



## Food and Nutrition Security Community



## Environment Water Community



# Solution Exchange for the Food & Nutrition Security Community Solution Exchange for the Water Community Consolidated Reply

## *Query: Promotion of Aqua-agriculture in Bihar - Experiences*

Compiled by [Gopi Ghosh](#) and [Nitya Jacob](#), Resource Persons, [Raj Ganguly](#), Consultant and [T. N. Anuradha](#) and [Sunetra Lala](#), Research Associates

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From [Jeevan Kumar](#), Institute of Environment and Eco-Development, Patna  
Posted 31 October 2008

I am Jeevan Kumar working at the Institute of Environment and Eco-Development, Patna on enhancement of livelihoods and management of existing indigenous water sources in some districts of north Bihar.

Gorgon nut or makhana (*Euryale ferox*) is extensively cultivated in stagnant water pools and lakes in these districts by members of the fishing community, who harvest the seeds from the deep water beds. It is cultivated along with local fish species such as Kawai, Mangur, Singhi with moderate supplementary feed. These species are well-adapted to the practice of cultivation with Makhana as the plant covers the entire water surface. Makhana produces white starchy seeds that are edible and have high nutritional and medicinal properties.

Makhana cultivation faces challenges in northern Bihar due to the rapid shrinkage of wetland areas, filling of biotopes naturally with mud, silt and detritus, eutrophication by weeds, shifting of riverbeds, poor marketing facilities, lack of incentives to cultivators and absence of new technology to boost production. However, it continues to be the basis of livelihood for a large number of fisher folk in northern Bihar.

Therefore, we are planning to promote Makhana cultivation and management of traditional water sources in the Madhubani district of Bihar. We plan to initiate a livelihood-based project entitled "Restoration of agro-bio-aqua diversity by conservation of indigenous Makhana species". It will be of immense strategic importance to the project if members can provide inputs on:

- What are your experiences and strategies for improving the productivity of aqua-agriculture?
- What strategies have proved effective in the coordinated use of water bodies?

Also, please share information you may have on integrated aquaculture technologies available, and how to access them.

The information shared by members would be useful in helping us to effectively implement the proposed project.

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### Responses were received, with thanks, from

1. [Neelkanth Mishra](#), Oxfam India, Lucknow
2. [Raj Ganguly](#), Consultant, New Delhi
3. [Ashok Kumar](#), VSED, New Delhi
4. [B. L. Kaul](#), Society for Popularization of Science and Progressive Educational Society, Jammu
5. [D. K. Paul](#), Indian Council of Agricultural Research, New Delhi
6. [K. V. Peter](#), World Noni Research Foundations, Chennai
7. [P. K. Thampan](#), Peekay Tree Crops Development Foundation, Kochi
8. [Arunabha Majumder](#), Presidency College, Jadavpur University, Kolkata
9. [Anupam Paul](#), Agricultural Training Centre, Fulia, West Bengal
10. [Prosun Bhattacharya](#), Royal Institute of Technology (KTH), Stockholm, Sweden
11. [Budhi Sayoko](#), United Nations Development Programme (UNDP), Indonesia
12. Prabhat Kumar, Asian Institute of Technology (AIT), Bangkok, Thailand ([Response 1](#); [Response 2](#))
13. [Roy Mathew](#), Department of Agriculture, Kerala
14. [P. S. Yadav](#), Haryana Institute of Rural Development and Department of Development and Panchayats, Haryana
15. [Sanjay Aggarwal](#), Clover Organic Pvt. Ltd, Dehradun
16. Maroti Upare, Independent Consultant, Mumbai ([Response 1](#); [Response 2](#))
17. [Bimal Biswas](#), Independent Consultant, New Delhi
18. [Pranaya Parida](#), Fisheries Specialist, Action for Food Production (AFPRO), Bhubaneswar

*Further contributions are welcome!*

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[Summary of Responses](#)  
[Comparative Experiences](#)  
[Related Resources](#)  
[Responses in Full](#)

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### Summary of Responses

One of the development pathways for farming is diversified agriculture such as Integrated Agriculture-Aquaculture systems, a system many small farmers practice. Responding to a query on restoring agro-bio-aqua diversity through conservation of indigenous Makhana species in Bihar, members highlighted the benefits of such integrated systems, shared experiences with similar initiatives and listed strategies for operationalizing it.

Discussants explained that **Makhana cultivation** is an old farming system practiced in northern Bihar, which accounts for over 80% of the Makhana production in the country. They pointed out that Makhana is an underutilized aquatic crop with considerable nutritional value; unfortunately, it currently brings insufficient economic returns for producers, due to the lack of concerted efforts for its promotion. Even

the work by the Indian Council for Agricultural Research (ICAR) to establish a National Research Centre on Makhana, only led to more of a focus on production rather than on processing technologies, which could increase the economic benefits for farmers.

Respondents noted several advantages of combining aquaculture with agriculture in terms of the benefits to crops from the waste of fish and vice-versa, "automatic tillage" through fish movement with zero costs in feeding fish. In addition, farmers can earn about 20-30% more. Members informed that aqua-agriculture is known by different names in different regions like in eastern part of West Bengal it is termed as 'paddy cum fish culture'. This system also works well in places like northern Bihar, which are prone to floods.

Members raised several **concerns** regarding the **diminishing practice of aqua agriculture** in the country. For example, in **West Bengal**, Sali lands were meant for Khariff rice cultivation due to their location 2-3 feet above water level. Previously, the area had several kinds of naturally occurring fish; however, the aquaculture practice was wiped out with the introduction of modern fish varieties.

Sharing **experiences of aqua-agriculture** in varied conditions and with different combinations of crops and fish species, discussants mentioned the experiments conducted by ICAR in Darbhanga district, [Bihar](#) where mixing catfish production with Makhana cultivation proved successful. Similarly, in the [Bundelkand Region](#), Oxfam supported fisherfolks in gaining control over their resources (a pond) by engaging in policy advocacy, enhancing production and access to markets. This led to development of inland fishery activities. Also in Ernakulam district of [Kerala](#) farmers are using an unique integrated system of agriculture, by growing coconut on bunds with a single crop of paddy and rearing fish and shrimps during lean period on left over waters.

Other experiences mentioned, utilizing reclaimed mangrove areas for fish culture in the [Andaman and Nicobar Islands](#), wherein coconut plantations are raised on bunds, with fodder species planted in the interspaces and the channels are used to rear fish; and use of sewage in **Kolkata** for 364 fish-ponds that annually produce 20,000 MT of various varieties of fish. However members underlined that using untreated city or factory wastewater, sewage etc. directly is not advisable due to chances of heavy metal toxicity and contamination with other bacteria and protozoa and other pathogenic microbes are very high. In [Orissa](#), Self-Help Groups (SHGs) are successfully undertaking precision farming of vegetables and growing marigolds, on pond bunds and the [Assam Agriculture Competitiveness Project](#) is effectively demonstrating a diversified agriculture system of fish with horticultural crops on bunds and fish cum livestock (pig) systems adopting participatory approach of forming Common Interest Groups.

Along with experiences in India, respondents also highlighted international experiences. In the Mekong Delta, [Vietnam](#) 'alternate rice-shrimp cropping' has proved to be a profitable option in low lying brackish water areas and in East Kalimantan, [Indonesia](#) farmers have been successful in saving the shrimp ponds industry by applying polyculture for fishery and advocacy for mangrove conservation. Members also highlighted the development of aquaculture in the Char areas of **Bangladesh**, which has shown promising results thus far.

To promote the adoption of aqua-agriculture, discussants advised introducing various **strategies and principles**, including:

- Create a sustainable and strong institutional base with fisherfolk/Makhana cultivators, possibly through a producer company
- Develop women's leadership to enhance their capacity to deal with the market
- Provide technical support for production/productivity enhancement and quality control related aspects
- Conduct a detailed value chain analysis of Makhana and its' different products to identify an area of intervention
- Market information dissemination

- Integrating agriculture component in aquaculture policy and its promotion for a diversified integrated system
- Apply sustainable practices that are suitable for the social, economic and ecological situation and catalyse wider synergies with all other local actors

Members also recommended supporting post-harvest handling, processing, packaging, marketing and value addition along with investment, technology, and business entrepreneurship among youths. They underlined the need for recognizing the various forms of Makhana consumption and developing markets. For example, in northern **Bihar**, the Makhana seed is consumed in a popped form and in **Manipur**, the leaves and stalks are consumed as vegetables. In addition, respondents reiterated developing technology to suit local requirements and needs, like having a bicycle-based “fish cooling/carrying device”. Other recommendations were to train farmers on fish fingerlings, exploring market linkages, and to encourage states/districts for reviving water bodies by desilting, as projects under the National Rural Employment Guarantee Scheme (NREGS). Finally, respondents advised utilizing as many water bodies for aquaculture as possible and integrating them with agriculture, as additional sources of livelihood.

Lastly, members outlined several situation specific **options for developing and maintaining aqua agriculture systems**, like:

- Integrate fish culture with rice fields and with makhana, singhara and Bhen (Kamal Kakri) etc. as per local situations. Exploring possibilities for other aquatic crops like Azolla, Chinese water chestnut etc.
- Combine aquaculture with crop production (vegetables like potatoes, cabbage, cauliflower and high value crops like capsicum and broccoli) and wheat
- Utilisation of ponds affected by floods - stocking overflowing ponds with yearlings, makhana culture along with 'magur' and other catfish or with common carp

In conclusion, members felt that the practice of aqua-agriculture is not new and it has proven benefits. It is a question of reviving these practices and encouraging the farmers to adopt such locally suitable integrated systems, backed by appropriate technology and market support, for better productivity and higher income.

## Comparative Experiences

### National

#### Bihar

**Supply Chain for Makhana Helps Farmers** (from [Sanjay Aggarwal](#), Clover Organic Pvt. Ltd., Dehradun)

Shri Shakti Sudha, a local commodity trader, established a successful supply chain for Makhana produce by creating a tripartite agreement between farmers, the panchayat and a company. This approach helped them to overcome challenges associated with providing credit to farmers, negotiating with the government to lease ponds to farmers and to ensure technology support to maintain quality at the end product. Makhana payments are now credited directly to the farmers accounts. Read [more](#)

#### Orissa

**Integrated Farming by SHGs Enhances Livelihood Options, Kendrapara** (from Maroti Upare, Independent Consultant, Mumbai, [response 1](#))

The M S Swaminathan Research Foundation successfully demonstrated precision farming of vegetables and horticulture crops on pond bunds by women SHGs. The Orissa Government has taken policy initiatives for leasing ponds to women SHGs. This initiative enhanced the ability of village institutions and

demonstrated how precision farming could utilize natural resources. It also helped 32 SHGs access additional livelihood options, including fish farming and integrated farming. Read [more](#)

## Assam

### **Integrating Fishes with Paddy and Flowers Increases Yields** *(from Maroti Upare, Independent Consultant, Mumbai, [response 2](#))*

The Assam Agriculture Competitiveness Project was successful integrating fish farming with horticulture, pig production and paddy cultivation. As a result of these efforts, the average fish production increased to 3,000 kg/per ha as against the average of around 2,000 kg/per ha perviously, it also helped improve paddy yields considerably. Read [more](#)

From [P. K. Thampan](#), Peekey Tree Crops Development Foundation, Kochi

## Kerala

### **Unique Integrated Agri System Improves Farmer Yields, Ernakulam District**

In the Pokkali rice fields an innovative integrated system of agriculture is giving profitable yields to local farmers. Farmers are growing coconuts and paddy and during the lean period using the esotred water for fish and shrimp rearing. The average yield of coconut using this system is over 4,000 nuts per ha and 2-3 tonnes per ha of paddy, while fish and shrimp production is about 900 kg per ha. Read [more](#)

## Andaman and Nicobar Islans

### **Quicker Yields through Integration of Resources**

Reclaimed mangrove areas are now being utilized for fish culture and yielding handsome yields for farmers. The approach followed involves planting coconut on raised bunds and in the interspaces fodder species are grown, and the channels are utilized to rear fish. The yields were 256-380 kg per ha of mullet in seven months, 175 kg per ha of prawn in six months, 1,260 kg per ha of tilapia in a year and 174 kg per ha of prawn natural stocking in two months.

## Uttar Pradesh and Madhya Pradesh

### **Fishing Cooperatives Prove Successful, Bundelkand Region** *(from [Neelkanth Misra](#), Oxfam India, Lucknow)*

Oxfam is training families to develop new skills, adopt innovative techniques, and share their training with villagers in neighbouring districts. Using their training, a co-operative of fishing families piloted a fish nursery. The co-operative then sold the "fingerlings" to neighbouring communities who wanted to restock their own fishing ponds. Through the nursery each of the 10 households have earned an extra Rs 2,000. Read [more](#)

## International

### Vietnam

### **Alternate Rice-Shrimp Farming Proves Profitable, Mekong Delta, Minh Hai Province** *(From [P. K. Thampan](#), Peekey Tree Crops Development Foundation, Kochi)*

The integration of dry season shrimp farming into rice fields has raised incomes over several consecutive seasons for many farmers in the region. Alternate rice-shrimp cropping has proved to be a profitable option in low lying brackish water areas. The system enabled farmers to produce over four tonnes of paddy per ha per year during the rainy season along with 700 kg per ha per year of shrimp fry during the dry season. Read [more](#)

## Indonesia

### **Synergies with Ongoing Programme Help Better Implementation, Mahakam** (from [Budhi Sayoko](#), United Nations Development Programme (UNDP), Indonesia)

Conversion of natural environment into commercial shrimp ponds led to disturbances in the ecological balance of the mangrove system. This caused high shrimp mortality levels reducing the economic benefits. UNDP along with the local government used polyculture activities to disseminate technology and synergize it with ongoing local government fishery programmes to help the environment and farmers.

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## Related Resources

### **Recommended Documentation**

From [Neelkanth Misra](#), Oxfam India, Lucknow

#### **Oxfam at Work**

Magazine; Oxfam; 2008

Available at [http://www.oxfam.org.uk/get\\_involved/companies/downloads/oxfamatwork\\_web08.pdf](http://www.oxfam.org.uk/get_involved/companies/downloads/oxfamatwork_web08.pdf) (PDF Size: 900 KB)

*Page 9 explains the Oxfam initiatives in Bundelkand region designed to build the capacity of fishing communities by through trainings and marketing skills to help revive their aqua culture*

#### **Frequently Asked Questions (FAQ) on "Farmers' Producer Company (PC)" an Institutional PC Concept**

Document; Devarao Shivaram Trust, Bangalore; International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad; Biotechnology Centre, Bangalore

Available at [http://km.fao.org/fileadmin/user\\_upload/fsn/docs/Microsoft%20Word%20-%20FAQ-PC%206Mar2k7.pdf](http://km.fao.org/fileadmin/user_upload/fsn/docs/Microsoft%20Word%20-%20FAQ-PC%206Mar2k7.pdf) (PDF Size: 48 KB)

*Provides information on the operationalisation of producer companies, which could be beneficial for initiating aqua agricultural operations*

From [Raj Ganguly](#), Consultant, New Delhi

#### **Makhana Crop Improvement, Production, Post-Harvest Management and Processing**

Note; Indian Council for Agricultural Research (ICAR)

Available at <http://www.icarrcer.org/achievements/makhana.htm>

*Outlines the research achievements of Indian Council for Agricultural Research (ICAR) in promoting Makhana cultivation and aqua agriculture*

#### **Integrated Aquaculture in Eastern India: Working Paper No. 5**

Working Paper; by K. Kumar and S. Ayyappan.; Central Institute of Freshwater Aquaculture; Bhubaneswar; March 1998

Available at <http://govdocs.aquake.org/cgi/reprint/2006/101/1010590.pdf> (PDF Size: 265 KB)

*Discusses how integrating fish farming systems or aqua agriculture has great potential for augmenting production, improving rural economies and generation of employment.*

#### **Flood Plains and Wetland Management on Watershed Approach** (from [D K Paul](#), Indian Council for Agricultural Research (ICAR), New Delhi)

Paper; by Dr. D K Paul; Indian Council for Agricultural Research (ICAR); New Delhi

Available at <http://www.solutionexchange-un.net.in/food/cr/res31100801.doc> (Document Size: 84 KB)

*Contains ecological data from floodplain ecosystems indicating that nutrient rich and diverse ecosystems have high potential for fish and allied agricultural production*

From [P K Thampan](#) Peekey Tree Crops Development Foundation, Kochi

### **Transformation of Coastal Wetland Agriculture and Livelihood in Kerala**

Report; by Manjunatha R Ranga; Natural Resources Institute; Canada; January 2006

Available at

[http://www.umanitoba.ca/institutes/natural\\_resources/canadaresearchchair/thesis/mranga%20masters%20thesis%202006.pdf](http://www.umanitoba.ca/institutes/natural_resources/canadaresearchchair/thesis/mranga%20masters%20thesis%202006.pdf) (PDF Size: 1.53 MB)

*Page 83 of the report explains the methods adopted for integrated aqua culture with rice and shrimp*

### **An Evaluation of Rice-Shrimp Farming Systems in the Mekong Delta**

Report; by Donna Brennan, Nigel Preston, Helena Clayton and Tran Thanh Be; World Bank, Network of Aquaculture Centres in Asia-Pacific, World Wildlife Fund (WWF), Food and Agriculture Organization of the United Nations (FAO), and Consortium Program on Shrimp Farming and the Environment; 2002

Available at <http://govdocs.aquake.org/cgi/reprint/2003/1101/11010090.pdf> (PDF Size: 418 KB)

*Explains integrated rice-shrimp farming as a system of alternative cropping as one of the aqua agriculture methods successful in Vietnam*

### **Makhana Gold** (from [Sanjay Aggarwal](#), Clover Organic Pvt. Ltd., Dehradun)

Article; by Naren Karunakaran; Outlook Business; 18 October 2008

Available at

<http://business.outlookindia.com/inner.aspx?articleid=2165&editionid=58&catid=2&subcatid=973>

*Explains the profitable initiative set by a local trader who developed a supply chain for Makhana by analyzing and understanding of the socio-political-cultural milieu of the area*

From Maroti Upare, Independent Consultant, Mumbai, [response 1](#)

### **Livelihood and Micro-Enterprise Development Opportunities for Women in Coastal Fishing Communities in India**

Case Studies; by U. Tietze, S. Siar, Suchitra M. Upare and M.A. Upare; Food and Agriculture Organization of the United Nations (FAO); Rome; 2007

Available at <http://www.fao.org/docrep/010/a1164e/a1164e00.htm>

*Findings suggest active promotion of self-help groups and cooperatives among women in coastal fishing communities through appropriate financial linkages help improve aquaculture activities*

### **Polyculture and Integrated Fish Farming**

Training Manual; Assam Agricultural Competitiveness Project (AACP), Government of Assam, and College of Fisheries, Assam Agricultural University; 2006

Available at <http://assamagribusiness.nic.in/Fishery23.pdf> (PDF Size: 481 KB)

*Presents various aspects of the polyculture of carps and fish farming practices with the integration of paddy and livestock as aqua agriculture*

### **Livelihood Assessment and Microfinance Programme for Women in Coastal Fishing Community in Orissa**

Report; NABARD Consultancy Services (NABCONS) and Food and Agriculture Organization of the United Nations (FAO)

Available at

<http://orissafisheries.com/File/Report%20on%20micro%20finannce,%20livelihood,%20women%20in%20coastal%20Oriss-dec04.pdf> (PDF Size: 538 KB)

*Assesses the livelihood options for women in coastal areas and supports creating microfinance programme linkages for improving their livelihoods through approaches like aqua agriculture*

From Maroti Upare, Independent Consultant, Mumbai, [response 2](#)

### **Assam Agricultural Competitiveness Project**

Note; World Bank; Assam; 2004

Available at [http://www.gln.net/index.php?option=com\\_external\\_tools&id=171&task=view&Itemid=129](http://www.gln.net/index.php?option=com_external_tools&id=171&task=view&Itemid=129)  
*Describes the Assam Agricultural Competitiveness Project, which has successfully engaged in aqua agriculture by cultivating fish along with paddy, horticultural crops and pigs*

### **UNDP Aquaculture Project Aims to Improve Livelihoods in Vietnam's Northern Uplands**

Article; by J. Schytt; United Nations Development Programme (UNDP); 17 May 1999

Available at <http://reliefweb.int/rw/rwb.nsf/db900sid/OCHA-64DFB2?OpenDocument>  
*Explains a project that proposed to integrate available water resources for fish farming along with paddy cultivation as aqua agriculture initiative*

### **Development of Freshwater Fish Farming and Poverty Alleviation**

Article; by Gertjan de Graaf and Abdul Latif; Nefisco Foundation, AmsterdamChar Development and Settlement Project, Noakhali, Bangladesh

Available at <http://www.nefisco.org/downloads/DevelopmentOfFreshwaterFishFarming.pdf> (PDF Size: 269 KB)

*Informs on the Char Development and Settlement Project that encourages productive development, in particular agriculture, and to some extent aquaculture*

From [T.N. Anuradha](#), Research Associate

### **Sustainable Management of Biotic Resources in the Wetlands of North Bihar**

Paper; by Vidyanath Jha; Department of Botany, C. M. Science College; Darbhanga

Available at [http://www.ces.iisc.ernet.in/energy/lake2002/proceedings/12\\_5.html](http://www.ces.iisc.ernet.in/energy/lake2002/proceedings/12_5.html)  
*Looks into various avenues that suggest better utilisation of north Bihar wetlands like integrating aquaculture along with these aquaphytes to augment the wetland productivity*

### **Western Orissa Rural Livelihoods Project, Aquaculture Development Report, Volume 6**

Report; by S. D. Tripathi and G. Haylor; Government of Orissa and Department for International Development (DFID); September 2006

Available at <http://www.worlp.com/images/publication/WORKING%20PAPER%2048.pdf> (PDF Size: 294 KB)

*Covers the sixth Aquaculture Development Report that looks at boosting the supply and quality of fingerlings, planning and management, training and exposure*

### **Project Report on Export Promotion of Makhana from Bihar**

Report; Agricultural Finance Corporation Ltd, Government of India (GOI), United Nations Conference on Trade and Development (UNCTAD) and Department of International Development (DFID); 2007

Available at [http://www.unctadindia.org/uploadFile.asp?upFile=Studies\\_ExportPromotionOfMakhanaFromBihar.pdf](http://www.unctadindia.org/uploadFile.asp?upFile=Studies_ExportPromotionOfMakhanaFromBihar.pdf)  
(PDF; Size: 180 KB)

*Recommends promoting Integrated Fish cum Makhana Cultivation which could play vital role in enhancing the livelihoods of poor growers*

### **Fish Farming in Rice Environments of North Eastern India**

Article; by D. N. Das; Department of Zoology, Arunachal University; Itanagar; April-June 2002

Available at <http://govdocs.aquake.org/cgi/reprint/2003/1201/12010310.pdf> (PDF; Size: 581 KB)  
*Informs on the indigenous rice-fish farming practices, a type of aqua agriculture, prevalent among farmers in the north eastern part of India*

From [Sunetra Lala](#), Research Associate

### **Scoping Agriculture-Wetland Interactions - Towards A Sustainable Multiple-Response Strategy**

Report; by Adrian Wood; Food and Agriculture Organisation; Rome; 2008;

Available at [ftp://ftp.fao.org/docrep/fao/011/i0314e/i0314e.pdf](http://ftp.fao.org/docrep/fao/011/i0314e/i0314e.pdf) (PDF, 7,570KB)

*A framework and assessment (based on 90 cases) of how aqua culture in wetlands can enhance agricultural productivity, thereby also transforming the state of wetland ecosystem*

### **Valuing Ecosystem Services - The Case of Multi-Functional Wetlands**

Book; by R. Kerry Turner, Stavros Georgiou and Brendan Fisher; Earthscan; United Kingdom; Location; July 2008;

Available at <http://www.earthscan.co.uk/?tabid=21116>

*Argues that it is not only wetland ecosystems themselves that should be valued, but also the goods and services provided by them through aqua agricultural opportunities, etc*

### **Dying Wisdom-The Rise and Fall of India's Traditional Water Harvesting Systems (from Name, Organization, Location)**

Book; by Anil Agarwal and Sunita Narain; Centre for Science and Environment; New Delhi; 1997;

Available at <http://www.cseindia.org/html/extra/twhs.htm>

*Contains a chapter on aqua agricultural practices in Arunachal Pradesh, which has not only helped to conserve water but also boost agriculture and pisciculture in the state*

### **Recommended Organizations and Programmes**

#### **Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar (from [Raj Ganguly](#), Consultant, New Delhi)**

Kausalyaganga, Bhubaneswar, Orissa 751002; Tel: 91-674-2465421/30; Fax: 91-674-2465407; [cifa@ori.nic.in](mailto:cifa@ori.nic.in); <http://www.cifa.in>

*Institute working on freshwater aquaculture and the Lead Centre on 'Carp Farming in India' in the Network of Aquaculture Centres in Asia-Pacific*

#### **Vivekananda Kendra Natural Resources Development Project, Kanyakumari (from [Roy Mathew](#), Department of Agriculture, Kerala)**

Vivekananda Puram, Kanyakumari, Tamil Nadu 629703; Tel: 91-4652-246296;

[ngc\\_vkndep@sancharnet.in](mailto:ngc_vkndep@sancharnet.in); [http://www.vkndep.org/program\\_schedules.html](http://www.vkndep.org/program_schedules.html)

*Conducts training programmes on dual azolla cultivation with paddy as a nutrient rich fertiliser and employs integrated aqua agriculture*

From [Sunetra Lala](#), Research Associate

#### **Aquaculture Foundation of India, Chennai**

4/40, Kapaleeswarar Nagar, Neelankarai, Chennai-600041; Tel: 91-44-24490924; [sakthi.afi@gmail.com](mailto:sakthi.afi@gmail.com); <http://www.aquaculturefoundation.in/activities.htm>;

*Promotes aquacultural practices, including training and awareness on marine life and fisheries aquaculture and development of aquaculture technologies*

#### **Central Institute of Brackishwater Aquaculture (CIBA), Chennai**

75, Santhome high road, Raja Annamalai Puram, Chennai-600028; Tel: 91-44-24616948; Fax: 91-44-24610311 [ciba@tn.nic.in](mailto:ciba@tn.nic.in); <http://www.ciba.tn.nic.in/frameset-contact.htm>;

*Conducts research for development of techno-economically viable and sustainable aquaculture system for finfish and shell fish in brackish water*

## *Related Consolidated Replies*

### **Revival of Depleting Minor Fish and Aquatic Resources, from Indira Chakrabarty, the Hunger Project, Kolkata (Advice). . Food and Nutrition Security Community,**

Issued 6 September 2005. Available at <http://www.solutionexchange-un.net.in/food/cr/cr-se-food-05090501.pdf> (PDF, Size: 172 KB)

*Examples and insights on ways to revive fish resources in rice fields and small inland water bodies that are depleted from use of fertilizers, chemicals and pesticides*

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## **Responses in Full**

### **Neelkanth Mishra, Oxfam India, Lucknow**

Oxfam has supported fisherfolks struggle in Bundelkhand region to get control over resources (Pond). In Due course of time, the program provided rationale to work on inland fishery related issue and right now working with more than 12000 fisherfolk community.

During program implementation process, Oxfam tried to address issue related to policy advocacy, production enhancement and access to market by fisherfolk community. Experiences from this program provide relevant background to support the raised query regarding Makhana cultivators in Bihar. We cannot overlook fact that Bihar state accounts for over 80% of the Makhana production of the country. Madhubani, Darbhanga, Sitamarhi, Saharsha, Katihar, Purnia, Samastipur, Supaul, Kishanganj and Araria Districts are major producer of Makhana. And it has a potential market in India and outside. China is already into commercialisation of Makhana Produces.

The Strategies Oxfam and partner organisation followed in Bundelkhand was based on geographical and socio-economical conditions. So those strategies can not be replicated in case of Bihar, but principal can be widely used for developing appropriate strategy for Madhubani.

Principals for developing appropriate strategy would be:

- **Institutional strengthening:** Creating a sustainable and strong institutional base with fisherfolk/ Makhana cultivators is one of the prime important area of intervention. During initial periods, we need to address issue faced by particular homogenous group of stakeholders (Makhana Cultivators). Instead of initiating market based interventions, putting effort on collectivization process will facilitate process to be scaled up in near future.
- **Working with Women:** Developing women's leadership and enhancing their capacity to deal with market so that they can consolidate their entrepreneur skill is utmost important. It require deliberate effort to address women's issue. If possible, develop women's group for makhana cultivation. It will support in developing women's economic leadership and enhance economic productivity of women groups who are excluded in economic-social development process (particularly in context of Mithila region of Bihar/Darbhangam-Madhubani area).
- **Technical support and facilitation:** The Program must look at providing technical support for production /productivity enhancement and quality control related aspects. Some micro level intervention related to processing may also be adopted. There is a technical/research institute by ICAR in Darbhanga called as **National Research Center** for Makhana. Government of Bihar has initiated the process of transfer of the proposed site to ICAR for establishment of the NRC for Makhana, where an ultra modern R&D infrastructure complex will be constructed. Presently the Centre is functioning from its camp office located at Central Potato Research Station, Near Civil Aerodrome, Patna. This centre could be liasoned to provide on farm support to makhana cultivators.
- **Value chain analysis:** Obviously, present day market is supportive for Makhana and processed food. But instead of following what others are doing; a detailed value chain analysis of Makhana and produces would be helpful to identify area of intervention and to initiate from less risk prone intervention. Value chain analysis must be inclusive of all stake holders that is farmers, traders,

processors, govt., private company etc. this process also needs to be accompanied by business plan for community based institutions. More on producer company can be accessed at [http://km.fao.org/fileadmin/user\\_upload/fsn/docs/Microsoft%20Word%20-%20FAQ-PC%206Mar2k7.pdf](http://km.fao.org/fileadmin/user_upload/fsn/docs/Microsoft%20Word%20-%20FAQ-PC%206Mar2k7.pdf). At this moment, we have different institutional arrangement to initiate collective intervention. It could be done through SHG, TRUST, Society, Producer Company, etc. what would be best form will emerge through institution building process and analysis of different options. But ofcourse Producer Company is one of the new option and can be worked out. PRADAN has used this option to develop community based enterprises in Madhya Pradesh, Jharkhand.

- **Market information dissemination and linkages development:** Makhana has a potential market in local haat of Madhubani and Darbhanga during all season (Most in Marriage and festival season), with Traders in Darbhanga , patna and local area and also national level market. E.G. Reliance, Spencer and all agro food processing units are looking for continuous supply of produce with premium price. China is already into export of Makhana to Arab and other countries. Value chain analysis will help in identifying area of linkages development in future and market info dissemination tool at community level. Bottom line " **let people/Producers should engage with market, rather than traders only**"
- **Opting for private players:** It is one of the lucrative offer that would come into near future. Group need to decide with whom to get engaged and who play market with ethical checklists. It is not at all advisable to get engaged with private players at nascent stage.
- **Policy advocacy:** There are lots of issue faced by Makhana growers/farmers. There is urgent need to collate all from community and produce it into policy advocacy document for government. Government of Bihar has priority area of Aquaculture development. There are into developing policy for fishery. Lets advocate for "Aquaculture policy" rather than only fishery policy.
- **Linkages with government programs and scheme:** As Makhana is aqua produce so it requires water throughout the year for sustained production. Day by day, water bodies are getting polluted and loosing production capacity. NREGA has potential to be utilised for regenerating water bodies in Bihar especially in Mithila region where program is targeting (Madhubani). Working on Agri. Credit card and insurance for makhana cultivators is also one of the feasible program strategy to be incorporated.
- **Differentiate social development programs and economic development programs:** The most important among all principal: There should be clear differentiation between social developments related intervention and economic development intervention. Both can go together but can not be addressed at same time with community. Its always useful to identify community based leaders/facilitators with different capacity like who is into social development process and who are into economic development process.

This will facilitate process of developing separate monitoring and evaluation tools for social as well as economic based interventions.

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**[Raj Ganguly](#), Consultant, New Delhi**

'Makhana' cultivation is very old farming system in North Bihar particularly in Darbhanga. However, although Makhana is marketed throughout India, it could never bring in sufficient economic returns to the producers. One of the reason that there was no concerted effort to promote the uniqueness of this product citing the medicinal and nutritional benefits.

ICAR had taken initiatives, by establishing National Research Centre on Makhana, but it's efforts are more on the production aspects. Few initiatives were there on processing technology (<http://www.icarrcer.org/achievements/makhana.htm>), but how it created impacts on local livelihood, remains to be seen.

I believe post harvest handling, processing, packaging and marketing are the key areas, and together with investment, technology, and business entrepreneurship among youths, 'Makhana' has the potential to bring in good economic returns.

Apart from this, there is no doubt that if production system is integrated holistically with some additional farming system, then the income flow is enhanced, sustainable and risk averse. Rice-Fish, farming system has been an age-old integrated farming system in Asian countries. Similar 'Aqua-Agriculture' systems, are finding new prominence with many innovative integrations like Horticulture, Sericulture, Mushrooms etc. A comprehensive note, detailing such innovative systems, from Central Institute of Freshwater Aquaculture is available at <http://govdocs.aquake.org/cqi/reprint/2006/101/1010590.pdf> (Size: 265 KB), which can incite some thought process to develop locally adaptable integrated 'Aqua-Agriculture' farming systems.

In north Bihar, the seed is consumed in popped form, but in Manipur, other parts (leaves and stalks) are consumed as vegetables. I believe such usage among local community will also help promotion of this crop.

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**[Ashok Kumar](#), VSED, New Delhi**

Frequent flooding with unpredicted magnitude are the major reasons in aqua-agri based intervention in North Bihar. North Bihar (North of Ganges) having very large number of natural water bodies (Chaur, Ox-bow lake).

But these are not isolated. They are connected directly or indirectly with the drainage channel. Many of these Chours (depressions) are full of reeds.

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**[B. L. Kaul](#), Society for Popularization of Science and Progressive Educational Society, Jammu**

Fish culture in rice fields is a practice common in West Bengal, Orissa and Andhra Pradesh and also some more places. It can be adopted in Bihar as well and benefit the rural population as a rich source of protein.

Additionally composite Carp culture along with duck keeping as a part of integrated animal culture could become a good source of income to unemployed youth of the State. Bihar needs an aggressive push in economic field more now than ever before in view of the devastation it has faced recently.

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**[D. K. Paul](#), Indian Council of Agricultural Research, New Delhi**

It is a very timely query on developing the rural economy in Bihar. I would like to share one of my paper for general view on developing wetlands/lowlands in Bihar available at <http://www.solutionexchange-un.net.in/food/cr/res31100801.doc>.

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**[K. V. Peter](#), World Noni Research Foundations, Chennai**

At a recent function on world science day a very tasty fish based lunch was served. The fish served was the much relished pearl spot cooked in a banana leaf. To our delight pearl spot, a brackish water fish is grown by traditional fisher men in paddy fields during monsoon. In local Malayalam it is called 'malsya kettu'-fish bundle-. Later we visited the famous tourist village Kumbalanghy, exactly Kallencherry where the above fish, crabs and lobsters are grown.

The backwaters the Homestay resort managed by Mr Lawrence and his wife organised the whole farm tourism using the services of two helpers. The items served were fermented rice bread, sear fish molly

and lobster. It was just fantastic. We tasted the food cooked by Mrs Lawrence to much of our delight with the 'Kumbalanghy lake in the back ground, Chinese nets and the deep red sun set looming. The fish culture is not only an economic activity but also a mind soothing activity to be realised only by experiencing it.

I am elaborating the above to bring home the role of fish in village life. Makhana is an underexploited and underutilized aquatic crop of considerable nutritive value.

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**P. K. Thampan, Peekay Tree Crops Development Foundation, Kochi**

The integration of pisciculture with farming system is popular in many countries. The system offers both ecological and economic benefits. The practice of alternate rice-shrimp cropping in low lying areas is common in some parts of India, Thailand, Vietnam etc. In the Pokkali rice fields in the Ernakulam district of Kerala strong bunds are put up with the earth brought from outside as a protection against the inflow of sea water. Sluices at convenient places are also provided to facilitate control of water level and drainage. Coconut is grown in single row on the bunds which are broad enough to accommodate 100-120 palms per ha. Single crop paddy is cultivated within the protected land which comes to flowering in the month of September.

At harvest, the ears alone are gathered and water is kept in the field till January-February and during this period fish and shrimp are reared. The average yield of coconut from this system is over 4,000 nuts per ha and of paddy 2-3 tonnes per ha, depending on the variety used. The average production of fish and shrimp from the pokkali lands is about 900 kg per ha where the shrimp component is about 800 kg. This is a unique integrated system where chemical fertilizers and plant protection chemicals are rarely used.

In some states different varieties of fish are reared in one metre deep trenches excavated all along the borders of the rice fields. Broad bunds are formed with the dug out soil as the field boundary and on which vegetables and pulses are cultivated, mainly for home consumption. The bunds also prevent the fish from jumping out. No special feed is given to the fish except occasional sprinkling with cowdung and oil cake in the trenches. This composite farming system succeeds only when the rice crop is free from excessive use of plant protection chemicals.

In the Andaman and Nicobar Islands, reclaimed mangrove areas are utilized for fish culture. Coconut is planted on raised bunds and in the interspaces fodder species are grown. The channels are utilized to rear fish. In an early study it was recorded that 256-380 kg per ha of mullet in seven months, 175 kg per ha of prawn in six months, 1,260 kg per ha of tilapia in a year and 174 kg per ha of prawn natural stocking in two months could be harvested from the channels.

In the Minh Hai province of the Meckong Delta, Vietnam, alternate rice-shrimp cropping has proved to be a profitable option in low lying brackish water areas. The system has been found to produce over four tonnes of paddy per ha per year during rainy season besides up to 700 kg per ha per year of shrimp fry during the dry season. The average production of rice and shrimp fry per farmer has been reported to be three tonnes and 150 kg per ha per year, respectively.

It may not be difficult to develop appropriate farming systems with makhana as a component in the wet lands of Bihar.

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**Arunabha Majumder, Presidency College, Jadavpur University, Kolkata**

Sewage of Kolkata City is utilised in pisciculture and agriculture. There are 364 fish-ponds measuring approximately 3900 hectares located at East Kolkata Wetlands. Approximately 20000 MT of different varieties of fish are produced in one year.

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Algae supplies oxygen in the pond by maintaining symbiotic relationship with bacteria. The pond effluent rich with nutrient is used for agriculture for growing different types of vegetables. In many areas raw sewage is also used directly in agriculture.

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**[Anupam Paul](#), Agricultural Training Centre, Fulia, West Bengal**

Our friend [P. K. Thampan](#) has pointed out a very relevant topic of Aqua-Agriculture. It has different names in different regions. It is known in many parts of the world. The eastern part of West Bengal and Bangladesh is a home aqua agriculture more precisely paddy cum fish culture. It does not require any western technology. We have the indigenous technology for this part of agriculture. But this has been lost due to Green Revolution Technology which talks about only grain yield not the total food generated from aquatic rice eco system.

In Bengal Sali lands are meant for Khariff (rainy season) rice in low land situation and accordingly the land races has the prefixes Sali. For eg-Jhinga Sal(Sal from the Sali land), Rup Sal, Sita Sal, Agnisal, Kartik Sal, Marich Sal, Kabiraj Sal etc. In these rice ecosystems with 2-3ft of water level there were several kinds of fish grew naturally. A farmer could easily get 14 quintals of fish/ha of in 4-5 months of rice growth. Present price of the fish-would be Rs 42000; and the cost of paddy would be (1.5ton/ha) Rs12000. plus paddy straw.

These provided easy source of protein in rural Bengal. With the advent of modern varieties-(High Yielding Varieties - this system has been wiped out and the farmers are not getting Rs 42000 for fish. By selling the paddy only they get (average yield 2.5ton/ha) only Rs 20000 and it is less than the price of fish. Fish, snails and prawn cannot live with fertilizer and pesticides used in HYVs and the indigenous land races are best suited for natural cultivation. After Khariff paddy farmers used the most scientific method of growing legume crops - the pulses. It enriches the soil and the crop itself provided cheap source of protein. Now the entire scenario of Bengal and Bangladesh has been vanished.

As the Global Warming is on us more area may be inundated that requires deep water or flood tolerant varieties. But we are proud that we have lost our own bio resources. Some farmers of Bihar living near the banks of Kosi have told me that they had a special variety, which could withstand flood as well as drought. It was really an unique variety.

However, in some parts of Bengal where fertilizers, pesticides are not used paddy cum fish culture exists. If this culture is returned at least 20 endangered species of fish can be saved. It is to note that we have Bio Diversity Act 2002 to protect our rich bio diversity.

One interesting point to be noted that paddy cum fish culture is also found in areas having deep water BORO (transplanted in winter) paddy. We usually talk about deep water Khariff paddy. It is found in Goalpara Village of Santipur Block, Nadia District, West Bengal.

Farmers are to be encouraged to grow paddy crops this way and they will see the real profit. The policy makers are to be more careful about our ecosystem and future food security.

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**[Prosun Bhattacharya](#), Royal Institute of Technology (KTH), Stockholm, Sweden**

Reference to [Arunabha's](#) response, hope checks have been made for the trace metal concentrations in the water and its suitability for use for pisciculture and/or agriculture.

It is ok for the nutrients but has been there any study on bioavailability of the metals in these wastewaters. I would presume that the sewage water also is mixed with industrial effluents.

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**Budhi Sayoko, United Nations Development Programme (UNDP), Indonesia**

I am not too familiar with the ecological characteristics and the aquatic biodiversity of the area you described in Madhubani district. However, it sounds to be that it is a area that has been exhausted off its productivities due to overtly intensive exploitation. Perhaps I could share with you and the other users of the network our similar experience in saving the shrimp ponds industry in the delta of Mahakam in the province of East Kalimantan, Indonesia.

Perhaps I should start with the background. In the 1970s, Fishery activities started to develop in the Delta of the Mahakam river, one of the largest mangrove and nypah areas in the world. The development of shrimp trade for export resulted in tremendous economic, social and ecological changes. Since 1990, migrants from other areas have joined the conversion of the mangrove to shrimp ponds at an ever-increasing rate. The economic boom of the 90s gave a further impetus to the shrimp business in the Delta and a sudden and exponential rush to convert the mangrove land occurred, with disregard to the mid-term and long-term impact of mangrove destruction. As a result, the conversion of the natural environment into shrimp ponds lead to a situation where the ecological balance of the mangrove system was broken: water quality drops, diseases develop in the shrimp ponds, upstream salinity levels rise, organic life perishes, acidity increases. Fresh water mangrove and forests, the ultimate upstream buffer area of the delta, are already encroached. The profitability of shrimp cultivation is down: waste from pond activities cannot be absorbed and cause high shrimp mortality levels reducing the economic benefits of the activity and threatening the livelihood of the communities that is almost exclusively based on pond products.

With the above, UNDP along with the local government proposed the following interventions which meant cancel out the negative impact of monoculture that has put tremendous pressure on particular aspects of the local ecology to the point of irreversible damage:

- Polyculture application: Where the catalytic support of the project is focused on effective dissemination technology to the farmer and synergizes the policulture activities with ongoing fishery and SME programmes from the local government. The underlying idea here is that the polyculture should be linked to government supports on local fishery support services and SME support services such as local microcredits and business development services which hopefully are available by the local government. Only then that introduction of polyculture significantly contributed to the sustainability of local livelihoods.
- Mangrove replanting: On this aspect, similar line of thinking to the policulture is also applied. The project alone could not make significant impact on mangrove conservation in Mahakam. But if synergy could be made with existing resources and initiatives from the local government and possibly NGOs. The catalytic role of the project here is in coordination with the different actors and empowering local populations to proactively involve in the replanting process. In this effort the role of "live in" National UN volunteers are vital. They have been assigned to live with the community and advocate good practices of mangrove conservation (and also polyculture).

So to put it shortly my advice is to look for an applicable and sustainable practices that are suitable or the social economic situation and ecological condition of the wetland in Madhubani district and try to catalyse wider synergies with all the other local actors to create leverage.

I hope this is helpful for you and my best of luck for the development of your project.

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**Prabhat Kumar, Asian Institute of Technology (AIT), Bangkok, Thailand (response 2)**

I agree that untreated city or factory wastewater, sewage etc. should never be used directly for agriculture purposes. Apart from heavy metal toxicity, chances of contamination with other bacteria and

protozoa and other pathogenic microbes are very high. Unfortunately, agriculture is not part considered a subject for city planning (in many of our cities especially in Bihar and for that matter other parts of India) and we do not have strong food safety regulations and its implementation leading to cultivation and supply of highly contaminated leafy vegetables to the city dwellers (often grown on city fringes using sewage etc.).

Coming to the original posting, I would request Jeevan Kumar to formulate or raise specific questions where a relevant experience could be heard from members. I would also expect to hear more on the previous attempts in this area by Government and Non-Government agencies in Bihar. I know that one NGO 'ADITI' was trying to work with a long leased ox-bow lake in North Bihar – working with local fishing communities. Also, the College of Fisheries at Dholi, Muzaffarpur (RAU, Pusa) is working on fish fingerlings (they have recently developed a nursery etc.).

In addition, if there are more technical questions that need to be answered, do refer it to me and I would consult scientists here at AIT, Bangkok, for suitable replies.

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**Roy Mathew, Department of Agriculture, Kerala**

Azola is a wonder plant with over 30 percent of crude protein and fibers and excellent food for human consumption also. But its rearing in nature is difficult and the two main limiting factors are - the water level shall not go beyond 15 cms and the optimum level is 5 cms because the excess nitrogen will negatively affect the growth and plant will die and it requires regular harvesting in its vegetative phase itself otherwise reproductive phase will immediately arrest growth and plants wither away after producing seeds.

More details and source materials shall be had from Vivekananda Kendra - Natural Resources Development Project (<http://www.vknardep.org/>) (VK- NARDEP).

Scope of rearing ornamental fish (I mean, get young ones especially colour full koi carp fresh water sharks etc and rear till marketable size is attained). Ornamental tortoise mollusks and aquarium plants also explorable.

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**P. S. Yadav, Haryana Institute of Rural Development and Department of Development and Panchayats, Haryana**

However, I am not from the field of science and hence can understand scientific terms less. However, I can make some suggestions for improving ' aqua-agriculture'.

First of all, let States / districts plan desilting of water bodies under NREGS. So that the water bodies can be revived and put to greater use.

Secondly, as I see in Haryana, Singhara and Bhen (Kamal Kakri) are grown in water bodies. Singhara is consumed locally and Bhen (Kamal Kakri) is consumed as vegetable. These are income generating crops (aqua-agriculture practices) and fetch good price in the market. There is no scarcity of marketing facilities for these vegetables. The local variety fish like katla, rohu, mrigal can be grown along with above.

This can be a formulated into a good livelihood project.

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**Prabhat Kumar, Asian Institute of Technology (AIT), Bangkok, Thailand (response 1)**

I would like to argue that instead of looking for Aqua-Agri and other integrated farming solutions; the basic training and marketing opportunities thereby ensuring fish fingerlings, its up-keep and linking the produce to the market would be a big boost itself for the smallholder fish farmers in Bihar.

The challenges are manifold – during the cold season the growth of two fish species (Indian major carps) is reduced and by the summer picks-up, water dries up from the small ponds and other areas. So, scientifically we need to ask:

1. Do we have a species of fish that could grow well even at slightly lower night temperatures? And If it is there, its introduction, provision of its fingerlings; training on its growth and other aspects
2. Marketing and value addition (cold storage) etc. – Until now it is very ad-hoc and not scientific in nature. Do we have technology and training to have a bicycle based fish cooling carrying devices?

Apart from that, there are some crops that could be grown, and of course, makhana is one of them. There has been no change in the way makhana is grown in Bihar for several centuries. All talk of technology availability is very superficial and a big challenge for the scientific community is to develop a farmer-friendly production system. I do not know, how many of you have seen real makhana cultivation, but to me when I went and saw it firsthand about 15 years ago, it was quite an experience. The same goes for processing – most of the produce is hand-processed and can be only done by those who have expertise (precisely one seed at a time). We need to remove all this drudgery by having appropriate machines. I should also admit that I have not been in touch lately regarding availability of processing machine.

The other crops like singhara (*Trapa natans* L. and *Trapa bicornis* Osbeck) could be easy for consumption or for starch production. Another interesting crop could be the Chinese water chestnut (*Eleocharis dulcis*) – with a good export potential to many countries. I have seen this grass crop in China and the Philippines but am not sure whether it can be cultivated in Bihar.

Apart from that, the ornamental fishes (coloured aquarium fishes) would be a worthwhile intervention and a good source of income to smallholder aqua farmers and their families; but again a lead center is must for developing low cost technologies, training and marketing. Here in Thailand, where I live, many villagers and village-based companies are big exporters and earn good returns.

Lastly, the challenge is in developing a cohesive area-based model starting with one and then learning improving, modifying and spreading to other enterprises...

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### **Sanjay Aggarwal, Clover Organic Pvt. Ltd, Dehradun**

We have worked intensively in promoting natural agriculture and aquaculture. We have done a little work in Punjab on aqua-agriculture, where paddy was the main crop integrated with many indigenous species of fish. I do not recall the species of fish cultivated as this happened many years ago. The advantage of combining aquaculture with agriculture are many. Some of them are:

- The crops benefits from the waste of the fish and vice-versa.
- Automatic tillage is provided to the soil with the movement of the fish.
- The main cost to an aquaculture farmer is the fish feed. This is almost zero in case of this synergistic combination.
- An average farmer could earn about 20-30% more from the addition of fish along with paddy at almost zero cost.

We are also manufacturing an eco-friendly biotech product, that could be used as a powerful tool to:

- Reduce sludge in the ponds.
- Increase the DO (Dissolved Oxygen) levels while stabilizing the pH.
- Increase the population of zooplankton and phytoplankton, which as you know are food for the fish.

- Suppress foul odour.
- Increase the root length of the plants grown.
- Reduce dependency on any synthetic inputs etc

Regards commerce, I suggest you have a look at this news article, which literally answers all your questions. It is a case study on Makhana growers in Bihar.

<http://business.outlookindia.com/inner.aspx?articleid=2165&editionid=58&catid=2&subcatid=973>

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**Maroti Upare, Independent Consultant, Mumbai (response 1)**

The topic is very important in the light of increased food prices and decreasing profitability of agriculture therefore Government of India is emphasizing diversification and composite farm practices for overall development of agriculture.

In Bihar Makhana cultivation in ponds is age old practice. In general it is taken as monocrop. Experiments conducted by ICAR in Darbhanga districts of mixed culture of cat fishes i.e Clarias batrachus, Heteropneustes fossilis, Anabus testudineus with Makhana found successful. A record high yield of 3600 kg/ha. harvested. Carps can be cultured with Makhana by providing central refuse in the ponds. This allows sufficient light penetration in the central open area which is useful for plankton production and growth of fish.

It is interesting to see the progress made by Assam State in Aqua-agriculture particularly plantation of banana on bunds of ponds and Paddy-cum-fish culture in World Bank assisted project Assam Agriculture Competitiveness Project, coconut plantation on bunds is very common in Kerala. M S Swaminathan Foundation has successfully shown precision farming of vegetables on pond bunds in Kendrapada district in Orissa. Cultivation of marigold on tank bunds is undertaken by Self Help Groups in Coastal area of Orissa state. The SHGs are women groups. Orissa Government has taken policy initiatives for leasing ponds to women SHGs.

Regarding strategy for development of `Aqua-agriculture' for promoting livelihood, I recommend to have a look of my publication brought out by FAO `Livelihood and micro-enterprise development opportunities for women in coastal fishing communities in India` (<http://www.fao.org/docrep/010/a1164e/a1164e00.htm>) FAO Fisheries Circular no 1021 and bankable schemes prepared by NABARD which can be obtained from NABARD Regional Office at Patna.

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**Bimal Biswas, Independent Consultant, New Delhi**

On the basis of my experience with fish culture with lotus, water lily and water hyacinth, I am of the view that the fish productivity could be increased if the mixed fish culture with makhana is practiced. Cat fish grows well in polluted water full of aquatic plants and their residues but carp, namely Rahu, Katla, etc., needs clean water and dissolved oxygen. The middle portion of the pond is to be kept clean i.e., free from aquatic plants and then cat fish and carp can be cultured together and high yields can be obtained.

High-yielding makhana varieties are to be evolved to suit the different situations. The price of cat fish (Sing and magur) in Kolkata is about Rs 300 per kg while Rahu and Katla, etc., are sold at Rs 140-150 / kg. The price of makhana in Delhi is Rs 480/kg. The marketing of the produce to the distant places has to be organised by the farmers themselves to get higher prices.

Aquaculture combined with crop culture (vegetables like potato, cabbage, cauliflower and high value crops like capsicum, broccoli, etc.,) can be grown if the water bodies dry up in winter. Wheat can also be grown to improve the total productivity and also supply food crop to the local poor. More information

could be obtained from the National Research Centre (NRC) for makhana established by the Indian Council for Agricultural Research (ICAR) at Darbhanga.

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**Maroti Upare, Independent Consultant, Mumbai (response 2)**

The experience and suggestion given by [Budhi Sayoko](#) can be applicable for brackish water fish /shrimp farming area where use of polyculture instead of single shrimp culture proved beneficial. But the Mudhubani in Bihar is having freshwater fishery resources. Hence the experience of brackish water fisheries development can not be replicated. The issues raised by Jeevan i.e how to improve productivity of fish along with Makhana and experiences of agri-aquaculture refers to freshwater aquaculture.

In this connection, the experiences of World Bank funded project Assam Agriculture Competitiveness Project in India will be worthwhile to study. More than 200 ha water area has been brought under diversified agriculture system, such as, paddy cum fish culture. Fish with horticulture on bund, fish cum livestock i.e. pig etc. The approach is participatory. Common Interest Groups were formed and they managed the fish farmers by procurement of inputs for group which reduces their cost of production. Effort is being made to market fish through marketing groups etc. About 150 ha of Beel has been brought under fish farming through community participation by forming Beel Development Committee at village level and guidance given by NGOs and Department of Fisheries. Bihar also is having substantial beel area.

Further I would like to draw attention for studying the UNDP project in Vietnam i.e. `Aquaculture Development in North Provinces` which is most successful project for development of aquaculture through microfinance. The methodology has been replicated in other provinces by other donors like Danida, EU etc. The success story is published in FAO technical Paper No-440 , Microfinance in fisheries and aquaculture - guidelines and case studies 2003. Similarly, "Development of aquaculture in Char areas in Bangladesh" i.e. waterlogged area has also shown promising results.

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**Pranaya Parida, Fisheries Specialist, Action for Food Production (AFPRO), Bhubaneswar**

As flood is a common scenario in Bihar, this suggestion may help you, Utilization of ponds affected by floods:

The ponds, which are over flowing during monsoon, can be stocked with yearling (1 year old seed) seeds at the end of September, as there is no flood risk at that time and the harvesting can be done in April/May. The yearling will get 8 months time to grow in year and 8 months time is enough for yearlings to be cultured in the pond to become marketable size.

Makhana culture along with magur and other catfish can be a good option or Makhana culture with common carp in the derelict water body is another option. Also please find some more comments for aquaculture and integrated aquaculture, which may helpful to you.

- All the water bodies can be utilised for aquaculture. The culture practice will vary as the water quality and pond size differs.
- The small ditches can be cleared from all type of weeds, along with the natural seeds, so that common carp can be cultured in these ponds
- The ponds choked by kolkati dala (water hyacinth) should be cleared first before stocking of fish species as weed infestation will hamper the fish growth in the pond. The aquatic weeds can be used as fodder for cattle after cutting it into smaller pieces and adding salt to it.
- The same can also be used as green manure in the agriculture field.
- If the water hyacinth concentration is less then common carp (bilatirohu) can be used/stocked in the pond for the biological control of these weeds.

- Small ponds can be used for magur (*C. batrachus*) culture for the best utilization of the pond water/area. The slaughterhouse waste can be fed to magur in these ponds.
- The small ponds in the village can be used for raising yearlings, which is an economic activity with less investment. The small ponds will be stocked heavily (20,000 nos/acre) with fish seeds (fingerlings). These yearlings can be sold per yearling to the farmers at a higher price.
- The small ponds, where water retains only up to December can be utilized for fingerling production. The fry can be stocked in these ponds for producing fingerling within 3-4 months.
- The yearlings thus produced will be utilised in bigger ponds for culture purpose. By April end the water from the small pond will dry.
- So the stocking of yearling in the bigger ponds should be in April and harvesting in March.
- Continuous harvest and culture can be done in the bigger ponds. In every three months harvesting will be done. The bigger fish will be sold and the smaller fish will be stocked again in the pond. The number of fish sold from the pond can be replaced with the same number of yearling (with 5% extra seeds).
- The ponds stocked with Tilapia (*china kau*) should be taken special care. As the tilapia multiply (through reproduction) very fast and are omnivorous and voracious in nature. Hence, it will destroy all the native stock in the same water body. So, monoculture of tilapia should be done. Care should be taken that; the water from the tilapia pond should not be mixed with carp culture pond.
- Cow dung should be used for manuring the pond, which is not practised by the farmers at present. The application of cow dung should be 4 tons/Ac/year. The lime should be used according the pH of water.
- Makhana culture can be done in un-cultivating ponds. The market price of Makhana is Rs.80-120/Kg. It is easy to culture and it does not require much attention/management.

Lime application in water:

The water pH of 7.0 to 8.0 is good for pisciculture. If the water pH is less than 7.0, then the pH can be brought to neutral by applying lime. The dosages of lime to be applied in the pond as per the water pH are given below:

Water pH	Lime (kg/ha)
4.5-5.0	2,000
5.1-6.5	1,000
6.6-7.5	500
7.6-8.5	200
8.6-9.5	Nil

Integrated Aquaculture:

Rice-fish culture

Horticulture-fish system

Livestock-fish system:

Poultry-Fish Culture

Duck-fish integrated system

Cattle-Fish Culture

Integration of fish-animal husbandry-agriculture/horticulture:

Azolla culture:

Azolla (an aquatic weed) can be cultured in all the ponds including the ponds where the water depth is around one foot only. It can be used as an organic manure in the agricultural land, pond and can be used as cattle feed. To be used as cattle feed the azolla should be mixed with salt and oilcake before given to cattle. Azolla is having a very high nitrogen fixing capacity. Azolla can replace the cowdung in agricultural land. It will increase the nitrogen content of the soil, which is a prime factor for paddy cultivation. Azolla in pond will help in Grass carp growth, as it is a delicious food for Grass carp.

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**Many thanks to all who contributed to this query!**

If you have further information to share on this topic, please send it to Solution Exchange for the Food and Nutrition Security Community in India at [se-food@solutionexchange-un.net.in](mailto:se-food@solutionexchange-un.net.in) and/or Water Community at [se-wes@solutionexchange-un.net.in](mailto:se-wes@solutionexchange-un.net.in) with the subject heading "Re: [se-food][se-watr] Query: Promotion of Aqua-Agriculture in Bihar - Experiences. Additional Reply."

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