when compared to poultry integrated with fish culture. Also owing to less preference for duck eggs in local market, this integration was found uneconomical too.

Farmers have faced some challenges in adopting this method. For example, unavailability of fish seed (fingerlings) in the hills forces them to transport of fish seed from long distance Tarai region (150-200 km) to these remote areas. It is an expensive and a tough job. To overcome this problem, farmers have started approaching State Fishery Department, other government organizations and NGOs working for rural development, for fingerlings.

Conclusion

The IFF model complements cropping activities of small farmers and generates employment and income, thus leading to social and economic uplift of the society. Demonstration and the requisite training to the farmers have been two crucial steps in the transfer of technology in the hills. The success of this model, demonstrated at nine different villages under various programmes, has motivated farmers in other villages to adopt this technology. The State Government is also promoting such activities.

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Small scale aquaculture

Boosting rural livelihoods

Biswa Ranjan Samantaray, Satyajit Kumar Bhuyan and Surendra Kumar Ghadei

Farmers in Orissa adopted small scale aquaculture by participating in the Aquaculture Field Schools. They also took up fish culture in community resources, enhancing fish production and fostering social cohesion.

Farmers were educated on fish farming through Aquaculture Filed School

Aquaculture is one of the most important potential sectors of the national economy. Fish has been a staple food and its demand is increasing due to growing population and awareness on health benefits. Aquaculture is emerging as an important solution and the challenge is to make this growth more inclusive. Given the growing pressure on natural resources and the mounting threat posed by climate change, it is important to make it more sustainable. Aquaculture has the potential to generate income and create jobs, especially to the local youth. Being small and less risky, small-scale aquaculture can be adopted easily by resource-poor farmers.

Sustainable livelihood approach

Fish farming in rural areas mainly rely on natural productivity of the pond and can be enhanced by adding animal manure to the water, which increases carrying capacity of the pond. Such systems may not generate substantial financial returns to rural communities but a small increase in food security and nutrition security, particularly in terms of protein, will have a significant effect on the livelihoods of the rural people.

Betnoti block in Orissa consists of 1654 water tanks covering an area of 599 ha. This includes those owned by the Gram Panchayat and also by private individuals. Farmers in the region are adopting traditional to semi intensive type fish farming practices. As the block has a great potential for fish farming, the Krishi Vigyan Kendra (KVK) in Mayurbhanj took up an initiative to promote pisciculture, adopting Sustainable Livelihood Approach (SLA)

Sustainable livelihood approach (SLA) aims to reduce poverty and vulnerability in communities engaged in small scale aquaculture and fisheries. Through SLA the fish farmers are encouraged to enhance the pond carrying capacity, involve farm family, improve resource utilization, integrate different components in the fish farming and optimally utilize farm areas and farm wastes (Cow manure, vermicompost) to enhance the farm

income for the family livelihood and better sustainability.

With people at the centre of development, women's groups and fish farming groups with 15-20 members are formed. Small and seasonal ponds close to home are used. Pond water is fertilized to enhance natural food (green water); kitchen wastes and on- farm by products are used as feed. Vegetables are grown on the dykes using fertile pond water.

Aquaculture Field School

Aquaculture Field School (AFS) is a farmer to farmer extension method adopted by ICAR- CIFA to double the fish production and enhance farmers income. AFS is a school without walls for improving decision making capacity of fish farming community. The AFS also serves as a learning centre for fish farmers who can upgrade their skills on brood stock management, nursery and feed management, disease diagnosis, feed formulation, integrated farming, soil and water analysis and technology on culture practices of more than 25 fish species, including fresh-water prawn.

The main objective was to educate 2000 farmers per year of Mayurbhanj district with support from Odisha Skill Development Authority (OSDA), through AFS. On 24th July, 2017 AFS was initiated at Kailash Fish Hatchery in Astapura under Betnoti block of district Mayurbhanj of Odisha in collaboration with ICAR-CIFA.

AFS was held for a period of one week. Participants were trained on specific skills like happa breeding, breeding through portable as well Chinese circular hatchery, nursery and rearing hatching practices of Indian Major Carps (IMC) as well as minor and exotic carps. The participants were also oriented on preparation of balanced pelleted feed, pre and post stocking management practices. Besides these, participants became well versed with the technical knowledge like identification of fish seedlings at Fry-Fingerling stage, feeding methods and preparation of feeding schedule, beneficial effects of organic and inorganic manure in fish farming and also the marketing strategies like time of harvest and time of sale. After completion of the programme, the farmers were trained on small scale income generating activities like Fry-Fingerling production in seasonal ponds and seed production programmes through portable carp hatchery.

Box 1: Fish contribution promote nutritional wellbeing

Fish have a highly desirable nutrient profile providing an excellent source of high quality animal protein that is easily digestible and of high biological value. Fish, in particular, are an extremely rich source of essential fatty acids, including omega-3 polyunsaturated fatty acids (PUFAs), hence, important for normal growth and mental development, especially during pregnancy and early childhood. Fish are also rich in vitamins and minerals (especially calcium, phosphorus, iron, selenium and iodine in marine products). Fish therefore can provide an important source of nutrients particularly for those whose diets are monotonous and lacking in animal products. Increasing the availability of fish in the diet increases palatability and leads to increased consumption of a range of foods thereby improving overall food and nutrient intakes.

A permanent exhibition point for aquaculture technology was set up in the farm of Mr. Akshya Kumar Sahu, where any farmer can visit any day to learn about aquaculture technologies. The farmer maintains a link with ICAR-CIFA and Department of Fisheries, Govt of Odisha and Krishi Vigyan Kendra of the district on a continous basis. He serves as a facilitator for learning and fosters innovation among the farmers. The facilitator is also trained by the KVK on different aspects like duck farming, mushroom cultivation, bee keeping and backyard poultry and off- season vegetable production.

After the programme, there is a follow up action too. Mr. Akshya Kumar Sahu, the facilitator selects 5-7 participants from each batch of 25-30 participants and allows them to practice the technology in his farm, for a period of one month.

Aquaculture Field School

The steps involved in the process for formation of aquaculture field schools

- Identification of entrepreneur farmers through whom the technology can reach thousands of farmers.
- Collection of the basic aquaculture status in that area like leasing period of community ponds, aquaculture management practices, production, marketing etc.
- CIFA, Line department and KVK staff train the entrepreneur farmers.
- Assistance in creating basic educational facilities at the AFS.
- Operationalization of AFS on freshwater aquaculture.
- Preparation of farmer centered literature.
- Technical backstopping of trained farmers throughout the culture period.
- Follow up visit to the farms of trained farmers to reinstate new learning.

Fish farming is carried out in village community pond through the group approach

Around 800 participants have completed the training programme through AFS. Of them, four have started breeding through own portable FRP hatchery (Echo hatchery), 200-250 farmers are adopting the fish farming practices in their own pond and also in the leased out community pond and 70-80 farmers are adopting the fish seed rearing (Fry-Fingerling-Yearling) practices.

Community-based management

Community-based management approaches were tried to use common property resources for fishing purposes. With government support, fish farming is carried out in village community pond through the group approach. Like field school approaches, three women SHGs in Badasahi block and two women SHGs in Udala block and three men group participants were involved in the community fish farming approach. The technical support was provided by KVK along with the government department for carrying out appropriate pisciculture practices. By adopting community approaches the groups are able to produce fish to a tune of 08-12 q/acre with a return of Rs 58000 per acre, within a period of 6-8 months. The benefits are generally shared based on the number of mandays contributed towards the activity.

In the village Bhimtalli in Udala block in Mayurbhanj district, there is co-existence of one women's group and a farmers interest group practicing fish farming. The women group consists of 10 participants. There are many short seasonal ponds and with the technical guidance of KVK the women group has taken six private ponds (0.6Ha) on lease. Fry-Fingerling production practices are being carried out earning a net profit of Rs.42000/- within four months. The farmer interest group consists of 15 participants and they have taken two community village ponds on lease and are producing table size fish. They have earned a net profit of Rs.71000/- within eight months. The women's group is the supplier of the seed to this farmer interest group and also of the neighboring villages. Thus, quality seed supply was ensured.

Community-based management approaches were tried to use common property resources for fishing purposes.

Some factors were identified by the users as important for successful community resource management. These include, among many, small size of the group size which facilitates observation and monitoring of a collective agreement and social cohesion. Hence, through effective rural community based approaches, there is a great potential to sustainably utilise seasonal wetlands, swamps, flooded forests and mangrove forests in the region.

Endnote

The adoption of sustainable livelihood approach (SLA) and AFS have been proved as a boon to enhance the livelihoods of fishing communities. Of the fish harvested, around 40% is consumed by the household and 60% is sold in the market. This ensured both nutrition security and income security for the fish farming households. The initiative proved that appropriate methods coupled with appropriate technologies can draw rural women towards aquaculture practice in a sustainable way. Also management of community resources will go a long way in providing livelihoods and conserving natural resources. Rural aquaculture developed as an entrepreneurial activity, through co-management and community-based management approaches can be a financial viable option.

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Sustainable agro-aquaculture farming

Deepjyoti Baruah, Ravindra Posti, K Kunal, P A Ganie, D Sarma and Gyati Rinyo

Integration of rice and fish is a low-cost sustainable practice of Apatani tribes in Arunachal Pradesh providing nutrition and income security to farmer households. Such traditional systems are economically viable and ecologically safe.

Skill development programme for women entrepreneurs of Ziro valley

The Ziro valley in Arunachal Pradesh at an altitude above 1550 meters of mean sea level and with an advantageous ecological condition makes agriculture as the main source of livelihood in the valley. The region receives a mean rainfall of about 400 mm with an annual temperature ranging from 5°C - 28°C. Apart from rice, the other important crops grown in the valley is comprised of maize, millet, buckwheat, fruits and vegetables. The agro-forestry is mostly comprised of pinewoods and thickets of bamboo. The cool summer weather makes the valley a major destination for tourists from all over the world.

Integrated Rice-Fish terraces of *Apatanis*

Initially, a field study was conducted in Hong, Hari, Hija, Bula, Dutta, Mudang, Bamin and Old Ziro villages to understand the aquacultural practices of the region. Ziro valley is mostly inhabited by the *Apatani* tribe and the land is known for its unique and a highly developed ingenious integrated rice and fish farming (locally called *Ajii-Ngyii*) contributing 59.12% of total land area. The *Apatani* tribe are mostly agrarian in nature and possess a rich traditional knowledge in efficient water management and sustainable use of the agricultural land and waste products for integrated wet rice-fish systems (*Ajii-Ngyii*). Women play an important role and share their work equally with men in rice-fish cultivation in these hilly terraces. Also, farmers incur high cost for importing fish seeds from neighbouring state of Assam. The valley being a hill locked area is devoid of a fish seed production unit in the form of a fish hatchery.

The *Apatanis* start preparing their rice-fish terraces in the month of November. The left over paddy stems are allowed to decompose on the field itself which later serves as a source of manure. The plots are exposed to sun for drying so that the pests present underneath the soil are destroyed. During December-January, the farmers start ploughing their fields with conventional chopping implements (*daos*) and spades, without making use of animals, machines or any advanced tools. A sufficient width of 30-70 cm is provided to the dykes, enabling the production of crops such as finger millets and maize.Vegetables such as cucumber, brinjal, tomato, pumpkin, chillies, beans etc., are also raised on the dykes as additional crops. The raising of crops on the dykes also prevents erosion of soil in these water logged terraces of the valley.

Fishes in trenches

> Women play an important role and share their work equally with men in rice-fish cultivation in these hilly terraces.

The irrigation system in wet rice terraces is unique in the valley. It is basically comprised of a primary channel connected to the main river Kille. The primary channel drains its water to highly webbed feeder channels of the rice-fish terraces. The feeder channels helps in optimizing

the usage of water and provide nutrient wash-out to the paddy field from the adjoining catchment areas.The water is equally distributed to each of these terraces with bamboo or wooden made ducts. The ducts installed at a height of 15-25 cm above the bed ensures proper water level of 25-35 cm in the rice-fish plots during the season. The trenches (30-45 cm depth) are most distinctively dug within the rice-fish terraces for facilitating refuge to fish during warmer hours of the day. The trenches are irregularly webbed and occupy 8-12% of the total area in each of rice-fish terraces. The trenches are provided with two outlets (*hubur*)-one at the surface side to release excess water and the other at the bottom side for drying up of the field water for harvesting the fish. Both the outlets are strictly guarded with bamboo screens to prevent escape of fishes during the culture period.

Fifteen varieties of the local rice (*Oryza sativa* Linn.) are reported to be cultivated in the Ziro valley. Transplantation of rice saplings from the nurseries to the prepared terraces are done in the month of April. Finger millets, soya beans, buckwheat, maize, barley are grown on the dykes as additional crops. Vegetables such as cucumber, brinjal, tomato, pumpkin, chilies, radish etc are also grown on the dykes. All these crops are sown in the month of April-May using a wooden made dibbler (*damu*). Fruits such as kiwi are grown in the adjoining lands if not directly over the dykes. Successive weeding (*Ahru-hodo*) in rice fields and dykes is carried out by manual labour, using artisanal tools during the growing season.

Fish is reared in one or two batches in a year, depending upon the terrace conditions. The most favoured fish species are the strains of common carp, scientifically known as *Cyprinus carpio specularis* (Mirror carp), *C. carpio communis* (Scale carp) and *C. carpio nudus* (Leather carp) for integration with local rice varieties. Young fishes of 5-8 cm size are stocked in the rice terraces, 10-15 days after paddy transplantation during the months of April-May. These fish also feed on small insects like water beetle, which are harmful to the paddy. Additionally, the fish help in release of fixed nutrients from soil for rice plants owing to its browsing habit. Apart from the common carp, species such as grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), *Barbonymus gonionotus*, *Labeo gonius* and other *Labeo* species etc., are also stocked in the plots. The fish get sufficient food in the form of planktons and periphytons, by treating these terraces with manures (cowdung, pig dung, poultry litter and agricultural residues). These reduce the cost incurred on fish feeds, supplemented from outside. Among the different fish species cultivated, the best results in terms of fish growth and survival is observed in common carp fish due to their robust and hardy nature. During weeding in the rice cultivated areas, fishes are guided to the dugout trenches. In the event of low rainfall and hot weather, the stagnant water of the open field becomes warm and the water in deep trenches serve as cool hideouts for the fish.

Harvesting and marketing of rice fish terraces

The fish are usually harvested before harvesting rice from the terraces. Water is first drained out from the rice plots completely. This compels the fish to concentrate in the trenches from where they are caught by hand or by using the traditional bamboo and cane woven gears. Common carp are reported to gain weight up to 300-500g within a span of 3-4 months. However, the farmers start selling the fish when the later attains a weight of 65-80g. The harvested fishes are cleaned in fresh water and are transported to the fish market in bamboo made baskets (*Ajii piiwa* or *Ajii raju*). The fish are packed in layers without using any oxygen filled polybags and water. They are mostly sold at the local market in live conditions at Hapoli, the district headquarters of Lower Subansiri. The fishes are kept alive by retaining them in water filled bamboo troughs overlaid with polyline sheet. There is no involvement of middlemen for selling of the farm produce. The live fish are sold at a rate of Rs. 300 per kilogram. The net profit for the farmer is more than 100% in addition to the regular rice harvest.

Paddy is harvested (*antee pila* or *antee dandu*) during September-October based on the time of transplanting of rice. The production of rice from rice-fish terraces was found in the range of 10-100 quintal/ha/season depending on the soil fertility. The rice varieties are mostly consumed by the households and hence not sold in the market. Additional crops grown on the dykes such as finger millets, soyabean, maize are harvested during August-September and are used for food in the form of flour and for the preparation of local wine (*sarse-o*). Similarly, the vegetables are harvested from time to time during July-

October. Vegetables are primarily used for household consumption and the surplus is sold in the market.

Some initiatives

Based on the results obtained from the field survey, to strengthen the existing fisheries scenario in the valley and to empower the fish farmers, team of scientists from ICAR-DCFR, Bhimtal took up certain initiatives during 2018-19. Some of the initiatives are:

As the valley is devoid of a fish seed production unit of its own, farmers buy young fishes from the neighbouring state of Assam incurring high fish seed cost. Therefore, a portable FRP made fish hatchery unit at Hari village was established during 2018, in association with the Department of Fisheries, Government of Arunachal Pradesh and with the cooperation of the *Apatani* community. The unit was set up under the banner of Gaumco Multipurpose Cooperative Society, led by a women entrepreneur Mrs. Gyati Rinyo. The society was formed in 2014, with an objective of developing agriculture, fisheries and livestock in the rural regions of the district.

An interactive meet was organized at Hari village on 22nd March 2018 on "Fish farming and seed production in cold regions of Arunachal Pradesh". The meeting which was participated by 200 farmers of the region served as a platform for interactions among farmers, government officers and scientists. In order to encourage the fish farmers, critical input in the form of advanced sized quality fish seeds were distributed free of cost to the farmers for stocking in their rice-fish plots and culture tanks.

This was followed by a skill development programme on "Start-up fish farming, seed production and hatchery management for hill farmers of Ziro valley, Arunachal Pradesh" during 20-24 May 2018 at Pabhoi Fish Farm, in Biswanath district, Assam. Five members of the society were imparted skills on broodstock management, hatchery operation, fish seed production, transportation and marketing. Also, knowledge on nursery management practices and fish seed raising was imparted to the members of the society. In addition, ICAR-DCFR, Bhimtal supported the society financially and technically in constructing four earthen nurseries and one broodstock pond within the premises of FRP fish hatchery. This enabled farmers in stocking different sized and species of fish seeds produced from the hatchery unit.

Irrigation channels for draining water to rice fish terraces

The aquatic environment in rice terraces is much influenced by water quality flowing through the connecting feeder channels. In order to understand the water quality and the fish food diversity, water was collected from the feeder channels and rice-fish terraces and analysed. It was observed that the rice-fish plots are rich in phytoplankton viz., Spirogyra (12-47%), Oocytis (40%), Navicula (5-14%), Pinnularia (6-13%), Nitzschia (13%), Ulothrix (13%), Closterium (13%), Stigeoclonium (11%) and Ankyra (7%). The zooplankton studies revealed that the copepods (11-90%) dominated the rice fish plots followed by Cladoceron (5-25%).

Farm advisory and technical guidance was also provided to the farmers from time to time by visiting the actual sites. For example, farm advisory was given to the rice-fish growers to deepen the trenches upto 90 cm and construct at the periphery of the rice-fish plots for better fish survival (more than 95%) with higher stocking density and ease of harvesting. By developing the deeper lateral trenches, the stocking density of fish fingerlings was raised from 1-2 to 4-5 per square meter area.

Conclusion

Integration of rice and fish is a low-cost sustainable practice for the rural mass to obtain high value protein, nutritional security and income from a unit area. Rice-fish farming reduces the usage of fertilizer, pesticides and herbicides in the rice field and zero input of artificial feed to fish. Such reduction of input costs lower farmer's economic load to more than 50 percent and simultaneously doubles their additional income from fish sale. Having such additional income, the net productivity from rice-fish integrated farming is observed to be much higher than monoculture of rice alone in the valley. Moreover, establishment of a private fish seed hatchery in the Ziro valley resulted in easy availability of quality fish seeds. Further, empowering women with the skills of fish seed production and fish hatchery management has led to enhancement of farm productivity through fish seed trade. However, there is still a need for a hygienic fish market with cold storage transportation facility.

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Installation of FRP fish hatchery

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Grow bamboo, capture carbon

Capturing carbon dioxide from the air is an important way to combat climate change, which is being caused by emission of excess carbon dioxide and other greenhouse gases. Plants use carbon dioxide from the air to manufacture food, so growing plants is the best to do this.

India is the fourth largest emitter of greenhouse gases after China, the US, and the European Union. India's emissions increased by an alarming 4.7% in 2016 compared to the previous year. However, India's emissions per head are among the lowest in the world.

With most of India's designated forest lands degraded, planting bamboo can be the first stage in long-term agroforestry and agricultural redevelopment, scientists say. The latest report from INBAR (International Bamboo and Rattan Organisation), an intergovernmental organisation of 43 countries, emphasises the point. The speed with which a plant grows has a part in determining how much carbon dioxide it can absorb in a given time. In a paper submitted at the National Workshop on Global Warming and its Applications for Kerala, researchers of Thrissur-based College of Forestry say, *"Bamboo potentially acts as a valuable sink for carbon storage, and on an average, one hectare of bamboo absorbs about 17 tonnes of carbon per year."*

On an average, bamboos grow at the rate of 1.2 metres a day, making it one of the fastest growing plants. Due to this, it takes only three years to establish mature groves. As a result, bamboos are effective carbon dioxide absorbers, not only above ground carbon (AGC), but also below-ground carbon (BGC) in roots, and rhizomes. To a lesser extent, it absorbs soil organic carbon (SOC) too. Importantly, growing out of a tangle of underground stems, bamboo can help reforest landscapes denuded by development or natural disasters, binding topsoil to prevent erosion.

As reforestation, afforestation and REDD+ are eligible for carbon trading, bamboo afforestation activities can be brought under CSR (Corporate Social Responsibility), making it a people-centric activity rather than the State's responsibility to meet the 12-year deadline to restrain the rise in planetary temperatures. *If adequate mechanisms are in place, there are possibilities for India too to incorporate bamboo CSR and earn credit,* says Nath. He goes on to add that the CDM (Clean Development Mechanism) Executive Board, which supervises the Kyoto Protocol's clean development mechanism under the COP (Conference of Parties) in its 39th meeting decided that *"palm (trees) and bamboos are equivalent to trees in the context of afforestation and reforestation."*

Including bamboo in climate change mitigation, adaptation, land restoration and restoration strategies makes national plans more effective and brings a host of climate-smart options to national and regional climate change strategies, experts say.

For more information, go to https://indiaclimatedialogue.net/2019/01/21/growing-bamboo-forests-could-boost-carbon-capture-in-india/

Shrinking biodiversity poses major risk to the future of global food and agriculture, landmark UN report shows

With the biodiversity of plants cultivated for food shrinking, the global population's health, livelihoods and environment are under severe threat. This warning from the Food and Agriculture Organization (FAO) comes as the UN agency releases a new report – the first of its kind – on the state of the world's biodiversity in food and agriculture.

The study delivers a stark message: that there is a real risk of the plant and animal species that provide our food, fuel and fibre (as well as the many animals, insects and micro-organisms that make up crucial parts of the food chain) disappearing for good.

The FAO received a large amount of information from 91 countries, provided specifically for the report, and the analysis of the latest global data to compile the report, which was prepared under the guidance of the Commission on Genetic Resources for Food and Agriculture, the only permanent intergovernmental body that specifically addresses biological diversity for food and agriculture.

While 6,000 plant species are cultivated for food, just nine of them account for two-thirds of all crop production. When it comes to livestock, around a quarter of breeds are at risk of extinction: just a handful provide the vast majority of meat, milk and eggs. And more than half of fish stocks are at risk of extinction. Wild food species are also rapidly disappearing, with just under a quarter of known wild food species are decreasing. However, the true proportion is believed to be much higher as more than half of reported wild food species is unknown. In addition, species that contribute to the food ecosystem, such as pollinators, soil organisms and natural enemies of pests, are under severe threat. Examples include bees, butterflies, bats and birds.

FAO chief José Graziano da Silva, quoted in a statement, described biodiversity as "critical" for safeguarding global food security, and called for food to be produced in a way that doesn't harm the environment: *"Less biodiversity means that plants and animals are more*

vulnerable to pests and diseases. Compounded by our reliance on fewer and fewer species to feed ourselves, the increasing loss of biodiversity for food and agriculture puts food security and nutrition at risk."

Human intervention is overwhelmingly at fault, says the report. Examples include the way land, water are used and managed; pollution; overexploitation and overharvesting; climate change; and population growth and urbanization. No regions are exempt from biodiversity threats, although the main driving forces differ depending on the region. For example, in Africa, a key problem is overexploitation, hunting in poaching; in Europe and Central Asia, deforestation and intensified agriculture are cited; and in Latin America there is concern over pest, diseases and invasive species.

The majority of the countries that provided data for the report show an interest in an agriculture-related practice that supports biodiversity, such as organic farming, sustainable soil management and ecosystem restoration. Most of the countries have also put policies in place for the sustainable use and conservation of biodiversity.

However, the legislation and institutional frameworks are often inadequate or insufficient, and the FAO is calling for much more effective action on a global scale. These include the promotion of pro-biodiversity initiatives, greater efforts to improve the state of knowledge surrounding biodiversity for food and agriculture, and better collaboration among policy-makers, food producers, consumers, the private sector and civil society.

Simple ways for consumers to make a difference include opting for sustainably grown products, buying from farmers' markets or boycotting foods that are unsustainably produced.

https://indiablooms.com/health-details/E/4375/shrinking-biodiversity-poses-major-risk-to-the-future-of-global-food-and-agriculture-landmark-un-report-shows.html

Padma Shri awardees include 12 farmers

Out of the 94 Padma Shri awardees, 12 farmers have been awarded for various activities like organic farming, traditional seed conservation and use of scientific methods in cultivation.

Out of 12, four are farmers who used traditional methods of farming to bring change. Kamala Pujhari is one of them, who conserved hundreds of local varieties of paddy and promotes organic farming. She comes from a tribal community in Koraput district of Odisha. Due to her efforts, farmers from Koraput village as well as other neighbouring villages gave up the use of chemical fertilisers. This is not the first recognition for her work. Pujhari has already received the 'Equator Initiative' award in South Africa in 2002, and has also been a member of the state planning board in March 2018, according to media reports.

Another winner, Rajkumari Devi, has been popular for her expertise in assessing the soil quality to ensure successful harvest. She is popularly known as 'Kisan Chachi', and hails from Muzzaffarpur district in Bihar. Devi has also helped mobilise over 300 women and successfully set-up a Self-Help Group (SHG).

Babulal Dahiyaa, a farmer from Madhya Pradesh's Pithaurabad village and one of the awardees, has been growing 110 varieties of crops within two acres of land. He has been collecting indigenous rice varieties since 2005, when he learnt that a traditional rice variety had vanished from the region, and was only described in folktales and poems. The state biodiversity board has also recognised his work, and initiated a *beej yatra* (seed rally) to collect indigenous verities of vegetables and medicinal plants. They have collected over 1,600 varieties from 24 districts, say media reports.

Hukumchand Patidar from Rajasthan is a farmer who has been practicing organic farming on a 40 acre piece of land. His produce is exported to over seven countries. Patidar started his farming journey in 2004, and is also the founder of Swami Vivekanand Agricutural Research Farm.

Apart from the four traditional farmers, the other farmers awarded are known for using technology mixed with other

farming methods. Venkateswara Rao Yadlapalli, who comes from Guntur district in Andhra Pradesh, has developed an app called Rythunestham. This app encourages farmers to stick to organic farming. It provides technical know-how, marketing tips, crop insurance details and details of nearest labs and research centres.

Ram Sharan Verma has been awarded a Padma Shri for introducing 'hi-tech agriculture' in Uttar Pradesh's Barabanki district. High-tech farming is all about adopting advanced techniques including hybrid tomato, banana tissue culture, rotation crop green manuring, biofertiliser irrigation management, crop management, management of tillering, and weed control. Bharat Bhushan Tyagi from Uttar Pradesh has also been awarded a Padma Shri under the same category.

Other farmers who were awarded for path-breaking innovations include: Vallabhbhai Vasrambhai Marvaniya, who developed a variety known as the madhuvan gajar, which he started cultivating in 1985; Kanwal Singh Chauhan from Haryana for innovation in babycorn and mushroom; Jagdish Prasad Parikh for growing jumbo variety of cauliflowers and Sultan Singh and Narendra Singh from Haryana were awarded for their work in fisheries and dairy breeding respectively.

https://www.downtoearth.org.in/news/agriculture/padma-shri-awardees-include-12-farmers-63000

Aquatic habitat development

A community approach

Manish Rajankar

Promotion of monoculture of fish species has contributed to depletion of biodiversity, thereby reducing productivity, further leading to livelihood challenges for the dependent communities. Habitat development restoring the aquatic biodiversity has benefited the Dhivar fishing communities in Maharashtra.

Planting seedlings in tank for habitat development

Bhandara and Gondia districts are known as lake districts of Maharashtra. There are thousands of traditional lakes, built about two to three centuries ago, during the reign of Gond Rulers, in the East Vidarbha region of Maharashtra. These tanks are known as ex-malgujari tanks. These traditional water bodies are used for many purposes at the village level, however, irrigation and fishery are the major economic activities since many years.

The population of Dhivar community is around 15% of the total population in Wainganga river basin. This community was working as household labourers in the houses of *Zamindar and Malgujar* families of this area. Fishing is their traditional business. They used to do fishing in the village tanks by the order of the landlords and used to get share from the catch. For household consumption, they used to fish in flowing water sources in the area. While male members of community did fishing activity, the women sold fish in the weekly markets.

After the abolition of *Malgujari*, and formation of fishing cooperative societies, Dhivar community got rights over these tanks for fishing, on priority, from the state government. Usually, the area of 5 square km is the jurisdiction of the fishing cooperative society. All tanks in this area, covering 2 to 3 villages and 2 to 5 tanks, falls under the jurisdiction of one society. All the male members of community are the shareholders of the society.

During this same period, the high yield species, Rohu, Catla and Mrigal, known as Indian Major Carps (IMC), were introduced in the tanks. With the introduction of IMC, fishing techniques also changed. Drag net came in to practice. The aquatic plants were considered as obstacle in dragging the net. The fishery department not perceiving any role for these plants in production of IMC, introduced Grass Carp as the scavenger species of these plants. The aquatic habitat was completely lost and the fish production declined owing to non-availability of food. Some of the knowledgeable community members, realized that aquatic plants are important in maintaining the habitat for growth of fish and for natural food availability. They also realized the key role of indigenous fish species for their own consumption. With this realization by community, a dialogue was initiated with the fishing cooperatives in Bhandara and Gondia districts.

> Aquatic plants are important in maintaining the habitat for growth of fish and for natural food availability.

The initiative

The traditional knowledge of the community regarding the biodiversity elements in water body was crucial in the process of conservation and habitat development. With the support of Small Grants Programme of UNDP, GEF, MoEFCC, a pilot initiative was taken up to restore biodiversity in a tank in Jambhali village, near Nawegaon Bandh. The species diversity was documented with the help of Botanists and Zoologists. However, the revival techniques and methods was finalized with the help of fisher folks, considering their immense traditional

Fig 1: Impact of habitat development on indigenous fish production

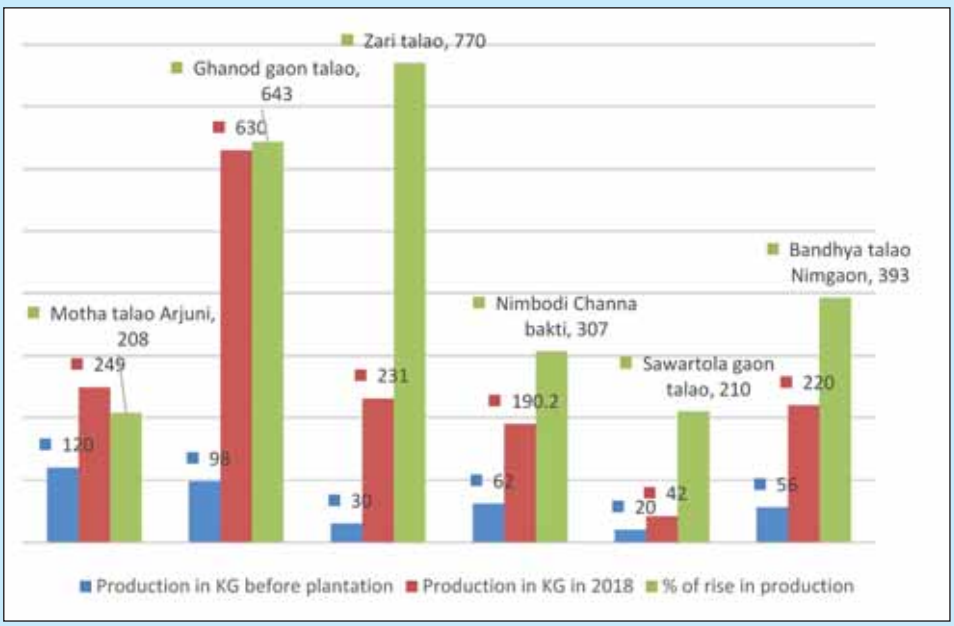

Table 1: Species diversity

Name of Wetland	Total plant species in plot area		Total individuals of all species		Proportion of Ipomoea regeneration (based on IVI)	
	2017	2018	2017	2018	2017	2018
Gaon Talav, Bhivkhidki	10	24	985	13113	1.97	0.98
Gaon Talav, Sawartola	12	34	1775	12454	0.98	1.26
Gaon Talav, Khamkhura	24	29	824	4476	7.63	1.36
Bandya Talav, Nimgaon	16	7	5085	7265	3.23	00
Gaon Talav, Kokna	—*	9	—*	4176	—*	2.24

Note: In 2017, the plot, from which Ipomoea was extracted, was under water and it was not possible to carry out the study.

knowledge. This activity was undertaken by the SHG of fisher folks in 2009 to 2011. This initiative was successful. The aquatic habitat was developed and the indigenous fish species diversity and production was also improved. The water birds activity also improved in the tank.

The success of the pilot initiative encouraged to explore the idea of aquatic habitat development with the fishing cooperative societies in Bhandara and Gondia districts. Meetings were held with fishing cooperative societies in both the districts and they expressed keen interest in the initiative. The programme was taken up with 12 fishing cooperative societies under Maharashtra Gene Bank Programme of Rajiv Gandhi Science and Technology commission and coordinated by IISER Pune.

Tank management

The major uses of ex-malgujari tanks are irrigation and fishery. Earlier, community used to manage them and all local level uses were recognized. Presently, the concerned

Meeting with community for habitat development

departments manage these tanks, particularly for the two major uses – irrigation and fishery. Irrigation department is responsible for the maintenance, repair and improving storage and distribution. Catchment management is also a part of the department's work but the department had not marked and mapped the catchments of these tanks, over the last sixty years. The rights of irrigation have been secured through the provision of Nistar rights, under the "Maharashtra Land Revenue Code". The fish farmers thereby get free water for irrigation. Fishery department with the responsibility of improving fish productivity has focused on high yield species of aquaculture, ignoring the indigenous species. Both these limited approaches of management and development contributed to the loss of freshwater biodiversity. Tanks, have thus lost their importance as life supporting structures.

Aquatic habitat development activity

Around 12 tanks, one in each society, has been reserved for biodiversity conservation. Out of these 12 tanks, 7 tanks were rich in diversity and the habitat development activity was needed in 5 tanks only. Additionally, six tanks, which were not reserved for biodiversity conservation, were selected by the community, for habitat development. In total, aquatic habitat development activity has been carried out in 11 tanks covering an area of 281.80 hectares.

Aquatic habitat development includes ploughing of tank bed in summer season. The area, which is under water in rainy season is ploughed. After the rains, when this area has the depth of water from 1 to 3 feet, the selected species of plants are transplanted. The plants which were existing in the tank, in past, are selected for regeneration. Mainly, the submerged plants like *Hydrilla verticilata*, *Ceratophyllum demersum, Vallisneria spiralis,* floating plants like *Nymphoides indicum, Nymphoides hydrophylla, Nymphaea cristata* and partly submerged plant like *Eliocharis dulcis* were selected and transplanted.

Habitat development has been carried out involving all the stakeholders like the members of local fishing cooperative society, the expert from local community and team member from organization. They jointly visit the tank to assess the need of work. Together, they prepare the list of activities to be carried out and the estimate the cost of work. Generally activities like ploughing, de weeding, requirement of plants/ saplings and tubers of selected species, bringing required plants from nearby tanks, cost of transportation, labour requirement for transplantation work etc., are included in the activities.

Out of 11, results of 6 tanks are shown in the graph. The results indicate rise in income for indigenous species only. This means it is the rise in net profit for the cooperative members, from 200 to 700%, as they don't have to invest in stocking and feeding.

The habitat development activity has been carried out in 4 tanks in 2018. The habitat development failed in one tank owing to the presence of Tilapia, *Oreochromis niloticus,* a species known for its omnivorous nature. It

feeds on phytoplankton, aquatic plants, and small fishes also. And, there is no natural controlling factor or enemy of this fish, which results in overpopulation of this fish, resulting in loss of aquatic habitat and fish diversity. Also, it adversely affects the growth of other fishes due to non-availability of food for them. This species is not permitted for rearing in open waters, as per the guidelines of Ministry of Agriculture, Government of India, but it was released by some trader, in the past, in the tank and now all other fishes are not yielding production and the indigenous species also vanishing from this tank. But the fishing society of Bampewada has this tank as the main source for livelihood and wanted to develop habitat in the tank. It is a perennial tank, thus, not dried up and the Tilapia remains in the tank destroying all the flora and fauna in this tank.

In tanks, where the plantation activity has been carried out, releasing of exotic fish species like Grass carp and Common carp is banned for initial 3 to 4 years. Later on, based on the vegetation cover, these species could be released, but in controlled and calculated manner for checking the over growth of vegetation. Same measures have also been followed in the reserved tanks for biodiversity conservation. The rearing of Rohu, Catla and Mrigal is going on in these tanks, as they are not a big threat to diversity.

Extraction of Ipomea

The experiences from our work has contributed to evolve some management and planning of tanks. The major one was regarding extraction of *Ipomoea fistulosa*. The *Ipomoea fistulosa* extraction activity has been carried out at 5 sites by the joint efforts of women SHGs, fishing cooperative members and BMC members. This plant species is exotic and it covers the peripheral area of every water body, which is actually the area of local plant species in wetland area. These local plants are not only important for the aquatic life forms, but the peripheral plant species are also the source of fodder for livestock in the summer season. It is a common belief that this plant cannot be eradicated by using human labour. Machines need to be used for the purpose. But, it has been observed by the local people that, at the places where poke lane machines were used, natural succession of local plant species is hampered. However, the community members decided to do it through *shramdan* (under MREGS) in the selected area of the water body. This initiative was also aimed at the prospect of including this activity under MREGS, so that Ipomoea is cleared on water bodies facilitating species diversity.

All the five tanks were monitored for two years. At places, where Ipomoea is dense, no other species was found on the ground, but where it is scattered, grasses like *Vetiveria zizanoids* or *Oriza rufipogon* were found. On the sites where the soil texture is loose, the plants were uprooted.

Out of the five sites, post monsoon study was carried out on four sites, as the other site was submerged and the depth of water restricted the access. Plots of 10 metre X 10 metre were measured for assessing the natural succession and rate of survival of Ipomea. Further, the 10 X 10 metre plots were divided into plots of 2.5 X 2.5 metres each to facilitate counting of the diverse species emerged. The count has been taken in the second also on same plots, to measure the results. The study indicated that biodiversity, indeed helps in better production of IMC as well.

Way forward

The results have been shared with the line departments at different levels. It is clear from the study, that regular monitoring and extraction of Ipomoea is needed for at least 3 years. If done through MREGS, it also provides work for village communities besides conserving the freshwater biodiversity - a win-win situation for villagers and the biodiversity.

The wetland management plans for 12 reserved tanks has been prepared. There is a need to discuss with fishing cooperative societies and BMCs for implementation. Also, a people's policy for biodiversity inclusive freshwater fishery at local level is needed.

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NEW BOOKS

Climate Change Adaptation and Social Resilience in the Sundarbans - 1st Edition

Anna O'Donnell, Quentin Wodon (Eds.), *2019, Routledge,* 208 p., £36.99, ISBN: 9780367173265

Household vulnerability to weather shocks and changing climatic conditions has become a major concern in developing countries. Yet the empirical evidence remains limited on the impact that changing environmental conditions have on households. This book explores climate change adaptation using a social resilience approach.

The book is based on primary data from the Sundarbans, a densely populated area located across parts of Bangladesh and India (West Bengal) which is highly vulnerable to extreme weather events and climate change. The focus is on assessing how households are affected by cyclones: whether they are able to cope with, adapt to and recover from events and changes; whether they are warned ahead of time; whether they benefit from government safety nets and other social programs; and finally whether they are driven to either temporary or permanent migration. This assessment leads to a better understanding of how exposure to an area of climate change vulnerability and risk affects and shapes human responses.

The Economics of Ecosystems and Biodiversity in National and International Policy Making 1st Edition

Edited by Patrick ten Brink, *2019, Routledge*, 528 p., £47.99, ISBN: 9781138327900

The Economics of Ecosystems and Biodiversity (TEEB) study is a major international initiative drawing attention to local, national and global economic benefits of biodiversity, to highlight the growing costs of biodiversity loss and ecosystem degradation, the benefits of investing in natural capital, and to draw together expertise from the fields of science, economics and policy to enable practical actions. Drawing on a team of more than one hundred authors and reviewers, this book demonstrates the value of ecosystems and biodiversity to the economy, society and individuals.

It highlights the need for new public policy to reflect the appreciation that public goods and social benefits are often overlooked and that we need a transition to decision making which integrates the many values of nature across policy sectors. It explores the range of instruments to reward those offering ecosystem service benefits, such as water provision and climate regulation.

Water Ethics: A Values Approach to Solving the Water Crisis, 2nd Edition

David Groenfeldt, *2019, Routledge*, £36.99, ISBN: 9780815392026

The book introduces the idea that ethics are an intrinsic dimension of any water policy, program, or practice, and that understanding what ethics are being acted out in water policies is fundamental to an understanding of water resource management. This new edition discusses in depth three significant developments since the publication of the first edition in 2013. The first is the growing awareness of the climate crisis as an existential threat, and associated concern about adaptive strategies for sustainable water management and ways of using water management for climate mitigation. Second, there has been increased clarity among the religious community, indigenous leaders, and progressive academics that ethics needs to become an arena for application and action. Thirdly, there have been new normative water standards ranging from "water stewardship" (industry initiative), water charters (Berlin) and the on-going initiative to develop a global water ethics charter.

Drawing on case studies from countries including Australia, India, the Philippines, South Africa, and the United States, this textbook is essential reading for students of environmental ethics and water governance and management.

SOURCES

The State of World Fisheries and Aquaculture

FAO, *July 2018, FAO Rome*, 224 p, ISBN 978-92-5-130562-1

The 2018 edition of The State of World Fisheries and Aquaculture emphasizes the sector's role in achieving the 2030 Agenda for Sustainable Development and the Sustainable Development Goals, and measurement of progress towards these goals. It notes the particular contributions of inland and small-scale fisheries, and highlights the importance of rights-based governance for equitable and inclusive development. As in past editions, the publication begins with a global analysis of trends in fisheries and aquaculture production, stocks, processing and use, trade and consumption, based on the latest official statistics, along with a review of the status of the world's fishing fleets and human engagement and governance in the sector. Topics explored in Parts 2 to 4 include aquatic biodiversity; the ecosystem approach to fisheries and to aquaculture; climate change impacts and responses; the sector's contribution to food security and human nutrition; and issues related to international trade, consumer protection and sustainable value chains. Global developments in combating illegal, unreported and unregulated fishing, selected ocean pollution concerns and FAO's efforts to improve capture fishery data are also discussed. The issue concludes with the outlook for the sector, including projections to 2030. As always, The State of World Fisheries and Aquaculture aims to provide objective, reliable and up-to-date information to a wide audience, including policy-makers, managers, scientists, stakeholders and indeed all those interested in the fisheries and aquaculture sector.

Strategies and Options for Increasing and Sustaining Fisheries and Aquaculture Production to Benefit Poorer Households in Asia

World Fish Center Studies and Reviews No. 1823, *2008, The World Fish Center, Penang, Malaysia*, 180 p.

The last three decades have witnessed dramatic changes in the structure of supply and demand for fish, especially in Asia. This WorldFish research study sponsored by the Asian Development Bank focussed on nine developing countries – Bangladesh, China, India, Indonesia, Malaysia, the Philippines, Sri Lanka, Thailand, and Vietnam, all active players in the transformation of global fish supply and demand. The study, broken into five components and reported here, considered: 1) the profile of key aquaculture technologies and fishing practices; 2) analysis of policies, institutions and support services; 3) socio-economic profile of major stakeholders in the fisheries sector; 4) projections of fish demand and supply in the nine Asian countries; and 5) formulation of national action plans based on the findings and recommendations of the study.

Climate Change and Fisheries: Perspectives from Small-scale Fishing Communities in India on Measures to Protect Life and Livelihood

Venkatesh Salagrama, *May 2012, SAMUDRA Monograph, International Collective in Support of Fish workers*, www.icsf.net

Through consultations with key fisheries-based stakeholders in four States of India, this study attempts to assess perceptions of fishing communities about the impact of climate change on their lives and livelihoods. It also evaluates the traditional knowledge, institutions and practices of fishing communities that are relevant to climate-change preparedness. The study identifies adaptation and mitigation measures that may need to be adopted by fishing communities and the State in relation to climate change. Based on this overall analysis, the study proposes measures to protect the lives and livelihoods of small-scale fishing communities in the context of climate change policies and programmes at different levels.

This study will be useful for researchers, policy makers, students and anyone interested in climate change and its potential effects on the lives and livelihoods of small-scale fishing communities.

Small farmers eye big fish in Jharkhand

Manu Moudgil

Pisciculture is changing the lives of farmers by offering a good alternative to land-based agriculture. Backed by the government, it is picking up well.

Dhanmaniya Devi had never tasted a 'good' fish. "All we had during my childhood were the small varieties which come to rivers during monsoon. They are rarely seen now," says the 65-year-old villager in Sildag of Palamau district in Jharkhand. This is why when her family reared the commercial variety fish last year, she was delighted. The fish also tasted good because the seed was bought with the money Dhanmaniya got as loan from a self-help group (SHG).

In Jharkhand, women SHGs are gradually venturing into popularising pisciculture or fish rearing, as they see in it an opportunity to break through the circle of poverty. At Sildag village, low rainfall leads to poor agriculture output. Wild animals also destroy crops leaving little for the locals to sustain on.

Unlike the neighbouring Bihar, fish farming is not a traditional occupation in north-west Jharkhand. People usually catch fish during monsoon for consumption from rivers or *ahar*s (area where rainwater collects due to natural slope of the land and embankment on three sides). Fishing lines, tyre tubes as floats and make-shift wooden platforms are very commonly used while professional equipment like nets, boats, et al., are still seen as luxury.

The region also has geographical limitations as it receives isolated rainfall. Sandy soils don't retain much water resulting in high evaporation and seepage rate. "This means the fish farming gets restricted to one half of the year. Still, people are willing to do this because it's better than doing one-season crop," says Ashrita Tirkey of Vikas Sahyog Kendra (VSK), a non-profit organisation which has been promoting fisheries in the region. Another welcome transition is the shift in focus from a few farmers with big ponds to many small landholders or joint ownerships.

The credit goes to the state fisheries department which has been actively promoting fish farming by extending trainings, subsidies on fishing nets, supplying free seeds and feed besides offering monthly mobile recharges and life insurance covers to fish farmers. A few of the enterprising farmers have also been given support to buy their own motorised two-wheelers. In fact, Jharkhand's training centre near state capital Ranchi was certified the best skill development centre by the union government last year. "The response is so good that we had a target of 250 farmers, but sent 291 for the training this year. People are willing to shift from less-profitable crop cycles to pisciculture," says Rann Vijay, extenstion officer with the state fisheries department at Latehar district.

An alternative livelihood

With fish farming giving them a livelihood in the absence of enough water from rain, the out migration for work, which is common here, is slowly decreasing. Rajdev

Photo: Shubham Sharma

Fish farming fetches better price than traditional crops.

Baitha of Rishiyappa village had migrated to Varanasi at the young age of 12 years. From pulling cycle rickshaw in Varanasi to maintaining railway tracks and driving a transport vehicle in Mumbai, he has done it all. He came back home, 20 years later in 2011, with tuberculosis. The one-acre farm the family possessed yielded little for sustenance. So, Baitha started selling trinkets and beauty products, moving from one village to another on cycle or by foot. Having experienced city life, Baitha was willing to experiment with new livelihood options. So, when fish farming came along, he decided to dive in, despite having no background in the field.

A training conducted by fisheries department in Ranchi opened his eyes to the 'blue world'. *"At the training, we met people who narrated how they earned more money by turning their farms into ponds,"* he says. Thankfully Baitha had a five-acre *ahar*, owned jointly with his extended family. *"In the first year, I earned Rs 70,000 profit by selling seven quintal fish. This was after giving out the share of my three uncles and consuming one quintal fish at home,"* he proudly shares.

In 2015, Baitha made Rs 1 lakh profit. Now, he is getting a small pond dug for himself with support under the rural job guarantee scheme. *"People now prefer fish to poultry since it is local and naturally produced. They don't like the big fish that is imported from Andhra Pradesh. So the market is ready, just the supply needs to be increased,"* Baitha says. Jharkhand's fish production stood at 80,000 metric tonne in 2014-15 while the demand was 1.40 lakh metric tonne.

Looking at Baitha's performance and enthusiasm, the fisheries department gave him subsidy to buy a moped, which he uses to sell fish in nearby Chattarpur town and other villages. The benefits are palpable in the health of his immediate family. *"Earlier, one of my five children would be sick every day. Malaria, common cold and fever were so common. Now, as we consume fish on a regular basis, the immunity levels have improved,"* Baitha says.

Nurseries for small lands

Satyendra Kumar Singh is the go-to source for all the fish at Palheya panchayat in Manika block of Latehar district. The 33-year-old runs a nursery which supplies fry (21-day fish offspring) at local level.

Nursery ponds are small-sized water bodies of about one hectare in area and 0.5 to 1.5 metre deep. Spawn, a three-day old fish offspring, is put in a nursery and nurtured into a fry or fingerling (a 60-day old fish). These are further purchased by the farmers who rear them till maturity.

Showing his two ponds of 70x40 feet each, Satyendra recalls how fish farming caught his attention: *"The 0.16 acre land I had, yielded only three quintal rice every season, fetching around Rs 3,000. Due to the non-availability of water, there's no rabi crop. I used to do odd jobs but it was very difficult to make ends meet. I was unsure if a small landholder like me could participate in fish farming."* At a training organised by the state fisheries department, Satyendra realised the possibilities his land held. The nursery ponds were to cost Rs 40,000. Thankfully, his wife, Kamla Devi was a member of a women farmers' group, which extended a loan of Rs 37,000 at an interest rate of two percent.

With money secured, Satyendra got the ponds dug and used lime to eradicate predatory insects. After the first rain, he rushed to the district fisheries department and purchased 25 lakh spawn at Rs 3,460.

Satyendra also shared his knowledge – preparation of a pond for new fish, disease control and neutralisation of acidic waters through natural remedies – with the other 24 fish farmers.

After 21 days, the spawn grew into fry and were sold at Rs 300 per 1,000 fry. Satyendra Singh and Kamla Devi earned Rs 74,400 by selling 2.38 lakh fry from their small land in just one and a half months. The remaining spawn were released into a pond they co-own with 25 neighbours. From this, all shareholders consumed two

quintal fish; Satyendra also sold two quintal of the produce.

The benefit for local fish farmers was also evident as they did not need to procure fry at high cost from dealers from West Bengal. Many fry die while being transported from far-off nurseries. *"With nurseries at local level, farmers can transport fry in big vessels with an oxygen pump. There is no need for special containers,"* says Bidhya Bhushan Dutta, a fisheries expert with VSK.

The husband-wife duo was able to repay the loan with the sales and get a fishing net, life insurance cover and monthly mobile recharge as rewards from the district fisheries department for their entrepreneurial spirit. One of the main grouse is that due to the lack of good hatcheries in the state, spawn has to be imported from West Bengal and many of them die enroute. Farmers have to pay upfront for the whole batch, but the survival rate is only 25 per cent. *"Lack of water the whole year around is the main reason. Hatcheries also require 24-hour surveillance and brooder fish which locals are yet to rear,"* says Rann Vijay.

All inclusive occupation

Not just women and small-scale farmers, even people with disabilities are trying their hands at pisciculture here. Differently abled people are often seen as unproductive, requiring assistance. This perception is starker in rural India. Sample Mithun Kumar Paswan. Despite his left hand rendered useless by polio, this 24-year-old has been an adept fish catcher since he was 10 years of age.

His joint family used to breed fish in their two-acre *ahar* at Rishiyappa village. They could, however, earn around Rs 10,000-Rs 15,000 only. A specialised training in fish farming he attended at the state fisheries department in 2014 changed his life. *"With the techniques they taught, the income from fish jumped to Rs 50,000 in the first year. After that we got another pond dug with financial support from the department and now we earn about Rs 1 lakh,"* Mithun says. It's also a much easier work for him to do than farming or labour. *"It's more about doing the right thing at the right time – preparing the ponds, feeding the fish well, monitoring their health and finally netting them. It requires less physical effort compared to other forms of agriculture,"* he says.

Of the total income, Mithun gets half as he manages all the work while the rest gets distributed among his four brothers. Mithun also gives maths tuition and is soon going to open a middle school in his village.

Now the attitude of people towards his disability has completely changed. *"Earlier, I was a disabled boy, now I am someone who gives business and education to others. They look at me with respect, not pity,"* he says.

Home for me, education for kids

Sitaram Singh's joint family, comprising around 40 people, lived off the 20-acre land it owns, consuming most of the harvested grain. Only Rs 50,000 worth of produce would be sold in the market. That did not help with the needs of education, health and special occasions like marriage. The children would drop out of school after middle school. Today, five of them are staying and studying in the district town, Latehar. *"Two are in college while three go to school. We also had three weddings recently,"* Sitaram says proudly. All this was made possible because of fish farming.

In 2013, Sitaram attended the training programme by the state fisheries department and started breeding fish in the *ahar*. *"The income from fish is Rs 1.50 lakh. Last year, we supplied fish for five weddings in the nearby villages. Dealers in Latehar market have already booked their quota with us for this year's produce,"* he says.

The family is now planning to dig three small ponds which can be supplied with abundant groundwater. The canals running through their fields will also be used to breed spawn by using small nets on both ends. *"We want to make best use of the natural resources available through the skills acquired over the last couple of years. From a simple farmer growing grains, we have taken to pisciculture literally like fish takes to water,"* Sitaram says.

As these farmers beat all odds to improve their earnings, Jharkhand is aspiring to export the best fish to other states.

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Shri. L Narayan Reddy
(1935-2019)

Shri. L Narayana Reddy, the legendary organic farmer, a role model and an inspiration to many in the farming sector, passed away on 14th January 2019.

Born into a large farming family, Shri Narayana Reddy got into farming, after making a living involving himself in odd jobs, for a brief period. He reached the pinnacle in conventional high external input agriculture with record yields in the country, with sheer hard work and dedication. Disillusioned with the consequences of conventional high external input agriculture, in early seventies, Narayan Reddy started to look for alternatives. Highly inspired by Masanobu Fukuoka's "One Straw Revolution", Narayan Reddy switched to natural farming methods.

He had a great passion for learning. He was forever reading, learning, experimenting and constantly adding value to the 'knowledge' on organic farming. He had immense clarity of thought and tried doing things differently. He was keen to share his knowledge. His farm was always buzzing with visitors, which ranged from novices to scientists. He was the first choice of learning for visitors from abroad.

He had immense passion to share knowledge and wisdom. He was highly articulate in several Indian languages and extremely competent in sharing his experiences in English too. He was a columnist in LEISA India magazine for more than a decade. Full of practical wisdom, Narayana Reddy Column is extremely popular among readers. He also shared through his regular columns in local newspapers.

He has travelled widely across the country and abroad, interacting with thousands of farmers and NGOs. Being fearless and sharp in expressing his views clearly, made him the most sought after special invitee for several national and international seminars and policy discussions in diverse media.

He has received several awards in recognition to his contribution to the farming sector - "Karnataka Rajyotsava" Award by Government of Karnataka for the services rendered to the state farmers; "Environmentalist" award from Karnataka State Pollution Control Board; "Nadoja" the highest degree from Kannada University, Hampi, Karnataka, in appreciation of promoting sustainable agriculture; "Krishika Mithrudu" by the Government of Andhra Pradesh in appreciation of efforts in educating farmers about System of Rice intensification at Krishna District during water scarcity and "Sadanaiyalar" by Tamil Nadu Organic Farmers Forum, for demonstrating low cost external input agriculture.

He is a rare combination of excellence, intelligence, acumen and a passion for sharing his knowledge. An extremely hard working person, Shri Narayan Reddy was uncompromising and adopted a simple life style. His demise has caused a great vacuum in the farming sector.

Celebrating 20 years of LEISA India – the product, the process and the movement

It all started in 1998. We started with just distributing quarterly ILEIA Newsletter to Indian readers, around 1000. Within a year, we got ambitious. After releasing a couple of Indian supplements, in the year 1999, we started publishing a full fledged Indian English edition – LEISA India. Since then, LEISA India has become one of the most preferred magazines for sharing practical field based ecological experiences. Published four times in an year, the magazine includes a combination of global and Indian experiences.

All along, we believed that it is not just a publication but a knowledge exchange movement. We forged a consortium of like minded partners consisting of GEAG, Kudumbam and Myrada to explore ways of strengthening knowledge building as well as sharing. Recognising systematic documentation as a crucial necessity for sharing field experiences, in early 2000, LEISA India team successfully guided the consortium for two years on systematic documentation and knowledge management. Also, LEISA India team of AME Foundation, on its own and in collaboration with ILEIA, guided several national and international documentation initiatives with international partners like MISEREOR, Caritas, as well as FAO.

In an effort to reach out to more number of readers, especially the grassroots, in 2009, we launched three language editions – Hindi, Kannada and Tamil, in collaboration with our consortium partners, GEAG, Mitramadhyama Trust and Kudumbam. In 2010, we further spread to Telugu and in collaboration with our Odiya partner, ORRISSA, a Odiya language editions. We further spread our outreach in 2014 to Marathi and Punjabi readers with help of Yuva Rural Association and Khethi Virasat Mission, repectively. Currently, the magazine is being produced in seven languages – Hindi, Kannada, Telugu, Tamil, Marathi, Punjabi and Oriya. All the editions put together reach more than 22000 readers across the country. Besides the print edition, the digital edition and the social media have helped in reaching out to many more interested in ecological agriculture.

The magazine is popular for its practical content. Our readers surveys and impact studies reveal extensive use of the magazine for field purposes, training, policy support as well as further sharing within their own networks.

To create a platform for sharing experiences from the field is never easy for the Editors. Being a thematic magazine, the experience to be shared has to be suitable for the theme of the magazine. It has to be sourced from those active in the field. It has to reflect deep insights and learnings on field realities and alternatives. It has to be written by practitioners who seldom write. **In this challenging scenario, we deeply acknowledge the commitment and enthusiasm of all our readers and authors who have been supporting the magazine as well as promoting wider sharing, thus strengthening an alternative paradigm of agroecological movement**.

LEISA India has spearheaded significantly several themes and movements like SRI, International Year of Family Farming etc. LEISA India programme has also brought out several products like calendars and posters to popularise LEISA Movement. LEISA India, a member of global Agricultures Network, has been part of international deliberations and exchanges in partnership with partners in Latin America, Brazil, Africa and Asia and Europe through Agricultures Network. A small programme has thus transformed into a movement, ably supported by DGIS (through ILEIA), IDRC for a brief while and MISEREOR, since, 2011.

Humbly, continuing to be relevant and useful...