Aquapreneurship Development for Unemployed Youth

2022
Edition

Edited by

Dr. G.K. Dutta
Dr. Shahaji Phand
Dr. Kamalesh Panda
Dr. Sushrirekha Das
Dr. B. Nightingale Devi

Late Shri Punaram Nishad College of Fisheries, Kawardha, Kabirdham Dist, Chhattisgarh
&
National Institute of Agricultural Extension Management, MANAGE, Hyderabad

Late Shri Punaram Nishad College of Fisheries, Kawardha

&

National Institute of Agricultural Extension Management, Hyderabad

Aquapreneurship Development for unemployed youth

Programme Coordination
Late Shri Punaram Nishad College of Fisheries, Kawardha

Jointly Published By
Late Shri Punaram Nishad College of Fisheries, Kawardha
&
MANAGE, Hyderabad

Aquapreneurship Development for unemployed youth

Editors: Dr. G.K. Dutta, Dr. Shahaji Phand, Dr. Kamalesh Panda, Dr. Sushrirekha Das and Dr. B. Nightingale Devi

Edition: 2022

ISBN: 978-93-91668-43-3

Citation: G.K. Dutta, Shahaji Phand, Kamalesh Panda, Sushrirekha Das and B. Nightingale Devi (2022). Aquapreneurship Development for unemployed youth [E-book] Hyderabad: LSPN College of Fisheries, Kawardha & National Institute of Agricultural Extension Management, Hyderabad, India

This e-book is a compilation of resource text obtained from various subject experts of LSPN College of Fisheries, Kawardha & MANAGE, Hyderabad, on " Aquapreneurship Development for unemployed youth". This e-book is designed to educate extension workers, students, research scholars, academicians related to fishery science about the Aquapreneurship Development for unemployed youth. Neither the publisher nor the contributors, authors and editors assume any liability forany damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permissionof the publisher/editors/authors. Publisher and editors do not give warranty for any error or omissions regarding the materials in this e-book.

Published for Dr. P. Chandra Shekara, Director General, National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India by Dr. Srinivasacharyulu Attaluri, Program Officer, MANAGE and printed at MANAGE, Hyderabad as e-publication.

MESSAGE

National Institute of Agricultural Extension Management (MANAGE), Hyderabad is an autonomous organization under the Ministry of Agriculture & Farmers Welfare, Government of India. The policies of liberalization and globalization of the economy and the level of agricultural technology becoming more sophisticated and complex, calls for major initiatives towards reorientation and modernization of the agricultural extension system. Effective ways of managing the extension system needed to be evolved and extension organizations enabled to transform the existing set up through professional guidance and training of critical manpower. MANAGE is the response to this imperative need. Agricultural extension to be effective, demands sound technological knowledge to the extension functionaries and therefore MANAGE has focused on training program on technological aspect in collaboration with ICAR institutions and state agriculture/veterinary universities, having expertise and facilities to organize technical training program for extension functionaries of state department.

The nation's fisheries and aquaculture sector has developed from a traditional source of income into a business sector that is heavily reliant on technology. Fisheries and aquaculture is witnessing a changed scenario from its traditional role as a supplementary subsistence activity in most of the States to viable and sustainable economic activity. The sector is now gaining importance as an attractive investment destination and a lucrative business activity. With the changing consumption pattern, emerging market forces and recent technological developments, the sector has assumed increased importance with farmers and other stakeholders in the country. Fish consumption has recently increased worldwide with high demands in the developing countries. Fish contains protein source because it is less expensive than other meats including bush meat, hog, chicken, and cattle. Fish is anticipated to be the most major source of protein in the human diet on a global scale, and it is believed that more than 30% of all fish consumed by humans comes from aquaculture.

It is a pleasure to note that, Late Shri Punaram Nishad College of Fisheries, Kawardha & MANAGE, Hyderabad is organizing a collaborative training program on "*Aquapreneurship Development for unemployed youth*" from 06-08th September, 2022 and coming up with a joint publication as e-book on "Aquapreneurship Development for unemployed youth" as immediate outcome of the training program.

I wish the program be very purposeful and meaningful to the participants and also the e-book will be useful for stakeholders across the country. I extend my best wishes for success of the program and also Late Shri Punaram Nishad College of Fisheries, Kawardha & MANAGE, Hyderabad, many more glorious years in service of Indian agriculture and allied sector ultimately benefitting the farmers. I would like to compliment the efforts of Dr. Shahaji Phand, Centre Head-EAAS, MANAGE, Hyderabad and Dr. Kamalesh Panda and Dr. B. Nightingale Devi for this valuable publication.

Dr. P. Chandra Shekara
Director General, MANAGE

PREFACE

In India population increasing every day with increase in the demand for the food. Aquaculture is the main source of food, income and employment. Since aquaculture is one among the rapidly growing profitable industry, it possess a lot of scope for employment opportunities among unemployed youth. Owing to the great diversity of aquaculture operations, the description of types ofaquaculture systems may be complex and sometimes confusing. Broadly, aquaculture structures include ponds, tanks, raceways, cages and pens. Economics of the different culture systems and its applicability in the small and medium scale fish production is required for existing as well as new entrepreneur in the sector. The use of these culture systems and its economics in the installation and maintenance has to be nurtured to the aquapreneurs for formulating their budget and adopting the right systems for the right species. This e-book will serve as a perfect guide for the budding aquapreneurs to take up Aquaculture a livelihood option.

This e-book is an outcome of collaborative online training program on "Aquapreneurship Development for unemployed youth" conducted from 06-08th September, 2022. This book will be highly useful to the young aquapreneurs and field workers who are working at the ground level. Various important topics on different culture systems which are practised in aquaculture have been covered for the benefit of the readers.

The editors express sincere thanks to Dr. N.P. Dakshinkar, Hon'ble Vice Chancellor, DSVCKV, Durg and Dr. S.K. Shakya, Director Extension education DSVCKV, Durg for the encouragement in publishing this e-book. The financial aid provided by MANAGE, Hyderabad for this training program is duly acknowledged. We hope and believe that the suggestions made in this e-book will help to improve the knowledge on the different culture systems in upcoming aquapreneurs.

Editors

Dr. G.K. Dutta
Dr. Shahaji Phand
Dr. Kamalesh Panda
Dr. Sushrirekha Das
Dr. B. Nightingale Devi

CONTENTS

ENTREPRENEURSHIP DEVELOPMENT AND LIVELIHOOD SUPPORT THROUGH ORNAMENTAL FISHERIES

Atul Kumar Jain and Abhinika Jain

Ornamental Fisheries Training and Research Institute, Udaipur-313001, Rajasthan (www.oftri.org).

The hobby of aquarium keeping is becoming very popular in country specifically in urban India. It is estimated that presently about 1.25% of urban house-holds are keeping an aquarium which could grow to 5% during the present decade. It may grow even faster as the country is transforming from a developing to a developed nation. It is noted that the number of aquarium hobbyist is 10-20% of total population in other developed countries of the world. The value of domestic aquarium trade which was only Rs. 55 crores at the end of 20th century have presently reached a mark of Rs. 555 Crore. It is now targeted for Rs. 5000 crores under Pradhan Mantri Matsya Sampada Yojna. The existing growth rate of Indian aquarium industry coupled with continuing economic development indicates that the number of aquarium hobbyists in the country will be much more than the several developed countries in next few years. The Indian aquarium industry offers vast opportunities for entrepreneurship development to the farmers, educated & uneducated youth, women, weaker sections of the society and many others in both rural and urban regions. A few of the well established and emerging entrepreneurship activities are briefly described here.

A. Production of freshwater ornamental fishes

The freshwater ornamental fishes are mainly cultured in the states of West Bengal, Tamilnadu and Kerala. It is mainly from these states that the fishes are transported to all other regions of the country. The ever-increasing transportation cost and high mortality during transportation increases the cost of fishes. Therefore, the setting up of freshwater ornamental fish culture units in other states including inland regions could be highly promising ventures. A freshwater ornamental fish production unit could be set up as backyard facility in an area of 500-1000 sq. ft at a cost of Rs. 3.00 lakhs only in the beginning.

A back yard ornamental fish

B. Manufacturing of accessories

The ornamental fish contributes only about 20% to total domestic aquarium trade while the share of aquarium & aquarium accessories is 63%. It is estimated that about 90% of these items sold in aquarium trade are of exotic origin. There is immense scope to set up manufacturing units of all these items indigenously owing to present technological advancements. The financial support to set up these units could be availed from the Ministry of micro, small & medium enterprises GOI as well as under Fisheries Infrastructure Development Fund of Ministry of Fisheries, Animal Husbandry and Dairying.

C. Live fish feed culture

A small Tubifex culture unit

Many types of small organisms found in nature are used as a source of fish food. These are collectively called as live fish feed because used in living form. It includes Daphnia, Moina, Blood worms, Tubifex worms etc. Live fish feeds are highly nutritive and balanced so considered excellent for brood stock development, rearing of young ones and colour enhancement. Many aquarium hobbyists also prefer to feed their fish on these live feeds to maintain health and colour of fishes. All these live feeds are mainly collected from natural sources and supplied to users. It is a very flourishing business activity around all the major ornamental fish production centres in the country. However, the use of such live feed is not advisable as it is mainly collected form sewage drainages. It is full of external and internal pathogens that lead to disease outbreak at production centres as well as in the aquarium of hobbyists. The commercial culture of all these live feed organisms could be a highly profitable business activity. The freeze-dried form of live fish feed organisms is also in high demand.

D. Breeding of native species

Ctenops nobilis sold for 8-10 US$ each in international trade

The several varieties of native ornamental fishes found in Western Ghats and north-east states of India are in very high demand in the international aquarium trade. The successful captive breeding technology of several native species viz; *Ctenops nobilis, Garra annandalei, Mirophis deocata, Danio dangila, Esomus danricus, Sahayadria denisonii* and many more has been successfully developed in the country. Therefore, the setting up of commercial facilities of producing native ornamental fishes could be a very flourishing business activity.

E. Aquarium servicing and maintenance

The keeping of aquarium both at home and commercial centres have increased several folds during last two decades. A hard-core hobbyist prefers to service the aquarium at his own but many of the hobbyists are not able to do routine cleaning or water exchange of the aquarium. It is more difficult at commercial establishment due to common ownership, large size of the aquarium and lack of technical knowhow. The setting up of an aquarium service centre could also be a highly profitable entrepreneurship activity specifically in cities. A certificate course on “Ornamental fish technician” from an institution recognised by National Skill Development Corporation could be highly beneficial.

F. Culture of aquatic ornamental plants

A large number of hobbyists prefer to keep a planted aquarium either for their liking for ornamental aquatic plants or to keep some specific varieties of fish that look beautiful in a planted tank. Some hobbyists are interested to keep only planted

An aquarium with ornamental aquatic plants aquarium and not fish due to religious or some other reasons. As a result, the trend of keeping a planted aquarium is becoming very popular specifically in the cities and the demand of aquatic ornamental plants as well as other components required to set up a planted tank is constantly increasing. The setting up and maintenance of planted aquarium is quite different than a fish tank. There are not many ornamental aquatic plant cultivation units in the country like other south-east Asian countries. Many of the common varieties viz *Vallisneria*, *Bacopa*, *Amazon*, *Hydrilla*, *Cabomba* etc. are locally collected from ponds, tanks and other water bodies while exotic varieties are imported.

G. Culture of marine ornamental fishes

The keeping of marine ornamental fishes is also gaining popularity specifically in metro and coastal cities. However, the keeping of marine fishes is more technical and costlier than a freshwater aquarium. The commercial scale breeding of marine ornamental fishes has yet not started in the country. These are either of wild collection or imported from other countries. The wild collection of marine ornamental fishes specifically those inhabiting the coral reefs are not permissible. The breeding technology of many varieties of ornamental fishes viz; clown fishes and Damsels has been developed at Central Marine Fisheries Research Institute, Kochi and Annamalai University. Therefore, the setting up of a large scale marine ornamental fish production unit could be another highly profitable venture.

A marine ornamental fish aquarium

H. Setting up of Public Aquarium Gallery

The "Taraporewala Aquarium" was the first "Public Aquarium Gallery (PAG)" in the country which was set up in year 1951. It was the only well-known PAG till the end of 20th century. Presently, there are several small setups at several zoological parks and a number of PAGs have been established in different parts of the country viz; Ahmedabad, Jammu, Surat, Lukhnow, Bhubaneshwar, Udaipur,

Birsa Zoo Aquarium, Ranchi, Bihar inaugurated on 28th June, 2017

Ratnagiri, Ranchi, Port Blair etc. since the beginning of 21st century. However, all these PAG's are very small in comparison to the present international standards and also inadequate in numbers considering the size of the country and number of important tourist destination. There is no PAG even in a city like Goa which is visited by lakhs of national and international tourists every year. The setting up of few international standard PAGs and several small PAG at important tourists' destinations of the country could be very good business option.

I. Export of ornamental fishes

The contribution of India is less than 1.0% to total world trade of about US$ 340 million while it is mainly dominated by other south-east countries mainly Singapore, Indonesia, Malyasia, Srilanka, Thailand etc. The country could not make a dominant presence in international ornamental fish trade due to low acceptance of our fishes by major importing countries. A one of the important reasons for the same is lack of large-scale ornamental fish production units with adequate fish holding and quarantine facilities so to produce high quality fishes to cater to international trade. Therefore, setting up of an "Export oriented unit" of freshwater/marine ornamental fishes/ornamental aquatic plants could be a highly profitable but challenging entrepreneurship development activity.

A freshwater ornamental fish export unit at Singapore

Conclusion

The domestic aquarium industry is following a cyclic relationship of demand and supply. The increasing number of aquarium hobbyists is triggering the setting up of new aquarium shops which in turn are adding many more new aquarium hobbyists. The increasing competition has caused lowering of basic aquarium cost. So, the aquarium keeping hobby have become less expensive and affordable for large number of families. The process of cyclic relationship between demand and supply may remain to continue for many more years in domestic aquarium industry. The hobby of ornamental fish keeping will become much easier to practice as the availability and choice of products will further increase. The demand of hobbyists is also expected to change from low and medium quality fish to high and premium quality fish as the hobbyists will become much more mature and knowledgeable about fish keeping. It is also realised that the hobby of aquarium keeping could grow more faster but due to the lack of technically skilled manpower at all levels from production to marketing as well as limited institutional support on R & D of Indian aquarium industry.

The ornamental fisheries have now been identified as a focus area for entrepreneurship development and livelihood support under Pradhan Mantri Sampada Yojna of Government of India with a provision of Rs. 572 crores. The financial support is being provided to take up ornamental fisheries developmental activities by the Ministry of Fisheries, Animal Husbandry and Dairying through state fisheries departments. The Agriculture Skill Council of India (National Skill Development Corporation, Ministry of Entrepreneurship & Skill Development) has identified ornamental fisheries as one of the important sectors for skill development training. The funding for setting up any business activity related to ornamental fisheries could also be availed through Fisheries Infrastructure Development Fund of GOI, Pradhan Mantri Mudra Yojna as well as bank loans.

ENTREPRENEURSHIP INCUBATION UNITS IN FISHERIES

B. Nightingale Devi

Assistant Professor, College of Fisheries, Kawardha
Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya (Chhattisgarh)

Introduction

Fisheries is a vibrant sector with diverse resources and vast potential, supporting livelihood of over 25 million fishers and fish farmers at the primary level and more than the twice the number along the value chain . It is an important source of food, nutrition, employment and income in India. The sector has demonstrated an outstanding double-digit average annual growth since 2014-15 with record fish production over 162 lakh tons in FY 2021-22 (provisional).

In Indian fisheries and aquaculture sector the dearth of technical expertise and competence among fishers and fish farmers is rendered worse by the complexity and constant change of contemporary technology systems. As a result, there is a significant skill gap throughout the whole value chain, from input production and transportation systems to processing and marketing, necessitating the role of entrepreneurs as accelerators for the adoption of innovation by all the actors. Thus, it is difficult to overstate how critical it is to encourage, support, and scale up entrepreneurial activity in the industry.

Entrepreneurship incubation units would open avenues for rapid commercialization of the available technologies and further, enable the establishment of a nation-wide network of entrepreneurs, investors, research institutions, leading industry players and financial agencies operating in this sector. In order to promote convergence with current initiatives and magnify effects, the entrepreneurship incubation unit would enable rising enterprises to access local knowledge banks and the aforementioned business networks.

A country's economic development is determined by its industrial development, which is directly proportional to its people's entrepreneurial abilities. Therefore, the idea of cultivating entrepreneurial abilities is crucial. An entrepreneur is someone who organises, manages, and bears the risks of a business or enterprise in order to make a profit. According to Schumpeter (1961) an entrepreneur was a dynamic agent of change or the catalyst who transformed increasingly physical natural and human resources, into corresponding production possibilities. They attempt to address local issues by utilising local resources, labour, and the application of new technologies, thereby creating employment and income for the local economy.

Fisheries Entrepreneurship

Entrepreneurship is the process of combining resources in novel ways. It is the process of identifying and launching a business venture, as well as sourcing and organizing the necessary resources and accepting both the risks and rewards of the venture. Mishra (2005) regarded entrepreneurship development as an approach of developing human resources. It is concerned with the growth and development of people towards high level of competency, creativity and fulfillment. Entrepreneurship in fisheries means undertaking a new business venture to make it profitable. It comprises of activities as gathering of information, communication with chain partners, market orientation, strategic decision making, learning etc. Entrepreneurship deals more with strategic issues than management which focuses more on operational and tactical decisions (Mohanty & Sajesh, 2018). The fisheries sector is a complex enterprise that includes capture and culture-based fisheries, particularly marine fisheries, coastal aquaculture, inland fisheries, freshwater aquaculture, and coldwater fisheries that contribute to the country's food, health, economy, exports, employment, and tourism. This sector promotes the growth of a number of subsidiary small, medium, and large-scale industries, as well as socioeconomic development. Currently, India is the third -largest producer of fish in the world and second largest farmed fish producer. This sector provides employment to more than 28 million fishers and fish farmers and contributes 1.12 percent of the national GDP and 7.28 percent of the GVA from the agriculture **(Handbook on Fisheries Statistics, 2020, GOI)**.

Challenges of Entrepreneurship in fisheries

There are numerous entrepreneurship opportunities in the emerging Aquaculture sector, but such ventures are prone to risk due to its unpredictable environment involving both natural and artificial entities, which poses the following challenges to sector entrepreneurship:

- **Knowledge:** The lack of technical capacity and know-how among fishermen and fish farmers is aggravated by the constantly evolving and multifaceted nature of modern technological systems.

- **Skill:** A wide skill gap emerges throughout the value chain, from input production and delivery systems to processing and marketing, entailing entrepreneurs to act as catalysts and drive innovation adoption among all actors.
- **Market and business development:** Choosing an appropriate market, developing marketing channels, and reaching end consumers are the challenges. These are formidable challenges for any entrepreneur, whether in an existing or developing market. Product development and customer acceptance remain critical challenges, particularly in the fish processing sector.
- **Technology gap:** The dissemination of appropriate technology at the appropriate time is an important factor in enhancing entrepreneurial competencies and efficacy.
- **Finance & Risk mitigation:** A substantial amount of fixed investment and working capital will be necessary for the growth of fisheries entrepreneurship. Early-stage start-ups usually have trouble obtaining financing. Additionally, the sector's risk mitigation system is underdeveloped, which puts business owners in a challenging situation.
- **Regulatory issues:** The new Indian regulatory scenario, following the introduction of Food Safety Standards Authority of India regulations, poses several challenges for entrepreneurs. Restrictions on marketing, futures trading, export and import of various items has the potential to constrain innovative agribusiness ventures. Each segment of the sector has its own rules and regulations and lack of knowledge and its applications will hamper the growth of entrepreneurship in the sector.

Fisheries Entrepreneurship Incubation

Fisheries entrepreneurship incubation is the process of fostering entrepreneurs and start-ups in the initial stages of enterprise development, in which new business organizations are formed from ideas. It assist in integrating a multitude of partners and business development services to assist the emerging enterprise in achieving sustainability.

The objectives of the Fisheries Entrepreneurship Incubation are:

- To create employment opportunities for youth, wealth and business aligning with national priorities.
- To promote new technology/knowledge/innovation based start-ups.

- To provide a platform for speedy commercialization of technologies developed by R&D institutions/Individuals in fisheries and aquaculture/ dissemination of new technology on 'Lab to land' basis.
    - To build a vibrant start-up ecosystem, by establishing a network between Researchers, Academicians, R & D Institutions, financial institutions and other stakeholders.
    - To provide cost effective, value added services to start-ups like mentoring, legal, financial, technical, Intellectual Property Rights (IPR) related services.

Strength of Fisheries Entrepreneurship Incubation

Fisheries Entrepreneurship Incubation may address and support with a number of socio-economic issues by

- Fostering entrepreneurship to generate income and jobs both locally and nationally.
- Technology transfer and commercialization platform
- Developing and promoting innovations
- Strengthening connections between universities, R&D facilities, and the commercial sector and bringing research to market
- Addressing market problems via knowledge and other creative contributions.

Fisheries incubator unit assists aspiring entrepreneurs by offering proactive and value-added business support in the form of technical consulting, infrastructure, professional mentoring, and training to create technology-based business concepts and long-lasting businesses. Through a networking and interface mechanism between research institutes, companies, and financial institutions, it serves as a platform for the quick commercialization of ICAR technology.

Under PMMSY, both the public and commercial sectors will be encouraged to establish Fisheries Incubation Centers (FICs). The State/Central Government, including the NDFB, and/or specialized private companies/agencies would be in charge of managing them. Fisheries Incubation Centers would give incubatees opportunities to showcase their innovations and innovative ideas, technologies in fisheries and commercialize them for the benefit of fishers/fish farmers, including young professionals/entrepreneurs, fisheries institutes, fisheries researchers, cooperatives/federations, progressive fish farmers, fisheries-based industries, and other entities. Additionally, this would aid in the growth of aquapreneurs, new business prospects, and the creation of employment opportunities in the fisheries industry.

Factors affecting the success of incubation unit

The role of incubation is crucial for raising awareness of emerging businesses, identifying entrepreneurs, developing strategies, and building business plans. Furthermore by establishing connections with important players including banks, markets, research institutions, and government departments, it facilitates access to the necessary information and resources. Some of the factors that facilitates incubation centre were:

- Physical infrastructure, including workplaces, conference rooms, incubators, labs, pilot plants, and processing units
- Information and communication Technology with well-connected internet and software.
- Technical experts.
- Business management services experts.
- Support services (operational managers, technicians)
- Seed capital for the new entrepreneurs
- Operational autonomy (separate account, independent board of governance, autonomy in decision making)
- Accountabilities (Measurable milestones and monitoring)

Table 1: Activities under Fisheries Incubation Units

S.No.	Key Areas of Fisheries Startups	Resources/Beneficiaries
1	Hatchery (Finfish/shrimp)	Freshwater/ Brackishwater /Marine/ Broodstock Management /Breeding /Live feed culture/Larval Rearing/Nursery Rearing/Breeding/Live feed culture/Larval Rearing/Nursery Rearing
2	Feed Mill Plant	Shrinking pellet, slow shrinking and floating feeds for fish and shrimp
3	Farming Practices (Capture/Inland Fisheries)	**Freshwater Fish Farming-** Earthen ponds and open water bodies (Cage & Pen culture); Improved varieties – Jayanti rohu, Amur carp – Earthen ponds GIFT - Open water bodies & Cages (RAS system) – Biofloc System, Murrel Fish Farming, Pangasius (Open water bodies and Cages and the

		RAS **Brackishwater Fish Farming:** High value fishes like Asian seabass, Grey Mullet, Milk Fish, Pearl spot & Cat fish – Mystus sp **Mariculture :** Asian Seabass, Cobia, Pompano, Grouper, Snapper and other species are breed by the ICAR Fisheries Institutions may culture in (Cages in Earthen ponds as well as open water bodies)
4	Shrimp Farming (Culture/Capture)	Freshwater/Brackishwater – Culture based (Penaeus monodon, Penaeus indicus, Litopenaeus vannamei&Macrobrachium rosenbergii (Freshwater prawn)
5	Mud Crab Hatchery	Bloodstock Management/Breeding/Live Feeds/Crab lets rearing /Nursery rearing
6	Mud Crab Farming & Fattenir	Brackishwater/Low Saline seawater areas
7	Aquatic Animal Health Management (AAHM)	Fish/Shrimps – Disease Management
8	Probiotics/Organic Products/Medicines	Startups companies/Industries
9	Post-Harvest Technologies	Freshwater/Brackishwater/Mariculture
10	Fish/Shrimp – Processing Centres	Freshwater/Brackishwater/Mariculture
11	Marketing & Exporting	Startups and Exporters
12	Value Addition (Fish & Fisheries Products)	ICAR – Fisheries Institutes - CIFT, CIBA, CMFRI, CIFE & CIFNET, NIPHAT and other stakeholders
13	Ornamental Fisheries	Breeding/Rearing/Marketing Aquarium Fabrication
14	Seaweed Cultivation	Mariculture – ICAR-CMFRI & CSIR-CSMCRI – Cultivation, Processing, Packing, Marketing and Value addition
15	Post-harvest infrastructure Cold storage, refrigerated/ insulated vehicle, kiosk,etc	Farmers & Entrepreneurs (Startups)

Fig 1: Business Planning and Development Unit (Source: ***: Agri-Business Incubation (ABI) Program, ICRISAT*****)**

Initiatives on business incubation system in Indian Council of Agricultural Research (ICAR)

After adopting its own IP policy in 2006, ICAR has institutionalized technology transfer office through its three tier system of technology commercialization. The Intellectual Property & Technology Management (IP&TM) Unit at the HQ is the top tier of the three-tier system and the middle tier is the Zonal Technology Management Centers (ZTMCs) and the bottom tier is the Institute Technology Management Units (ITMUs) in different research institute. A total of 25 institutions under the ICAR have been successfully operating incubation facilities promoting individual entrepreneurs and MSME enterprises license and scale up technologies (Mysore *et al*., 2020). The ICAR's technology-based incubation centre promotes market-ready solutions that adhere to legal requirements and regulatory frameworks, making it simple for aspiring company owners to launch their ventures right away.

Agrinnovate India Limited (AgIn)

Agrinnovate India Limited (AgIn), a Government of India Enterprise that has been incorporated under the Companies Act, 1956 under the direct administrative control of DARE, Ministry of Agriculture & Farmers' Welfare was established by ICAR. It will promote technology transfers in a centralized manner with better accessibility and cater to a variety of growing needs of different institutions. It is envisaged to speed up the commercialization process by facilitating the large-scale sourcing and supply of distinctive bio-based products for mass production with the necessary legal and statutory compliances; to facilitate professional service functions of the National Agriculture Research and Education System (NARS); and to increase the pace of commercialization through capacity building for national and international clientele. Agri-business Incubation (ABI) Centres in ICAR were established in 2016 with total strength of 50 numbers (Animal Science: 7, Crop Science: 13, Agricultural Engineering: 5, Agricultural Education: 2, Horticulture: 12, Fisheries: 4, Natural Resource Management: 7) of ABI network in ICAR (Saxena *et al*., 2020).

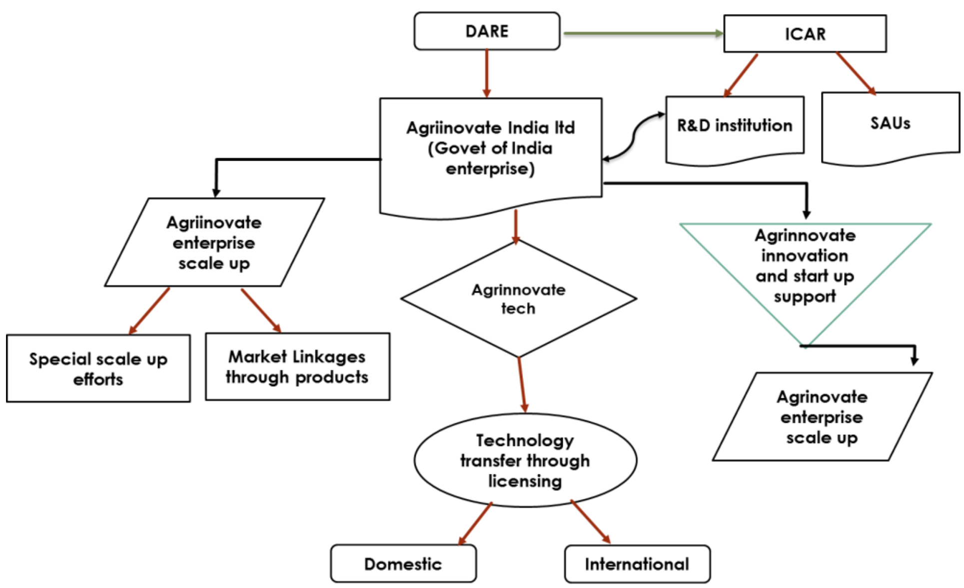


Fig 2: Integrated Technology Based Entrepreneurial Ecosystem for NARS (Mysore *et al.*, 2020)

Agrinnovate India limited is promoted as:

- One stop shop for market ready fisheries technologies with suitable regulatory compliance
- Facilitate strategic collaborations and turnkey projects (domestic and foreign) as per the client requirement

- Capacity building on IP and technology management and specific technology related programmes (both domestic and international)
- Technology valuation and pricing and Impact assessment for all agriculture and allied sectors including field crops, horticulture, fisheries, animal husbandry, dairy and agricultural engineering

Any interested person or business can access the technologies and submit their expression of interest to Agrinnovate through a website (www.agrinnovate.co.in), which indicates/lists institute-specific technologies that are ready for commercial licences cutting across various disciplines.

Conclusion

The Fisheries incubation unit offers possibilities to the incubatees, including young professionals and entrepreneurs, fisheries researchers, cooperatives and federations, progressive fish farmers, fisheries-based companies, and other organisations, to demonstrate their inventions and new ideas, technologies, and methods in fisheries and commercialise them for the benefit of fishers and fish farmers. The sector provides a living for a significant number of small and marginal fish farmers, and there is potential for additional entrepreneurship growth along the value chain in fisheries and aquaculture through a variety of incubation facilities. The National Agricultural Entrepreneurship Project, Student Rural Entrepreneurship and Awareness Development Yojana (Student READY), Attracting Rural Youth in Agriculture (ARYA), and Farmer FIRST are just a few of the initiatives the ICAR proposed during the Plan period that all have a grassroots component and promote entrepreneurship and technological advancement. The NCDC has established the LINAC Fisheries Business Incubation Centre (LIFIC) under PMMSY in Gurugram, Haryana, which is connected to the LINAC Regional Training Centers (RTC) in 18 different sites across the nation which is first of its kind in fisheries. Such facilities aid and encourage aspiring business owners to market their inventive fisheries ideas, technology, and advances for the benefit of fishermen and fish growers.

References

Department of Fisheries (GoI), 2021. Guidelines on Entrepreneur models in fisheries and aquaculture under PMMSY. Department of Fisheries, Ministry of Fisheries, Animal Husbandary, Dairying. Government of India.

Mishra, A. (2005). Entrepreneurial motivations in start-up and survival of micro-and small enterprises in the rural non-farm economy. Journal of Small Business & Entrepreneurship, 18(3), 289-326.

Mohanty, A.K. and Sajesh, V.K. (2018) Fishpreneurship development – a new direction in enhancing the farm income. Compendium of lectures: ICAR sponsored winter school on Enahancing farm Income through entrepreneurship development in fishing and fish processing; ICAR-CIFT, Cochin, 05-25.

Mysore, S., Kalkal, A., Singh, M.M.S. and Gopal, K. (2020). Agri-Business opportunities through Innovative Technologies prospects and the way forward. Indian Farming. 70 (01): 56-59.

Philroy, J., Karuppanchetty, S.M., Divya, N.G., Bhubesh.K.R. and Selvaraj, A. (2014). Agribusiness Incubation Transforming Indian Agriculture –A business Incubation approach of NARS-BPDs. International Crops Research Institute for the Semi-Arid Tropics, India.

Saxena, S. Datt, S. and Singh, V. (2020). Agri-business Incubation System in India: An Overview of ICAR. 70 (01): 64-68.

Handbook on Fishery Statistics, 2020. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmer Welfare, Govt of India.

VALUE ADDITION IN FISH AND FISHERY PRODUCTS

Jitender Kumar Jakhar

Assistant Professor, Department of Fish Harvest & Post Harvest Technology, LSPN College of Fisheries, Kawardha (DSVCKV),

Corresponding address: jakhar005@gmail.com

Value addition is the most talked about word in the industry, particularly in fish processing industry, mainly because of the increased opportunities, the activity presents for earning foreign exchange. Besides, value addition is one of the possible approaches to raise the profitability of fish processing industry, which now lays greater emphasis on quality assurance. A large number of value added and diversified fish products both for export and internal market based on shrimp, lobster, squid, cuttle-fish, bivalves, farmed fish and minced meat from low priced fish.

Value addition

About one third of the world fish production is not used for direct human consumption but converted into useful by-products and number of value added products. Value addition is gaining more importance in present days of change life styles & eating habits and also brings good income to the producer. Lack of time for cleaning the whole fishes purchased from market together with lack of space for waste disposal contributed towards the preference for ready to cook or ready to eat products in modern home market in India. Value addition is the process of changing or transforming a product from its original state to a more valuable state. Adding value means employing processing methods, specialized ingredients or novel packaging to enhance the nutrition, sensory characteristics, shelf life and convenience of food products.

The rapid development of the minced fish technology over the last four decades could make a major contribution to the increased exploitation of low cost fish. The upgradation of these species may be achieved by the use of improved handling, processing and developing different value added product. Value added fish product may be 1) Mince or Mince based products 2)Battered , Breaded or coated products 3) Surimi based products. Basic descriptions of a few of the value added fish and fishery products are discussed below:

FISH CHAKLI

Generally Chakli made from rice flour and fish meat is mixed with rice flour to make fish chakli. These types of products are very popular among the people of India. Fish meat was incorporated in to chakli to enhance its taste, flavor and nutritive value.

Preparation of Fish Chakli

Step1. Raw material- Fresh pangasius fish used for preparation of fish chakli.

Step2. Washing- Washing was done by using adequate quantity of water to remove dust particle and bacteria from the Gill and Skin.

Step3. Deheading and Dressing- Remove scale, eviscerate and wash thoroughly with portable water to make it free from blood and any other extraneous material.

Step 4. Boiling- Boil the fish for 10-15 mins. Allow it to cool to room temperature.

Step5. Deboning- Separate muscle from skin and bone by hand.

Step6. Homogenize- Make meat into a fine paste in an electric or stone grinder. Make ginger and garlic into a paste.

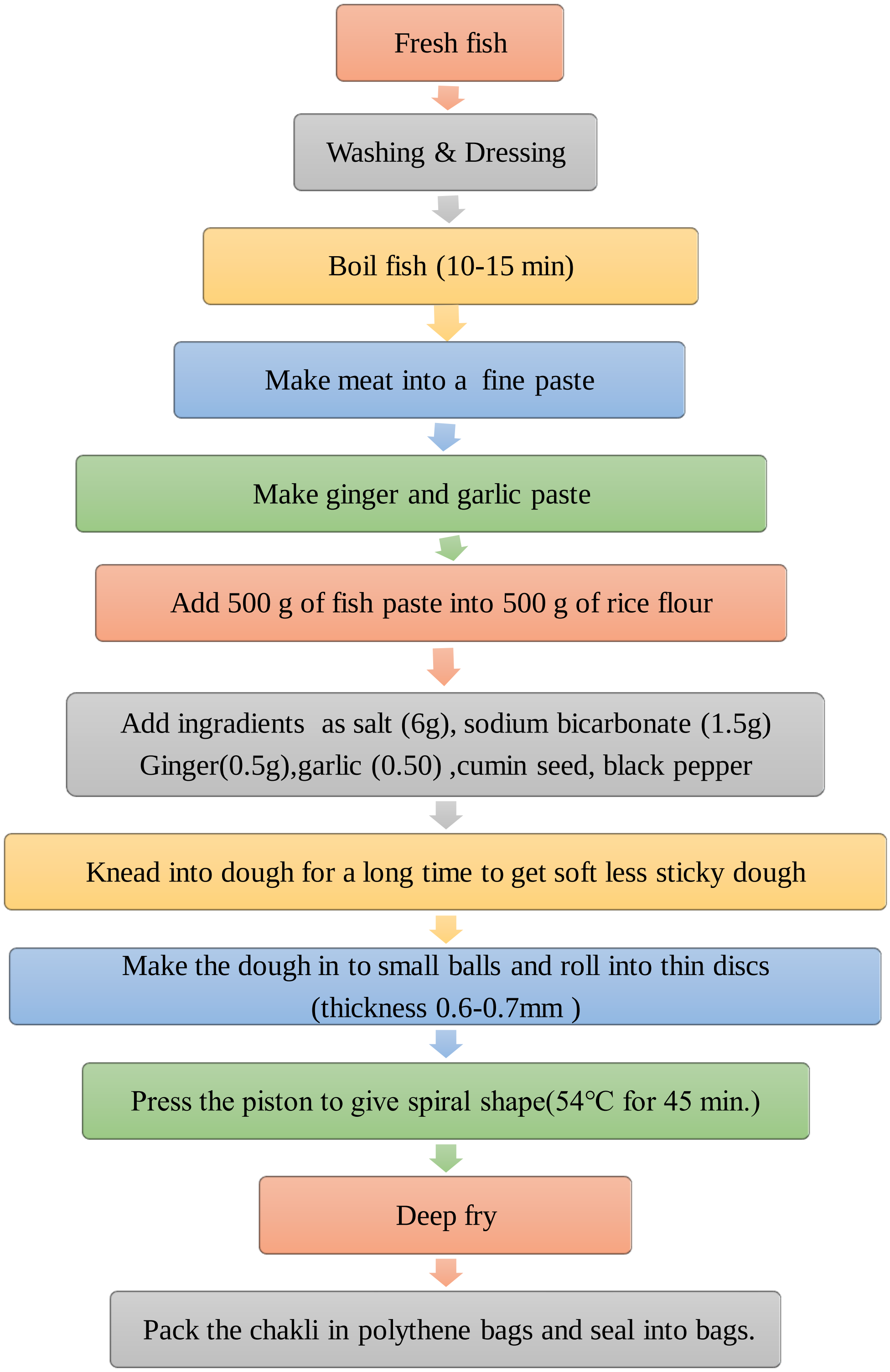
Step7. Mixing of homogenized meat with ingredients- Add 500g of fish paste into 500g of rice flour along with other ingredients ginger, garlic & salt.

Step8. Make dough- Place smooth dough smeared with little oil in the piston type hand extruder heaving a designed die at the end of the extruder.

Step9. Chakli maker- Press the piston, give the spiral shape to the material with comes out of the die.

Step 10. Deep frying- Deep fry chakli in oil at low flame till golden brown colour to a moisture level to around 3%.

Step 11. Packing- Pack the chakli in air tight polythene bags and seal


Fresh fish
Washing & Dressing
Boil fish (10-15 min)
Make meat into a fine paste
Make ginger and garlic paste
Add 500 g of fish paste into 500 g of rice flour
Add ingradients as salt (6g), sodium bicarbonate (1.5g)
Ginger(0.5g),garlic (0.50) ,cumin seed, black pepper
Knead into dough for a long time to get soft less sticky dough
Make the dough in to small balls and roll into thin discs
(thickness 0.6-0.7mm)
Press the piston to give spiral shape(54°C for 45 min.)
Deep fry
Pack the chakli in polythene bags and seal into bags.

FISH PAPAD

Papad is the dried product commonly preferred all over India as a side dish. The technology is well known and simple. Commonly, Papad is prepare with flour of black gram and split green gram. Fish papad are made using other gram flours such as green gram, arhar ,cowpea, bengal gram etc in place of black gram. Pangasius fish meat was used to prepared fish papad.

Preparation of fish Papad

Step 1. Raw material - Fresh Pangasius fish used for preparation of fish Papad.

Step 2. Washing-Washing was done by using adequate quantity of water to remove dust particle and bacteria from the gill and skin.

Step 3. Deheading and Dressing-Remove scale eviscerate and wash thoroughly with portable water to make it free from blood and any other extraneous material.

Step 4. Boiling - Boil the fish for 10-15 min. Allow it to cool to room temperature.

Step 5. Deboning- Separate muscle from skin and bone by hand.

Step 6. Homogenize-Make meat into a fine paste in an electric or stone grinder. Make ginger and garlic into a paste.

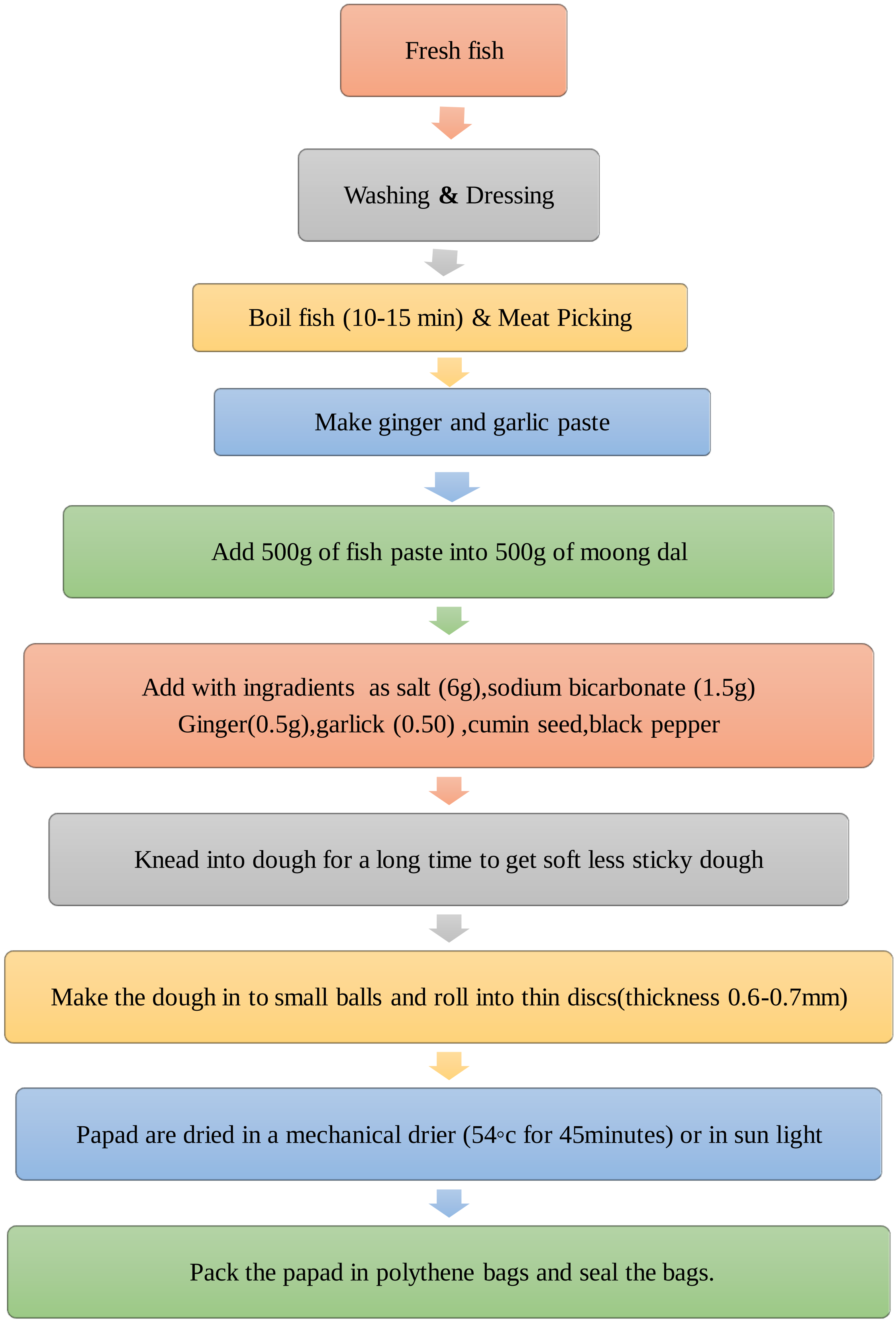
Step 7. Mixing of homogenized meat with ingredients- Add 500g of fish paste into 500g of split green gram along with other ingredients Ginger, Garlic, salt, Black, pepper, Cumin seed.

Step8. Make Dough - knead into dough for a long time to get soft less sticky dough.

Step 9. Make Discs- Make the dough in to small balls and roll into thin discs of 0.6 to 0.7 mm thickness. Use little oil to make the rolling easy.

Step10. Drying- The papad are dried in a mechanical drier at 54° C for 45 minutes to a moisture level 11-12%.

Step11. Packaging- Packs the fish papad airtight in polythene bags.


Fresh fish
Washing & Dressing
Boil fish (10-15 min) & Meat Picking
Make ginger and garlic paste
Add 500g of fish paste into 500g of moong dal
Add with ingradients as salt (6g),sodium bicarbonate (1.5g) Ginger(0.5g),garlick (0.50) ,cumin seed,black pepper
Knead into dough for a long time to get soft less sticky dough
Make the dough in to small balls and roll into thin discs(thickness 0.6-0.7mm)
Papad are dried in a mechanical drier (54◦c for 45minutes) or in sun light
Pack the papad in polythene bags and seal the bags.

FISH WAFER

Fish wafer can be prepared from boiled fish meat. The fish meat is boiled and made into a paste by grinding well by adding sufficient water. Tapioca flour and corn flour are also made into a paste by grinding and mix with the fish meat paste. Cumin seed and salt are added to the mixture and after that sodium benzoate is mixed as preservatives. The paste is then spread on a plate and steamed for about 15 minutes. The layer of paste is then cut into small pieces and allowed to dry. The dried wafers are stored in air-tight containers and can be fried when needed. Fish wafers are to be used as a snack food. The products can be readily fried in any cooking oil or dehydrated product can be used as ready to fry.

Preparation of Fish Wafers

Step 1. Raw material -Fresh Pangasius or any other low value fish may be used for fish wafer.

Step 2. Washing-Washing was done by using fresh water to remove unwanted materials.

Step 3. Deheading& Dressing- Removed the part of fish such as fins, visceral parts and head.

Step 4. Boiling- The dressed fish was boiled for 40-45 minutes.

Step 5. Deboning & Deskining- Deboning was done by removing spines from the meat.

Step 6. Homogenize- Homogenizing of the boiled fish meat was done with adequate quantity of water for 10 minutes in a mechanical grinding machine.

Step 7. Making paste of tapioca flour & corn flour- The tapioca flour and corn flour were made into fine paste by using mechanical grinder.

Ste 8. Mixing of homogenized meat with paste- Mixing of homogenized meat with paste of tapioca flour and corn flour and adds rest of water and blends the whole mass.

Step 9. Mixing of ingredients- Mix the whole mass with cumin seed, salt & make fine paste.

Step 10. Spreading in Aluminium trays- Spread the fine paste uniformly in aluminium trays in a thin layer of 1.5-2 mm thickness

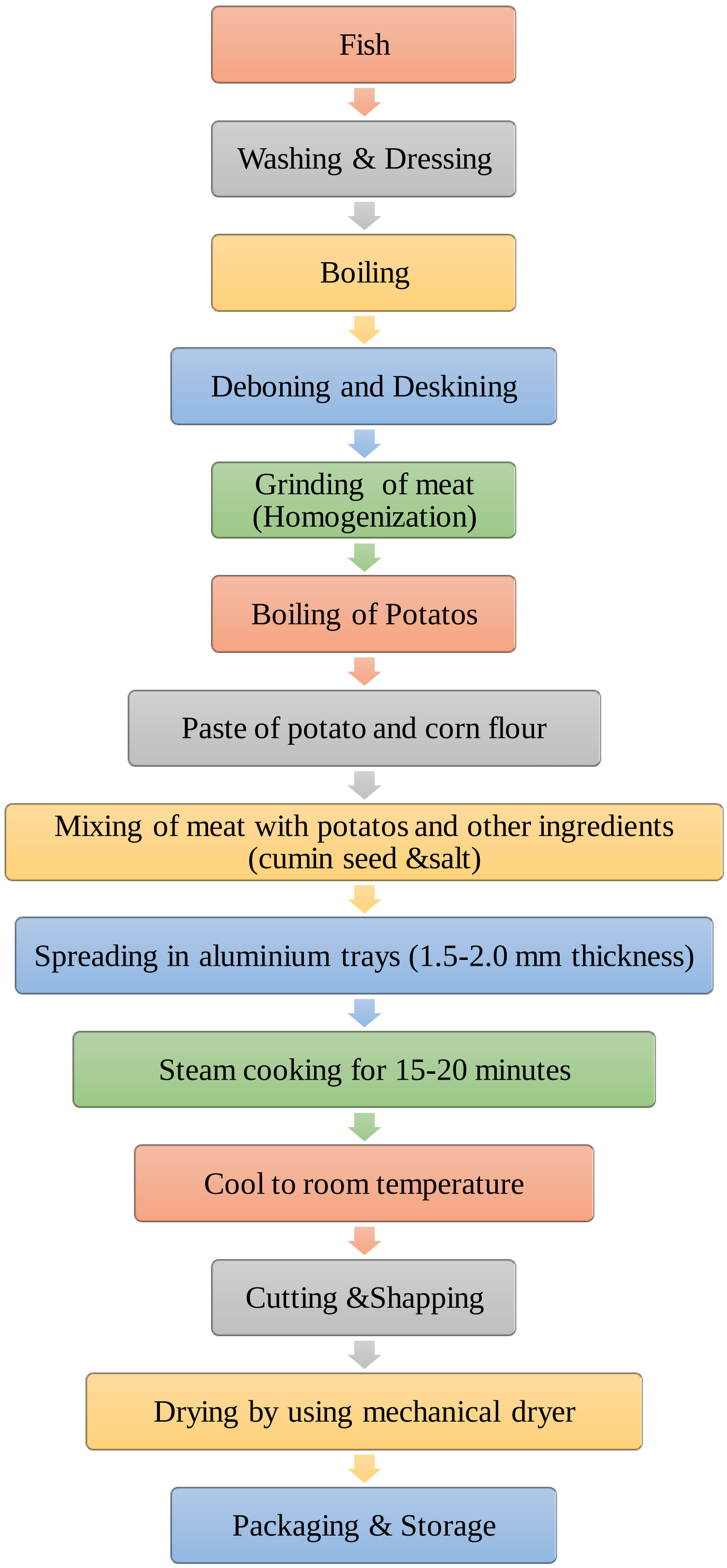
Step 11. Steam cooking- Cooked in steam for 15-20 minutes.

Step 12. Cooling- Cool to room temperature.

Step 13. Cutting- Cut the cooked material into desired shapes by using knife.

Step 14. Drying- Dry under preferably in artificial dryer at 45° C to 50° C at a moisture content below 10%.

Step 15. Packing & Storage- Pack the dried product in sealed polythene bags and store it in a cool and dry place till marketing.


Fish
Washing & Dressing
Boiling
Deboning and Deskining
Grinding of meat (Homogenization)
Boiling of Potatos
Paste of potato and corn flour
Mixing of meat with potatos and other ingredients (cumin seed &salt)
Spreading in aluminium trays (1.5-2.0 mm thickness)
Steam cooking for 15-20 minutes
Cool to room temperature
Cutting &Shapping
Drying by using mechanical dryer
Packaging & Storage

FISH BALL

Fish ball is a ready to cook convenient product prepared using the minced fish meat. Minced meat is mixed with various ingredients and shaped in the form of ball. Minced fish meat is cooked and cooled. Boiled and peeled potatoes were made into fine paste and mixed with cooked minced fish meat along with, fried onion, garlic, ginger and green chilli paste. Add salt, turmeric powder, chilli powder, cumin powder, coriander powder and monosodium glutamate and mix well. Shape about 30gms of the dough into ball shape. Cool and batter by dipping into egg. Roll over bread crumbs and fry in oil before use.

Preparation of fish ball

Step 1. Raw material -Fresh Pangasius fish are used for preparation of fish ball.

Step 2. Washing - Washing was done using fresh water to remove unwanted materials.

Step 3. Dressing - Removed the part of fish such as fins.

Step 4. Filleting - Fish fillet is a strip flash that has been cut or sliced away from the bone by cutting lengthwise along one side of the fish parallel to the backbone.

Step 5. De Skinning - Removed skin from fish.

Step 6. De Boning- Deboning was done by removing spines from the meat.

Step 7. Mincing- Mincing was done by using meat mincer.

Step 8. Frying - The minced fish meat was fried into hot edible oil.

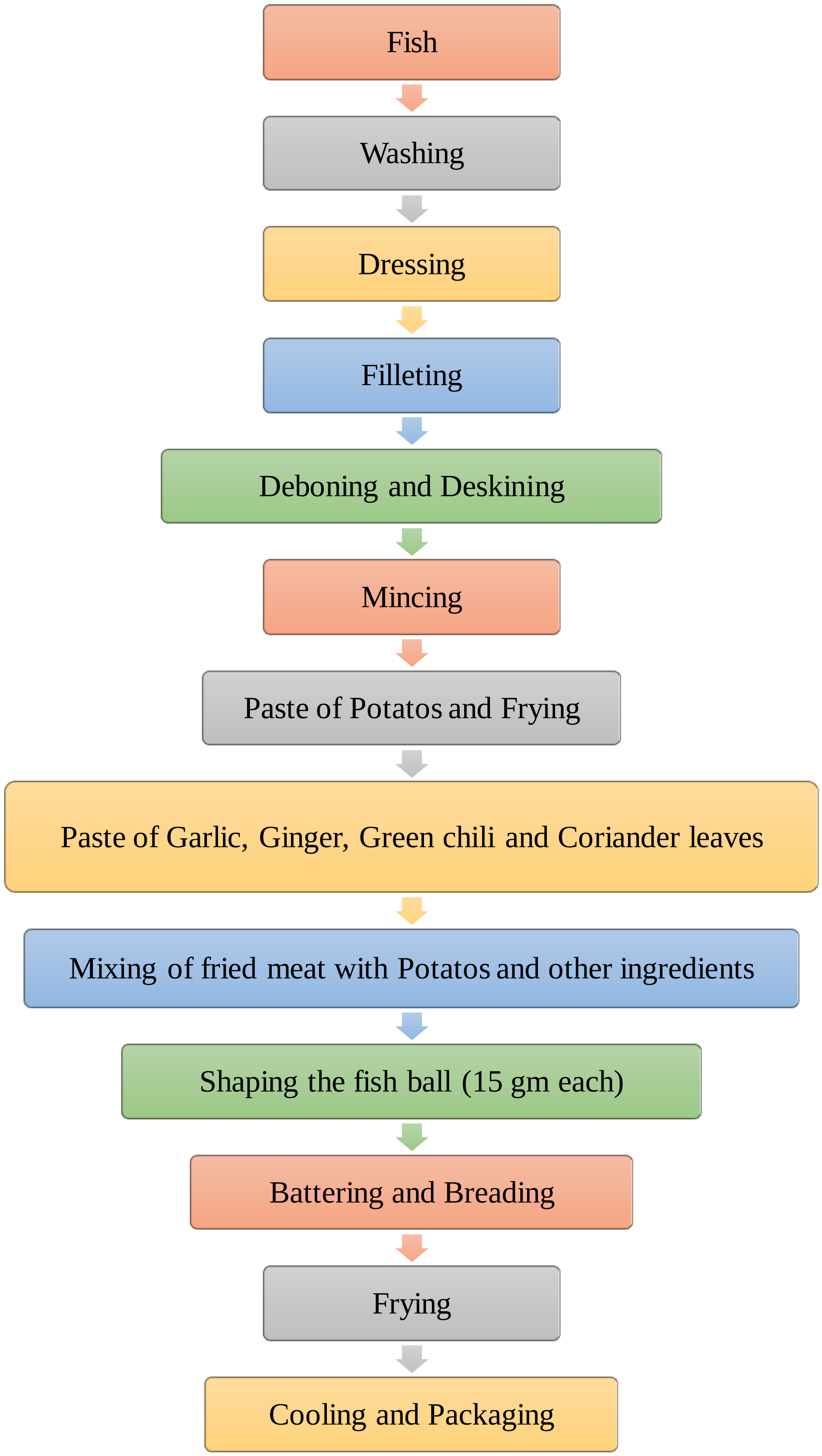
Step 9. Making paste of potatoes- The boiled and peeled Potatoes were made into fine paste and fried them.

Step 10. Mixing of meat with ingredients- Fried meat get mixed with paste of potato, fried onion, garlic, ginger and green chilli paste. Add salt, turmeric powder, chilli powder, cumin powder, coriander powder and monosodium glutamate and mix well.

Step 11. Preparation of fish ball- 30gm of mixed material was shaped into ball.

Step 12. Battering and Breading- Batter the prepared product by dipping in egg white and bread the product by rolling over bread crumb powder by mechanically by using batter and Breading machine.

Step 13. Frying- The battered and breaded product was fried at 160-170^{o}C in hot edible oil


Fish
Washing
Dressing
Filleting
Deboning and Deskining
Mincing
Paste of Potatos and Frying
Paste of Garlic, Ginger, Green chili and Coriander leaves
Mixing of fried meat with Potatos and other ingredients
Shaping the fish ball (15 gm each)
Battering and Breading
Frying
Cooling and Packaging

FISH CUTLET

Fish cutlet is prepared from minced fish meat. Fish cutlet is a highly acceptable consumer product both for urban and rural person. Minced fish meat is cooked and cooled. Boiled and peeled potatoes were made into fine paste and mixed with cooked minced fish meat along with Salt, Baking powder, Chilli powder, Pepper power, Garam masala, and Coriander powder. Fried Onion, Garlic and Ginger paste were mixed thoroughly. Paste material (30 gm) was shaped into ball and flattened to any desire shape. Batter the fish ball by dipping in egg white and breading is done by rolling over bread crumb. Prepared cutlet can be stored at -20^{o}C. Cutlets can be fried at 160 ^{o}C for 45 minute in edible oil.

Preparation of fish cutlet

Step 1. Raw material –Any low cost fish may be used for preparation of fish Cutlet.

Step 2. Washing-Washing of whole fish was done using adequate quantity of water to remove dust particle, and bacteria from the Gill, Skin.

Step 3. Dressing- Removed the parts of fish such as fins, visceral organs etc.

Step 4. Filleting- Fish fillet is a strip flash that has been cut or sliced away from the bone by cutting length wise along one side of the fish parallel to the backbone.

Step 5. Deskinning - Removed skin from fish.

Step 6. Deboning- Deboning was done by removing spines from the meat.

Step 7. Mincing- Mincing was done by using meat mincer.

Step 8. Frying - The minced fish meat was fried in hot vegetable oil.

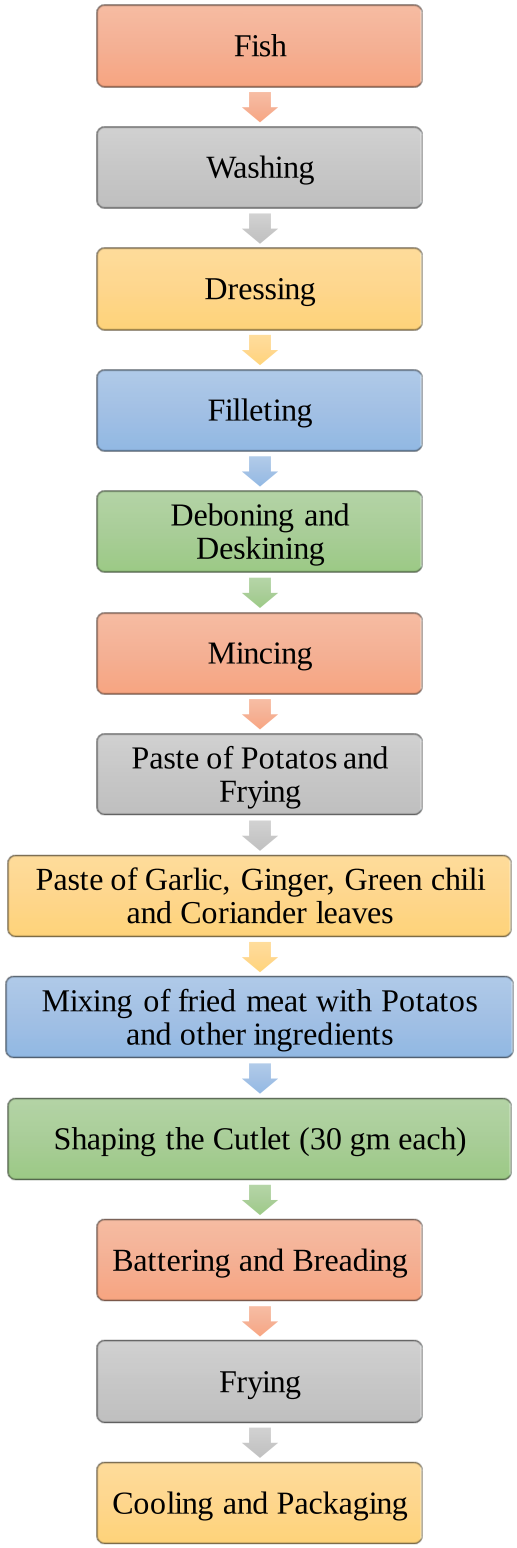
Step 9. Making paste of potatoes- The boiled and peeled potatoes were made into fine paste and fried.

Step 10. Mixing of meat with ingredients- Fried meat get mixed with paste of Potato, Salt, Baking powder, Pepper powder, Garam masala, Coriander powder, and other spices along with fried Onion, Garlic and Ginger paste.

Step 11. Preparation of fish cutlet- 30 gm of mixed paste was shaped into ball and flattened to 1 cm thickness of any desire shape.

Step-12. Battering and Breading- Batter the prepared product by dipping in egg white and breaded the product by rolling over bread crumb.

Step-13. Frying- The battered and breaded product was fried at 160-170^{o}C in hot vegetabl


Fish
Washing
Dressing
Filleting
Deboning and Deskining
Mincing
Paste of Potatos and Frying
Paste of Garlic, Ginger, Green chili and Coriander leaves
Mixing of fried meat with Potatos and other ingredients
Shaping the Cutlet (30 gm each)
Battering and Breading
Frying
Cooling and Packaging

FISH PICKLE

Pickling is a traditional method of preservation. Preparation of pickle from fruit and vegetables is an old practice but the preparation of pickle from fish a recent practice. Now a day's fish pickle is getting more consumer acceptance because of its high nutritional value and it also adds palatability to starch based bland tasting Asian dishes. At present there is an expanding export and domestic market for fish pickles.

Fish pickle can be prepared from low cost marine or fresh water fish. Fish fillets are made and fillets are cut into small pieces of 1.5 × 1.5 cm. These fish cubes pieces were used as raw material. The recipe is as follows:

Procedure:

Raw material: Good quality fish is used for pickle production.

Washing: The raw material was washed to remove mud, slime, blood and unwanted matter.

Dressing: The raw material was dressed to remove head, scales and viscera.

Filleting: The fillets were prepared from whole fish and skin was removed. After that fillets were mixed with turmeric and salt mixture and kept it for one hour.

Cutting: Fillets were cut into small cubes of 1.5 × 1.5 cm pieces.

Frying: Fry the fish meat cubes in oil (50%) till golden brown coloration.

Mincing: Minced the peeled garlic, ginger, cleaned green chillies into paste with help of a mixer.

Frying: Fry the fenugreek, cumin seed, mustard and asafetida were made powder.

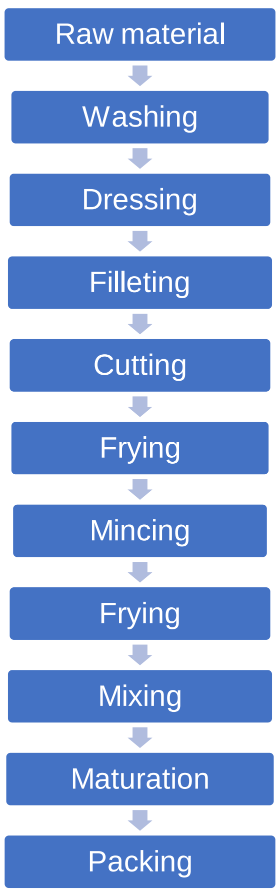
Mixing:

- Added curry leaves to the hot oil in the frying pan.
- Added garlic, ginger, and green chili paste into hot oil and fry for a while.
- Added the fenugreek, cumin seed, and asafetida and mustard powder and continued to fry until characteristic odour.
- Added vinegar and salt- boiled it till characteristic smell emerges.

- Added turmeric powder and chili powder under low flame.
- Added garam masala for good flavor and odour.
- Added citric acid and sodium benzoate when the of the content was little higher than the room temperature and mix thoroughly.
- Added fried meat and mix with gravy.

Maturation: kept it at room temperature overnight for maturation.

Packing: Pickle was packed into sterile glass bottles and it should be that a layer of oil floats on the surface of the pickle.



Ingredients	**weight**
Fish meat	1000 gm
Ginger	120 gm
Salt petre	100 gm
Mustard oil	500 gm
Chili powder	15 gm
Cumin powder	25 gm
Green chilly	50 gm
Garlic (peeled)	80 gm
Turmeric powder	5 gm
Vinegar	400 ml
Salt	100 gm
Garam masala	10 gm
Fenugreek	10 gm
Asafoetida	15 gm
Mustard powder	25 gm

Curry leaves	10 gm
Citric acid	5 gm
Sodium benzoate	0.5 gm
Sunflower oil	400 ml

Fig: Flow chart of fish pickle preparation

SEAWEED: ITS NUTRITIONAL VALUE AND ENTREPRENEURSHIP DEVELOPMENT

Jesmi Debbarma*, Viji P. and B. Madhusudana Rao

IACR-Central Institute of Fisheries Technology (ICAR-CIFT), Visakhapatnam Research Centre, Visakhapatnam – 530003

*jessmi.cife@gmail.com

INDRODUCTION:

Seaweeds are macroscopic, multicellular, benthic algae that live either in marine or brackish water environments and grow in the rocky intertidal as well as in the sub-tidal regions up to a certain depth where very little photosynthetic light is available. Seaweeds can be categorized into 3 groups based on pigmentation type, namely: red seaweed (Rhodophyta), brown seaweed (Ochrophyta) and green seaweed (Chlorophyta). Worldwide, around 9200 species of seaweeds are reported with red algae comprising of 6000, brown algae 2000 and green algae 1200 species (www.patentlens.net). They are available in different colours and composition, shapes, sizes, and occupy various habitats, such as, some species remain attached to coral reefs, rocks and ocean floor through root like structures (holdfasts), while, others float on the water surface which form single or multi-celled colonies (Murty and Banerjee, 2012). Some of the Important cultivable seaweed species in India are: *Kappaphycus alvarezii, Sargassum wightii, Gracillaria dura, Gracillaria edulis, Gracillaria edulis, Gelidiella acerosa* and *Turbinaria* sp.

Seaweeds are a rich source of nutrients, bioactive compounds, aid in enhancing nutritional value and functionality of food products. Among health-conscious Consumers, seaweed holds a reputation as a nutrient-rich superfood. Seaweeds have various commercially valuable products such as pharmaceutical and cosmeceutical compounds, plant growth pro-moters, nitrogen fixers, bio-energy and functional foods. Though, a wide range of seaweed based products are available in the world market especially in Asia, seaweeds-based products are not available in the Indian market. The demand for seaweeds as an ingredient to develop novel products in permaceuticals, nutraceutical, cosmeceutical and food industries opens up new opportunities in India. Seaweeds consumption can be promoted among the Indian populations as a cheap alternative source of protein, dietary fibre, essential micronutrients and dietary supplements. This not only promotes seaweed consumption but creates livelihood opportunities through entrepreneurship development among the people.

NUTRITIONAL COMPOSITION

Seaweeds are a rich source of macro elements (Na, Ca, K, Mg, S, Cl and P) and micro elements (I, Zn, Cu, Se, Ni, Co, B and Mn) and contain plenty of iodine which has important role in preventing goiter disease in humans. They are also rich in protein, fibre and vitamins, especially vitamin K and folic acid. Though, Seaweeds are low in calories and fat, but they have a higher proportion of essential fatty acids as eicosapentaenoic (EPA) and docosahexaenoic (DHA) fatty acids as compared to terrestrial plants. The dietary fiber content of edible seaweeds ranges from 33% to 62% of dry mass which is much higher as compared to dietary fiber content found in higher plants. Seaweeds are a good source of both water-soluble vitamins such as B1, B2, B12 and C and fat-soluble vitamin such as Vitamin A and Vitamin E. Seaweeds are generally rich in B group vitamins (B1, B2, B12) than any other group. Ortiz et al. (2006) suggested that the daily vitamin requirements of the human body could be met by consuming 100 g of seaweeds.

SEAWEED AS FOOD

Since ancient times, seaweeds are being utilized as an oriental diet in East Asian countries, especially in Chinese, Japanese, Korean and other South-East Asian cuisines. In Japan, the red seaweed nori (Pyropia and Porphyra), is used as a traditional wrapping for sushi and consumed in soups. Pyropia and Porphyra (nori), Undaria pinnatifida (wakame), Euchema sp., Saccharina japonica (Japanese kelp), Gracilaria sp., and Sargassum fusiforme and Caulerpa spp are important food resources in Asia and are most importantly eaten raw, dried or boiled in soups and stews. They are considered to be a good source of food fibre, protein and minerals for human consumption. While in Western countries, their main application has been as gelling agents and colloids for the food, pharmaceuticals, and the cosmetic industry. The polysaccharide from seaweeds such as agar, carrageenan and alginate have traditionally been used by Western counties as stabilizing, thickening and gelling agents in the food industry. Recently, the demand for plant-based food or vegetarian food is increasing among the consumers as is the awareness of health issues and environmental sustainability concerning food choices. Nowadays, edible seaweeds were widely consumed not only in East Asia, but also in other Asian counties (e.g., Taiwan, Singapore, Thailand, Indonesia, Philippines, Malaysia, Cambodia and Vietnam), South Africa, Peru, Chile, the Canadian Maritimes, Scandinavia, South West England, Ireland, Wales, California, and Scotland). Recently, France has approved the use of seaweed for human consumption as vegetables and condiments which had opened new opportunities in the food industry (Klnc et. al., 2013). Today, the global seaweed industry is worth more than USD 6 billion per annum of which 85% comprises of food products for human consumption and seaweed derived extracts (carrageenan, agar and alginate) make up almost 40% of the world's hydrocolloids market.

SEAWEED HYDROCOLLOIDS

Seaweed-derived food hydrocolloids have been known for over a long period of time, and the processes of their extraction from the respective types of seaweeds have also been evolving for a long time. The seaweed hydrocolloid business represents the main part of the seaweed processing industry, and its activities are centered on the sourcing of raw seaweeds; extraction of the hydrocolloids; and sales of alginate, carrageenan, and agar; in addition to some relatively minor products and applications such as iodine, mannitol, and seaweed fertilizers. Carrageenan, agar, and alginate are seaweed-derived carbohydrate hydrocolloids which are used as thickening and gelling agents in foods, pharma and biotechnology applications due to their unique gelation properties. Today the global seaweed in Global seaweed industry is worth more than USD 6 billion per annum of which 85% comprises food products for human consumption. Seaweed derived extract (Carrageenan, agar and alginate) make up almost 40% of the worlds hydrocolloids market in terms of foods, the rest come from certain animals, microbes and land plants.

NUTRACEUTICAL AND MEDICINAL APPLICATIONS

Seaweeds are macroscopic algae, also termed as the 'Medical Food of the 21st Century' due to their usage as laxatives. They are also used for making pharmaceutical capsules for treatment of goitre, cancer, bone-replacement therapy, and in cardiovascular surgeries. Besides rich in nutrients, seaweeds contain a wide range of novel bioactive compounds such as polysaccharides (agar, carrageenan, alginate, laminarin, ulvan etc.), polyphenols, pigments as well as proteins (lectins, phycobiliproteins, peptides, and amino acids), which are not found in terrestrial plants, vegetables and fruits (Brown et al., 2014). Bioactive compounds from seaweeds have well acknowledged health benefits including antioxidant, antimicrobial, anti-cancer, anti-diabetic antiviral, antitumor, anticoagulant, immunomodulatory activities, anti-metastatic, anti-inflammatory, antiproliferative, anticoagulant activities, lower body weight and can help to prevent the risk of cardiovascular-associated disorders, such as hypertension, diabetes mellitus type 2 and metabolic syndrome etc.

(Roohinejad et al., 2017, Kang et al., 2020). Bioactive from seaweeds have long been used in industries including nutraceuticals, pharmaceuticals, food industry, biomedical materials, cosmetics as well as in fertilizer. Seaweeds are a cheap source of bioactive substances and besides being nutrient supplements; seaweeds can be also be used as a potential functional ingredient in the development of functional food in prevention of diseases.

COSMETICS APPLICATIONS

Seaweed is often used for the production of ingredients in cosmetics in the treatment of skin problems, such as aging, tanning and pigment disorders. These ingredients can have one of the three main functions: (1) they are considered as additives which contribute to the organoleptic properties; (2) they are used for stabilization and preservation of the product; (3) or finally, they are bioactive compounds which fulfil a real cosmetic function and activity.

Metabolites derived from seaweeds have been shown to be active in antiaging skin care, anticellulite treatment and slimming, as well as having antioxidant, photoprotective, moisturising, and whitening properties. Among the various classes of seaweed components, sulphated polysaccharides, peptides, carotenoids, fatty acids, and phytohormones exhibit antiaging and antioxidant properties, while mycosporine-like amino acids, flavonoids have an antiphotoaging activity. Flavonoids (i.e. phlorotannins) are lipolytic agents which are isolated from seaweeds and which also inhibit melanogenesis.

SEAWEED AS A BIO FERTILIZER

Seaweed is used as natural bio fertilizer, plant growth supplement (PGR), natural hormone supplement and growth booster. Seaweed is a natural highly specialized biostimulant and biofertilizers, which will helps to improve the root of the plant. Seaweeds species use as a as fertilizer in India includes *Sargassum* Spp., *Ulva* spp., *Enteromorpha sp.*, *Kappaphycus sp.*, *Fucus vesiculate*, *Padina* sp. etc. Seaweed based bio fertilizers are either available in the form of liquid or solid. Seaweed extract is used as liquid organic bio fertilizer because of it's organic micro nutrient, NPK, alginic acid, mannitol, gibberellins and natural growth hormones content such as cytokinins. Seaweed extract based natural bio fertilizer have plant growth supplement (PGR), natural hormone supplement and growth booster. It contains more than 63 different macro & micro nutrients and bio active matter from natural sources. Seaweed based bio fertilizers are non toxic and completely chemical free. Seaweed can be applied to all kinds of plants for better growth and production of flowers and fruits through foliage application (spray on the leaves), soil application (spray near the roots of the plant) and hydroponic application.

SEAWEED AS BIO FILTER

Seaweeds are most suitable for bio-filtration because they probably have the highest productivity of all plants and can be economically cultured. Only a handful of seaweeds have been thoroughly investigated for their aquaculture and/or bioremediation potential. For example, Gracilaria, Ulva and Laminaria have showed reasonably high efficiency in the removal of waste inorganic nutrients. Porphyra has been recommended as an attractive candidate for the integrated aquaculture with salmonids. Seaweeds are also being used in treatment of sewage and some agricultural wastes to decrease the total nitrogen and phosphorus and removal of toxic metals from industrial wastewater. Another example where seaweed can be used as a bio filter is in Integrated multi-trophic aquaculture (IMTA). This farming method is different from finfish “polyculture”, where the fishes share the same biological and chemical processes which could potentially lead to shift in ecosystem. Multi-trophic refers to the combination of species from different trophic levels in the same system. Along Indian coast *Kappaphycus alvarezii* were used in IMTA and has emerged as a promising species in open sea integrated aquaculture.

SEAWEEDS: A RESOURCEFUL MATERIAL FOR BIOGAS

Our ever-growing energy needs have forced us to look for other renewable resources such as biofuel and biogas. In this context, seaweeds have been identified as a sustainable biomass that can potentially support biofuel production demands. They have better biomass productivity, cheaper cultivation, and greater mass farming potential. Seaweed biomass can be converted to biofuels by various processes such as thermal treatment, fermentation and anaerobic digestion. The biofuel produced by these methods have ~ 60 per cent is methane. Seaweed bio fuel can be used for heating, cooking, power generation as well as transport fuel.

SEAWEED BASED PRODUCTS DEVELOPED BY ICAR-CIFT

Diversifying the utilization of seaweed, ICAR-CIFT has developed varieties of nutraceuticals from seaweeds and value added food products enriched with seaweed nutrients, such as cookies, nutra-drink and fucoidan - dietary supplements, dietary fibre fortified-fish sausages, seaweed - yoghurt, seaweed-enriched noodles etc. ICAR-CIFT also developed edible, biodegradable films and sachets from seaweeds. Adding value to seaweed by extracting their different bioactive compounds and incorporating them into foods represent an interesting and strategic approach to diversify the functional foods offer. The technologies such as seaweed cookies, nutradrink etc were taken up by entrepreneurs. Seaweed Cookies was transferred to Zaara Biotech, Kochi and Zcorp Organic Pvt. Ltd. and products are launched under the brand name 'B-Lite' and smile and take. Technology for Seaweed Nutridrink was transferred to Amalgam Foods, while, the product like FucoTeaEx (microencapsulated dietary supplement containing the Fucoidan from brown seaweed and green tea phenolics) has been licensed to M/s. Bodina naturals Pvt. Ltd., Kerala and the company has started production and will be marketed under the trade name 'Seavina'.

CONCLUSION:

Seaweed is not a popular commodity in India. Seaweeds and its metabolites have been used in pharmaceutical, nutraceutical and food industries for their nutritional value and bioactive compounds which contain health beneficial properties. The utilization of seaweed as a source of food and functional food ingredients, polysaccharides such as agar, alginate, carrageenan, Proteins, dietary fibre and other bioactive compounds can be increase through awareness programmes among the Indian populations. By promoting seaweed, it will not only increase the consumption of seaweed among the Indian population but also it will help to increase the income generation through marketing diversified seaweed based products.

CONSERVATION OF AQUATIC BIODIVERSITY THROUGH SUSTAINABLE AQUACULTURE

By

Kamalesh Panda and N. Sarang

Asstt. Professor, LSPN College of Fisheries, Kawardha, Kabirdham Dist, Chhattisgarh

Email: kamalesh.panda@gmail.com

Biodiversity:

The Convention on Biological Diversity, describes “Biodiversity as the variations among all organisms”. Biodiversity can be termed as the variations among living biota performing their ecological functions in the terrestrial marine and other freshwater ecosystems and the other ecological complexities where they are living such as intraspecific diversity, interspecific diversity and diverse biota in the ecosystems. Aquatic biodiversity is comprehensive term that comprises freshwater ecosystems with lakes, ponds, reservoirs, rivers, streams, groundwater, and wetlands. The other part of aquatic biodiversity has marine ecosystems, which makes up an ocean, estuaries, salt marshes, coral reefs, mangroves and algal colonies. Different kinds of phytoplanktons, zooplanktons, aquatic plants, insects, fishes, birds and mammals are also an important part of aquatic biodiversity.

Aquatic Biodiversity:

Marine ecosystems are valuable wealth but vulnerable too. Extended sea and ocean water contributes about 90% of the marine ecosystem and shares about 10% of the total marine animal population whereas, freshwater resources occur in insignificant proportions comparison to other water systems on the earth and their distribution and usage are also not balanced. Gleick reported that surface freshwater habitats accounts for only 0.01% of the earth’s water which is covering only about 0.8% of the globe surface.

Human life has closely been associated with the water bodies with various functions ever since the ancient times. Water reservoirs and aquatic biodiversity have intimate relationship and both the ecological units have interdependency on each other. Evaporation of surface water from the ocean has major role in continuation of water circulation from atmosphere-to-lithosphere. Ocean has a great capacity to transport heat from the earth, mitigation of severe natural calamities through its reciprocal interactions with atmosphere, providing optimum temperature for occurrence and growth of organisms. Oceans are significantly involved in the global weather conditions and climatic transitions. There is occurrence and growth of unique ocean life with variety of organisms present making it a diverse ecosystem. Recently, there is a great emphasis on the function between the ocean and the climate change. The ocean ecosystem not only stores a great amount of water but also absorbs plenty of carbon and hence are also termed as “carbon sink”. Marine phytoplanktons are capable of processing annual net primary production of around 50 billion tons of carbon. This amount is approximately equal to the primary production of terrestrial plants. Primary production turnovers are fast moving and the transportation of matters is highly active.

Primary producers of the oceans are occupying the photic zones down to about 200 m from the water surface and sea bottoms areas adjacent to the shallow coastal water. In the deep-sea zone, there is an existence of entire different life. It is a true fact that the oceans and seas are support system of an extended number of biological diverse species, which are immensely important for the ecological diversity. There are total 2,22,000 – 2,30,000 marine species listed and almost 2,00,000 belong to Animalia. Marine habitats are fragile because they are highly reactive to the variations and transformation in physical environments.

Sensitivity of the biodiversity in fresh water resources is more than any other terrestrial ecosystems. The vulnerability of the freshwater habitat is because disproportionate numbers of plant and animal communities are growing in the water regime. As estimated by Lundberg *et al*. freshwater bodies are enriched with more than 10,000 fish species, which comprises approximately 25% of global fish communities and one fourth of diverse vertebrate population at global scale. Combining countless number of amphibians, aquatic reptiles and mammalian populations to the total quantity of freshwater-fish clearly depicts the freshwater habitat as the only favorite biological spot of all vertebrates. Comprehensive information about the total species diversity in the freshwater resources is incomplete especially among invertebrates and microbes and in the tropical zones of the world that serves as a dwelling spot of different species of the world. From amphibian’s phylum, total of 5778 species has been identified since last 10 years. Mekong drainage in Cambodia has been identified as one of the global “hotspots” for regional river fish biodiversity; Rainboth estimated that Mekonge basin has variety of species richness making it globally recognized. Recent research estimation has revealed fish wealth of about 1700 species. It has been noticed that freshwater biological regions are given less interests than terrestrial zones. Documentation about invertebrate animals diversity in tropical freshwaters are not available. However, great endemism and species richness at regional habitat do exist in the groups of crustaceans, mollusks and aquatic arthropods. Information on microbial biodiversity in the freshwater bodies is also not well recorded, not indicating the vital function of microorganisms in biogeochemical cycles operation on the earth. Most of the prokaryotic taxonomic groups are still not discovered.

Aquatic biodiversity increases with latitudes with maximum in the tropical zones. The best examples of aquatic ecosystem biodiversity can be seen in the Amazon River. The Great Barrier Reef in Australian continent is the largest coral reef ecosystem in the world, habitat of over 700 varieties of coral and also giving shelter to diverse varieties of fish and mollusks species. Coral reefs are the systems with extreme biodiversity of marine animals. One studies from the Red Sea region of Gulf of Aqaba, has revealed that egg releasing phase of aquatic animals are different throughout the year in this particular region of marine ecosystem. This gives the strikingly different detail from the Great Barrier Reef, where aquatic animals and coral spawning occurs at the same time.

Not only marine systems many fresh-water ecosystems are also a favorable biological spot of unique species, because freshwater habitats are isolated environment on the natural landscape, facing obstacles of distance and weather conditions which is a difficult task to tolerate. Such kind of ecological phenomena favors the evolution of new species in different fresh-water resources.

Hynes categorized a number of diverse plant species found in and around aquatic bodies: flowering plant, mosses, liverworts, species of encrusting lichens, stonewort and other enormously growing algal species. The uninterrupted water cycles in the aquatic bodies have an immense role in the arrival of minerals and nutrient components from high level to low-lying area and eventually to the extended sea and ocean water. Aquatic bodies downstream support a rich diverse species of plants: cool hard bottom streams containing mostly bryophytes and large soft bottom rivers supporting angiosperms. Among macrophytes the plant species, which is most diverse in running water bodies, is the benthic algae. They occur on all possible surfaces along the river and are intimately associated with microbes and an extracellular organic matrix called Aufwuchs (minute plants and animals attached to rooted aquatic plants and other exposed layers, this also collects scrapers who are organisms and detritus covering rocks and plants colonizing the aquatic environment and often serve the purpose of fish food).

In aphotic zones of the rivers the diatom species abound in large numbers. Large aquatic bodies in the tropics have more species diversity than those in temperate regions; in addition species richness increases rapidly in lower latitudes than higher ones. Flow regimes of running aquatic bodies are important. It adds to the sustaining capability of Rivers and their associated flood plain. Any alteration of flowing stream often claims to be the serious and threatens wetlands and their species diversity.

Many authors have observed the distinction in plant group structure related to spatial and temporal distribution, which has influence of flood and scour, desiccation, substrate stability and localized variations in water velocity, turbulence and shear stress.

Sometimes aquatic flora has isolated or discontinuous growth and availability in the environment because of differences in distribution, frequency and intensity, establishment success and growth rates. Rørslett found that increased stability of base flow and reduction of flow variability led to excessive growths of aquatic macrophytes. Similarly seedling survival and plant growth rates are affected by changes in rates of water level fluctuation and disturbance frequency and intensity.

Role of Aquaculture:

Aquaculture is currently one of the fastest growing food production systems in the world. Most of the global aquaculture output is produced in developing countries and significantly in low-income food-deficit countries. As defined by the united food nations Food and Agriculture Organization (FAO), aquaculture is the "farming of aquatic organisms including fish, mollusks, crustaceans and aquatic plants. With stagnating yields from many capture fisheries and increasing demand for fish and fishery products, expectations for aquaculture to increase its contribution to the world's production of aquatic food are very high, and there is also hope that aquaculture will continue to strengthen its role in contributing to food security and poverty alleviation in many developing countries. However, it is also recognized that aquaculture encompasses a very wide range of different aquatic farming practices with regard to species (including seaweeds, molluscs, crustaceans, fish and other aquatic species groups), environments and systems utilized, with very distinct resource use patterns involved, offering a wide range of options for diversification of avenues for enhanced food production and income generation in many rural and peri-urban areas.

Sustainable development:

Though living resources are self-renewable, they have to be utilized rationally on a sustainable basis in harmony with the environment. Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources and it is environmentally non-degrading, technically appropriate, economically viable and socially acceptable.

Need for Sustainable development:

Aquaculture now accounts for roughly one third of the world's total supply of food fish and undoubtedly the contribution of aquaculture to sea food supplies will increase in the future. Aquaculture has potential to become a sustainable practice that can supplement capture fisheries and significantly contribute to feeding the world's growing population. Aquaculture is the fastest growing sector of the world food economy, increasing by more than 10% per year and currently accounts for more than 30% of all fish consumed.

Aquaculture, in common with all other food production practices, is facing challenges for sustainable development. Most aqua-farmers, like their terrestrial counterparts, are continuously pursuing ways and means of improving their production practices, to make them more efficient and cost-effective. Awareness of potential environmental problems has increased significantly. Efforts are under way to further improve human capacity, resource use and environmental management in aquaculture. COFI emphasized enhancement of inland fish production through integrated aquaculture-agriculture farming systems and integrated utilization of small and medium-size water bodies

Unsustainable aquaculture will only generate short and medium term profits for multinational corporations at the expense of long-term ecological balance and social stability. An unsustainable aquaculture development could exacerbate the problems and create new ones, damaging our important and already stressed coastal areas. Sustainable development alternatives are needed to ensure that in the future aquaculture can contribute to the growing need for seafood products. The sustainable development includes- "the management and conservation of natural resource base, and the orientation of technological and institutional change in such a manner to ensure the attainment and continued satisfaction for present and future generations. Such developments conserve land, water, plant and genetic resources as well they are environmentally non-degrading, technologically appropriate, economically viable and socially acceptable.

The promotion of sustainable aquaculture development requires that "enabling environments", in particular those aimed at ensuring continuing human resource development and capacity building, are created and maintained. The FAO Code of Conduct for Responsible Fisheries contains principles and provisions in support of sustainable aquaculture development. The Code recognizes the Special Requirements of Developing Countries, and its Article 5 addresses in particular these needs, especially in the areas of financial and technical assistance, technology transfer, training and scientific cooperation.

There are a number of alternatives for sustainable development of aquaculture which include ecological aquaculture, organic aquaculture, composite fish culture, integrated aquaculture and closed recirculatory systems. These systems not only increases the fish production but also provides the scope for conservation of aquatic biodiversity.

Ecological Aquaculture

Ecological aquaculture has been defined as- "an alternative model of aquaculture research and development that brings the technical aspects of ecological principles and ecosystem thinking to aquaculture and concerns for the wider social, economic and environmental context of aquaculture".

There are few main principles of aquaculture:

- To preserve the form and function of natural resources
- To ensure trophic level efficiency
- To use native species so as not to contribute to biological pollution
- To share the practices and information on a global scale
- To ensure that system is integrated into the local economy and community in terms of food production and employment

Ecological aquaculture focuses on the development of farming systems that protect the environments in which they are situated and enhances the quality of these environments while at the same time maintaining a productive culture system.

Organic Aquaculture

Sustainability is one of the main goals of organic food production. Some of the basic principles of organic aquaculture according to the International Federation of Organic Agriculture Movements are as follows-

- To encourage natural biological cycles in the production of aquatic organisms
- Using various methods of disease control
- No use of synthetic fertilizer or other chemicals in production

- Use of polyculture technologies whenever possible

Polyculture and Integrated Aquaculture

Polyculture and integrated aquaculture are methods of raising diverse organisms within the same farming systems, where each species utilizes a distinct niche and distinct resources within the farming complex. This may involve the rearing of several aquatic organisms together or in conjunction with terrestrial plants or animals.

Polyculture system can provide mutual benefits to the organisms reared by allowing for a balanced use of the available aquatic resources while integrated systems can increase the economic efficiency through improved conversion rates of input materials. The waste from one organism is used as input to another resulting in the optimal use of resources and less pollution overall. Although still experimental, other systems such as- integration of sea weed, fish and abalone culture and polyculture of shrimp and tilapia, have proved to be ecologically efficient methods for growing a variety of organisms and may increase profit at fish farms.

Recirculating system

Concerns for water conservation and reduced waste discharges have realized the use of closed recirculating aquaculture systems. This system is made up of three basic components: culture chamber, settling chamber and biological filter. Water enters the culture chamber, flows through the settling chamber and then moves through the biological filter to remove additional particulate matter. The water is then circulated back through the system culture chamber.

Recirculating systems conserve water and allow control of environmental factors (temperature, salinity and oxygen), predators and introduction and transfer of diseases. This system has less impact on environment because of their close nature - wastes and uneaten feed are not simply released in the ambient environment. In recirculating system, wastes are filtered out of the culture system and disposed of in a responsible manner.

Conclusion:

In order to develop aquaculture into an environmentally and socially responsible food production endeavor, following points should be kept in mind:

- Implement more ecologically sustainable practices

- Transition to use of closed systems and low discharge systems, especially those that provide total containment of fish and recovery or reuse of wastes
- Significantly decrease or eliminate the dependence on wild fisheries
- Develop sustainable aquaculture operations that provide long term social and economic benefits to communities

FUNDING BANKABLE PROJECTS IN AQUACULTURE

M. Krishnan
Former Principal Scientist & Head, ICAR – CIFE, Mumbai
mkrishnan57@gmail.com

Private equity

Private equity is a substitute method of private financing, composed of funds and investors that directly invest in private companies or that participate in buyouts of public companies, bringing about the delisting of public equity. These companies are not listed or traded on any stock exchanges. Private equity investors by and large work towards funding new technology and innovation, making new acquisitions, reinforcing working capital and bolstering balance sheets and other accounting reports of companies.

Private Equity firms additionally work in a similar manner as Venture Capitalists, invest in the long term in start-ups to assist them in accelerating and then receive benefits after the companies go public or converge with different firms.

Private Equity investors follow a similar procedure as venture capital funds, except that private equity investors, typically enter at a later point of time in the business cycle and will invest in companies that are as of now at a stable position in the business rather than at the beginning phases.

Generally, they will enter a phase near to an Initial Public Offering (IPO). They will then buy out the angel investors and VC investors as well. In any case, PEs are diverse as, unlike Venture Capitalists who only invest in start-ups they invest in mature and developed companies also that seek funds to improve their performance. Private Equities bring in cash from management fees and also charge performance fees for the sale or turnaround growth of the company.

Fish Food and agricultural start-ups

In India agriculture is more of a 'lifestyle' than a 'method of life'. Viewed as the soul and spirit of the economy, the country holds more than fifty per cent of the population engaged in agriculture and agribusiness, thus making it the single largest source of employment.

Despite the fact, the agricultural sector contributes to sixteen percent of GDP yet at the same time, the sector remains highly unorganised, burdened by a host of problems. The serious issue that has been ailing in this sector is the minimal engagement of modern machinery & technologies and the existing gap in supply chain management.

Observing this worsening and demolishing condition and the immediate requirement to take prompt measures, numerous start-ups have emerged with their inventive ideas to revolutionize this sector. Modelled on the conventional Mandi system, the start-up provides a digital platform for small farmers and merchants to directly purchase and sell farm produce without the engagement and association of middlemen and other market intermediaries. In this case, the farmers receive payment directly in their bank accounts via e-wallet AgriPay.

Agri/Fish-tech start-ups

The Indian agriculture sector throughout the years has step by step opened its arms and accepted innovation and advancements. Considered perhaps the most backward and technology-resistant sectors of this country, farmers have now cut down the mass of wariness towards post understanding what cutting-edge advancements have to bring to the table.

Despite the government and big corporations have done their offer to furnish farmers with technology, it is the start-ups that have been the main impetus of innovation entrance in cultivating. From farm to fork, agri/fish-tech start-ups have been attempting to settle problem areas at different levels, which traditional cultivating neglected to address.

As per a Nasscom report in 2019, there were in excess of four hundred and fifty new businesses in the agritech space in the country. Without a doubt, these numbers have just gone up in two years, as this space has gradually developed, with a pool of financial investors siphoning in reserves. Media reports propose that in any event, during the pandemic year, the agri/fish-tech sector saw 11.9 percent of development in revenue from investors regarding funding.

General funding of agricultural/ fisheries start-ups

The agriculture ministry has funded start-ups in the agricultural and allied sectors with a sum of ₹24.85 crore, under a central scheme in the current fiscal. The government is promoting innovation and agri-preneurship by providing financial aid and nurturing the incubation ecosystem under the Rashtriya Krishi Vikas Yojana (RKVY).

As of late, in any case, there has been a flood in the establishment and financing of start-up companies seeking to develop and apply new technologies in agriculture including fisheries and the food system. These companies are privately held and have accumulated significant amounts of equity-based investment from venture capital funds and related private sources such as seed, angel, and other private equity investors.

According to industry reports, in recent years up to 3 billion 3 dollars annually have been invested into such agricultural/ fisheries technology (or "agtech") start-up companies. While the phenomenon of start-up companies or new technology-based firms (NTBFs) acquainting new advancements with agribusiness is itself not new, both in terms of the numbers of start-ups and the resources being invested in them.

The VC-backed start-up is a proven successful mechanism to contain the monetary dangers of prospecting in the process of R&D, decreasing or managing the technical and market vulnerabilities of innovation and development.

While numerous start-ups fail in their endeavours, some do persist in presenting their advancement to market. An increment in the pace of fruitful start-ups may help to counter recent trends of expanded market fixation in agribusiness, in which fewer larger firms have been accounting ever more noteworthy shares of private sector R&D. Venture-backed start-ups bring about the principle of creative intervention, overriding some current technologies and companies. Without development and innovation, market concentration can prompt manipulative monopolies, yet with advancement, new competition can disintegrate monopoly power.

The venture-capital-backed start-up is an instrument to contain the financial risks of prospecting and thereby deal with the technical and market ambiguities of innovation. The number of start-ups creating innovation for agriculture has expanded substantially in the last decade; not only in developed economies but also in emerging and developing countries.

Venture investments in such start-ups have germinated as well, practically half as much as the estimated measures of worldwide corporate agriculture R&D expenditures. This initial picture has raised extensive representative data on start-up companies related to agriculture and their financial transactions, and it has explored several factors likely to have driven the absolute expansion in private venture investment in agricultural R&D.

Challenges in agri/fish opportunities in start-ups

In the last three years, agri-tech in India has seen increased attention from industrialists, accelerators, incubators and alternate fund investors apart from established venture capitalists. This is due to innovation in technology that enables addressing new challenges. According to a Nasscom report, there were over 450 Indian agri-tech startups and they raised over three times the venture fund in 2019 as compared to 2018, amounting to over $250 million. In 2021, this number is expected to be even higher, pending thorough assessment. The innovation has also been the main attraction of other funds and venture development platforms.

Technology can play a disruptive role in input costs optimisation, farm management, precision farming, integrating financial services, value chain enhancement among many others, for agriculture and allied sectors such as livestock, fisheries and non-timber forest produce. Recently, the platform, along with Cisco India, via its Krishi Mangal programme, has accelerated five agri-tech startups

A deep-tech company, TraceX Technologies, from the Krishi Mangal programme, has been innovating in blockchain technology for agriculture. The startup has been working with 1000 maize farmers in Belgaum, Karnataka to make a connected supply chain. Together with the on-field partner, the aim is to increase the income of the farmers by 25%. Blockchain can be leveraged to digitalise the entire supply chain providing transparency, trust and traceability according to TraceX Technologies.

Tan90, another startup from the Krishi Mangal programme, has been working along with consortium partners Greenbliss Agro and DByT Dynamics to implement cold storage solutions for marginal farmers in Andhra Pradesh and Telangana. Organic farmers are the major beneficiaries, where storage at low temperatures is the only way to extend shelf life. Cost effective cold chain solutions are the need, with a major aim to keep both capital costs and operational costs minimal according to Tan90. The approach further extends to data driven analytics for price prediction, to provide the best returns to farmers. Social Alpha and Cisco India's programme has also given further boost to meat and fisheries tech solutions along with data driven advisory services for farmers.

Another novel approach to the industry has come from Ventureland Asia, a marketing opportunity fund, by the way of acquisition. Arpit Organic, which was acquired in 2019 by Sajan Raj Kurup led Ventureland Asia, has transformed into a complete tech stack firm called Saintfarm, which takes organic farm produce to consumers.

Venturland invested in creating end-to-end tech solutions, touching not just one, but all points in the organic farming supply chain. The firm uses IoT based farming solutions, analytics for farmers, price and demand predictions, logistics management and finally a consumer facing mobile application for taking orders. It had an initial investment of around $3 million for the complete tech overhaul.

As a consequence, the startups have been able to overcome challenges in accessing funds, exploring and developing new markets and covering the whole length of the value chain without compromising on the gestation period to engineer solutions.

Conclusion

In the course of the most recent decade, the area is being gushed with the surge of educated youth, terminated by the thoughts, enthusiasm and advancements to dispatch more current sorts of innovation and plans of action to lift the substance of agri-food start-ups from crude to hi-tech one. New start-ups are giving missing connections in the agriculture value chain and conveying effective items, advances and administrations to the farmers on one hand and the consumers on the other.

From ICT applications to cultivate mechanization and from climate determining to drone use and from inputs retailing and gear leasing to online vegetable advertising, and from shrewd poultry and dairy dares to brilliant agribusiness and from secured development to creative food handling and bundling its expansion, all things considered, and innovation-driven incredible start-ups set to change the food and agricultural sector of the global economy.

References

- https://www.business-standard.com/about/what-is-private-equity/16#:~:text=Private%20equity%20is%20an%20alternate,the%20delisting%20of%20public%20equity.
- http://ficci.in/spdocument/23049/Agri-start-ups-Knowledge-report-ficci.pdf
- http://nmoop.gov.in/conference/docs/Background_Paper_Agri_Startups.pdf
- https://www.livemint.com/news/india/govt-to-fund-234-more-agri-startups-with-rs-24-85-cr-in-fy-21-11596720644175.html
- http://nmoop.gov.in/conference/docs/Background_Paper_Agri_Startups.pdf
- http://ficci.in/spdocument/23049/Agri-start-ups-Knowledge-report-ficci.pdf

AUGMENTING FISH PRODUCTION IN NATURAL WATER BODIES

N. Sarang[1], Kashti Prerna Deorao[2], K. Panda[1] and Chennuri Sathish[1]
[1]College of Fisheries (DSVCKV), Kawardha -491995 Chhattisgarh[1, 3& 4]
[2]Fisheries Polytechnic (DSVCKV), Rajpur, Dhamdha -401331 Durg, Chhattigarh[1&2]
Saranglimno@yahoo.com

Introduction:

Aquatic environments on Earth are divided into freshwater, brakishwater and marine water ecosystems. They consist of sea, ocean, lagoon, estuaries, bogs, rivers, rivulet, lakes, ponds, rivers, streams, and wetlands. They can be compared to marine habitats, which contain more salt than terrestrial ecosystems. Brakishwater have moderate salinity and fresh water have very less salinity.

About 41% of all fish species known to exist worldwide are found in freshwater habitats. Different characteristics, like as temperature, light permeability, nutrients, and vegetation, can be used to categories freshwater ecosystems. Freshwater ecosystem mainly categories in to three group, Lentic (slow moving water, such as lakes, ponds, and pools), lotic (rapid moving water, such as streams and rivers), and wetlands are the three main categories of freshwater ecosystems (areas where the soil is saturated or inundated for at least part of the time). 29000 km area of our country was covered by river. Rivers are the main resources of lotic system; rivers are the richest fish faunal resources of the world. Our country has innumerable small rivers, 44 medium and 14 major rivers. Average production of major rivers are 1 tones/km with rang of 0.64 to 1.64 tones/km.

Reservoir is the main resources of lentic water system covering 3.15 million ha area. Due to different in size and geo-climatic situation Indian reservoirs are classified in to three categories such as large, medium and small. The reservoirs having area less than 1000 ha are termed as small reservoirs. India has 19134 small reservoirs which cover 1.485 million ha water area. Small reservoirs have high fish yield than that of large and small is of 50 kg/ha. There are 180 medium reservoirs in our country covering 0.527 million ha water area. Medium reservoirs have size range from 1000-5000 ha. Large reservoirs have area greater than 5000 ha, there are 56 large reservoirs which cover 0.527 million ha water area. The fish yields of large and medium reservoirs is in the rang of 11-15 kg/ha.

S. No.	Type	Size	No. of reservoirs	Area covered	production
1.	Large	>5000	56	1.14 m ha	11-15 kg/ha
2.	Medium	1000-5000	180	0.527 m ha	11-15 kg/ha

3.	Small	<1000	19134	1.485 m ha	50 kg/ha

The third main potential freshwater resources are floodplain wetland. The 0.2 million ha area was covered by floodplain wetland. Floodplain wetlands or beels are mainly found in Assam, West Bengal and Bihar. The potential production of level of beels range from 1000-1500 kg/ha/year.

But the production of natural water bodies is decreasing day by day due to various reasons. Habitat alteration, over exploitation, aquatic pollution, illegal fishing, and introduction of exotic species, disease, harmful algal blooms and global warming are some threats to fishes.

S. No.	Causes	Effects
1.	Over-exploitation	Extinction of population Reduction in population size
2.	Non-selective fishing pressure	Extinction of population Reduction in population size
3.	Pollution load	Population extinction Genetic abnormalities Reduction in population size
4.	Habitat modification	Reduction in population size Genetic abnormalities
5.	Stock transfer	Genetic abnormalities
6.	Species introduction	Hybridization and back-crossing leading to introgression

Increasing fish production in capture system

This brief is intended to:

(i) Raise awareness of the value of inland fisheries
(ii) Highlight the effects of dams and other water control structures on fisheries
(iii) Outline strategies for increasing fisheries yields and benefits, both within Reservoirs and downstream in rivers and irrigated areas.
(iv) By elimating the threats to the fishes we can increase the fish production.
(v) By adopting the sustainable fisheries the fish production can increase.
(vi) By stock enhancement trough ranching we can increased fish production

Stock enhancement:

It is generally defined as the hatchery production of a particular species of fish to a particular size or stage, for release into an area or stock, to increase some aspect of fishing quality in the future (e.g., catch rates, total catch, biomass, abundance, etc.).

Three broad types of stock enhancement, as defined by Bannister (1991), are widely recognized:

(i) Restocking, or rebuilding, is the production and release of hatchery-reared fish into an area where the species historically occurred, but are now rare or extinct, or where a fishery has declined or collapsed. This is what most people mean when discussing stock enhancement.

(ii) Augmentation, or supplementation, refers to the situation where key habitats are no longer present or available to the stock or species, and decline in the fishery is primarily due to habitat loss or modification. Augmentation involves the production and release of fish at a size where habitat is no longer a limiting factor. Such an approach may range from increased connectivity between an estuary and adjacent ocean (e.g., dredging sand-banks at the mouths of modified estuaries; to the installation of artificial habitats (such as sunken ships or artificial reefs; and fish ladders. Although artificial habitats are popular and widely used, evaluation of the effectiveness of habitat restoration, especially in the marine environment, is generally lacking.

(iii) Addition is the introduction of a new species into an area outside of its natural range.

There are several major assumptions underlying all stock enhancement projects. For example, an enhancement project that aims at stock recovery implies that information on historical stock size and fluctuations are available. Secondly, that the local carrying capacity and seasonal fluctuations are also known and understood. Furthermore, the niche (ecological space) left by the decline in abundance of the species of interest is still available to accommodate hatchery-reared fishes. This in itself may not be possible as ecosystem shifts are likely to have occurred and are unlikely to be simply reversed by restocking. Finally, use of the term ‘‘stock enhancement’’ implies that the overall objective is to increase a particular stock, which is different from simply increasing catches. In today’s world of fisheries management, stock enhancement cannot simply be the addition of more fish, although this is what many agencies worldwide have done in the past. Best-practice stock enhancement should include scientific planning and evaluation of a stocking program against a priori objectives, rather than undertaken simply to placate fishers, politicians, or environmentalists. This may include the subsequent modification and refinement of a stock enhancement project, to produce the most cost-effective result for the fishery. Results should be compared with other alternative management tools. Stock enhancement must not be seen in isolation from other fisheries management tools, but must be incorporated into the overall management arrangements for a fishery and ecosystem, as hatchery produced fish support (not sustain) good fisheries management. Finally, it should also be acknowledged that stock enhancement will not solve all fishery problems.

Stock enhancement will be of benefit only where the supply of juveniles regularly falls well short of the carrying capacity of the ecosystem and desired levels of recruitment. In cases where restocking and stock enhancement are used as management tools, a second series of decisions are needed to manage the released animals. Otherwise, the benefits of the technology can be reduced or lost altogether. For restocking, the imperative is to ensure that the remnant wild stock, the released individuals, and their progeny are protected until replenishment occurs. This will often involve a moratorium on fishing. Successful stock enhancement will depend on releasing juveniles in a way that uses the carrying capacity of the ecosystem to deliver consistent, substantial harvests.

Management options to improve fisheries in river basins where dams are built

Considering fisheries in dam operation and attempting to minimize changes to natural patterns of water fluctuation (depth, quantity, quality, flow), both within the reservoirs and downstream of the dams; constructing or modifying water control structures for appropriate fish passage to enhance fish migration and movement across dams (i.e. both upstream and downstream) and within irrigation command areas; protecting existing fish habitat (in particular spawning habitat) on rivers flowing into reservoirs by creating fish sanctuaries or closed fishing seasons;◦ introducing measures (e.g. appropriate stocking) to increase recruitment of fish (i.e. the number of eggs/fry that survive to a size that can be caught and eaten);◦ improving reservoir habitat for fish by, for example, ensuring vegetation growth or creating wetlands on the drawdown zone; regulation to prevent overexploitation of fisheries, improve access to reservoir fisheries for local people and prevent outsiders from plundering the fishery; creating fisheries groups/organizations to empower local people (including women) to manage fishing, stocking, harvesting and marketing more effectively.

Increasing fish production in culture system

The fish production can also be increased by using scientific method in culture system. Culture systems range from extensive to intensive depending on the stocking density of the culture organisms, the level of inputs, and the degree of management.

Cage culture in Inland water bodies:

Cage culture is when fish are reared from fry to fingerling, fingerling to table size, or table size to marketable size while captive in an enclosed space that maintains the free exchange of water with the surrounding water body. A cage is enclosed on all sides with mesh netting made from synthetic material that can resist decomposition in water for a long period of time and is sold under the brand name Netlon. Cages are generally small, ranging in freshwater reservoirs from 1 square meter (m2) to 500 m^2. Several small cages combined in a battery, as described below, are suited for even intensive culture.

The reservoirs of India have a combined surface area of 3.25 million hectares (ha), mostly in the tropical zone, which makes them the country's most important inland water resource, with huge untapped potential. Fish yields of 50 kg/ha/year from small reservoirs, 20 kg/ha/year from medium-sized reservoirs and 8 kg/ha/year from large reservoirs have been realized while still leaving scope for enhancing fish yield through capture fisheries, including culture-based fisheries. The success rate of auto-stocking is very low in Indian reservoirs, especially in smaller ones. Many of the smaller reservoirs dry up during the summer, partly or completely, with no stock surviving. A policy of regular, sound and sustained stocking would greatly augment fisheries in such water bodies. The prime objective of cage culture discussed here is to rear fingerlings measuring >100 millimetres (mm) in length, especially carp, for stocking reservoirs. Stocking with the right fish species, using seed of appropriate size and introducing it at the right time are essential to optimizing fish yield from reservoirs. Though 22 billion fish fry are produced every year in India, there is an acute shortage of fish fingerlings available for stocking reservoirs. Where fingerings are available, transporting them to reservoirs usually incurs high fingerling mortality. In this context, producing fingerlings in situ in cages offers opportunity for supplying stocking materials, which are vital inputs towards a programme of enhancing fish production from Indian reservoirs.

Cage Culture unit at Saroda Reservoir

Types of cages

Four types of cage are used in cage aquaculture: fixed, floating, submersible and submerged. The fixed cage is the most basic and widely used in shallow water with a depth of 1-3 metres. It consists of net bag fitted to posts and is normally placed in the flow of streams, canals, rivers, rivulets, shallow lakes and reservoirs, not touching the bottom. Fixed cages are comparatively inexpensive and simple, but their use is restricted. Floating cages, on the other hand, are supported by a floating frame such that the net bags hang in water without touching the bottom. Floating cages are generally used in water bodies with a depth of more than 5 metres. Enormous diversity in size, shape and design has been developed for floating cages to suit the wide range of conditions of fish culture in open waters. The net bags of submersible cages are suspended from the surface, have adjustable buoyancy, and may be rigid or flexible. Submerged net bags are fitted in a solid and rugged frame and submerged under the water. Their use is very limited.

Components of a Cage

Frame- It can be made up of wood, plastic or steel. Generally plastic is used.

Floats- They are made up of empty barrels or polythene balls.

Sinkers- They are made up of stone concrete or metal.

Site selection for installing cages

- The selection of site for cage culture is very important, as success often depends largely on proper site selection. Potential sites vary according to the size and shape of the reservoirs where cages are to be installed. The critical issues in selecting sites are the following:

- The depth of the water column should be at least 5 metres.
- Water quality and circulation should be good, free from local and industrial pollution.
- In large and medium-sized reservoirs, sites should be in sheltered bays for protection from strong winds. In small reservoirs, the cage should be anchored in the deeper lentic sector to avoid the current flow through sluice gates and irrigation channel.
- They should be safe from frequent disturbance from local people and grazing animals.
- There should be access to land and water transportation.
- They should be devoid of algal blooms to avoid fouling.
- They should be free of aquatic macrophytes and high populations of wild fish, which can cause oxygen stress.

- Cages should be placed where they will not hinder navigation.
- They should be at a distance from bathing and burning ghats.
- Sites should be secure.

Stocking the cages

For raising fingerlings in cages in Indian reservoirs, healthy carp fry measuring 12-15 mm long, or even up to 25 mm, are best suited. Advanced fry longer than 35 mm should be avoided for cage culture to fingerling size, as they routinely are affected by fungal diseases such as *Seprolegniosis* if collected from nurseries that have eutrophied. Indian major carps are especially prone to fungal diseases. A stocking density of 250 carp fry measuring 12-18 mm per cubic meter is best for cages installed in Indian reservoirs. Fry should be shifted late in the day or early in the evening to allowing conditioning at the site of procurement and acclimatization at the site of release in cages. Conditioning is required to transport the fry with empty stomachs, as the ammonia and carbon dioxide generated by fish waste may prove lethal to fry during transport. Fry acclimatization is essential at the site of release in cages to ensure a balanced environment, especially in terms of temperature. The oxygen packets transported with the fry (1,000 fry in 4 litres of water in a polythene packet 2/3 filled with oxygen) are kept inside cages for at least an hour before the fry are released. Prior to release, fry are subjected to some prophylactic measures to protect them from diseases and ecoto-parasites. They are dipped in a 5-6% salt solution as well as potassium permanganate (5-8%) for 1 to 2 minutes and then released into the cage water.

Supplementary feeding

Feeding is essential for carp fry in captivity, as the natural food in many Indian reservoirs may not be sufficient for their growth even to fingerling size. Feeds should be available locally and inexpensive to contain production costs. Carp accept a wide variety of feed, providing a range of options for selecting locally available feed ingredients with an eye on cost. In general, rice bran and mustard oil cake blended 1:1 provides a mixture with vitamins, amino acids and minerals available at concentrations of 0.01%. As the cages are installed in reservoirs and subjected to waves, it is not advisable to provide supplementary feed in floating trays, as is the practice in cages installed in wetlands or calm lakes. In general, the fine, flaky powdered form of rice bran and mustard oil cake mixed together is spreading over the water surface inside each cage twice daily at 08:00 and 17:00 hours, at a rate of 3-5% of aggregate fry body weight. Initially, 3-4 kg of feed is applied per cage per day. This is reduced as time passes. Feed floats on the water surface for a time before sinking slowly, thus favouring in succession the feeding habits of surface feeders like C. catla, column feeders like L. rohita and bottom feeders like C. mrigala, as well as common carp. Excessive feeding should be avoided in cages, as it may pollute the environment and hamper the growth rate of stocked fish. Feed usually comes in bulk, requiring proper storage to protect it from excess humidity and heat, insects, rodents, fungi, and contaminants. The spoiled feed can become less palatable and nutritious to fish, or even toxic. So, due care has to be taken to keep feeds properly and maintain their quality.

Fish Production in the cages

The fish production ranges from 3000 to 25,000 kg/ha/year in large cages.

Harvesting and marketing

Here is one way of harvesting fish: For the net cage, untie the bindings at the corners and sides of the net from the float frame. Insert a bamboo pole at the upper edge of the net cage and push the net along in order to corner the fish at one end. Scoop the fish with hand nets.

The fish, if sold live, fetches a higher price. It is, therefore, advisable to place the fish in double plastic bags containing well-oxygenated water. The bags are then placed in styrofoam or burl bag containers. Dead fishes to be sold should be packed in crushed ice at the rate of 1:4 by weight (1 kg ice to 4 kg fish) for nearer markets and 1:1 ratio for more distant markets at a temperature of 0° C which is good only for 24 hours or less.

Pen culture:

Pen culture is defined as rising of fish in a volume of water enclosed on all sides except bottom, permitting the free circulation of water at least from one side. This system can be considered a hybrid between pond culture and cage culture. Mostly shallow regions along shores and banks of the lakes and reservoirs are used in making pen/enclosure using net/wooden materials where fish can be raised. In a fish pen, the bottom of the lake forms the bottom of the pen. Pen has the advantage of containing a benthic fauna which serves as food for the fish and polycultue can be practiced in pens as it is in ponds. The environment in fish pen is characterized by a free exchange of water with the enclosing water body and high dissolved oxygen concentrations. Fish pens can be set up in brackish and freshwaters, depending on the type of culture and kind of fish to be grown. Bays and coves, places with laminar and steady flow of water, optimum oxygen content and food are desirable places for establishing a fish pen. For small lakes and rivers, fish-pen management is relatively easier due to its proximity. However, seasonal patterns (e.g., seasonal overturn or oxygen cycle) should first be determined to ensure viability of this activityIn freshwater bodies, polyculture may be done to maximize its use and efficiency, provided the species to be grown are compatible. An example of polyculture is a combination of carp, tilapia, shrimp and clams in the fish pen. Tilapia is a surface feeder while carp is a bottom eater, like the clam and shrimp. *Tilapia mosambica* can also exist in brackish water and can be combined with sea bass or grouper.

Advantages

a) Intensive utilization of available space: Stocking density can be increased compared to that of a pond culture system

b) Safety from predators: Within the enclosure the predators can be excluded. In the larger pens this would be more difficult, but in smaller pens this can be done as efficiently.

c) Suitability for culturing many varied species: Due availability of more space and the natural water system

d) Ease of harvest: In the large pens the harvest may not be as easy as in cage rearing but it more controllable and easier than in the natural waters.

e) The flexibility of size and economy: When compared with the cage, pens can be made much larger and construction costs will be cheaper than that of the cages.

f) Availability of natural food and exchange of materials with the bottom : Since, the bottom of the pen is the natural bottom, the pen cultured organisms are at an advantage that they can procure food/exchange materials from the natural bottom.

Disadvantages

a) High demand for oxygen and water flow

b) Dependence on artificial feed

c) Food losses: Part of the feed is likely to be lost uneaten, and drifted away in the current, but the loss here would be less than in floating cages.

d) Pollution : Since a large biomass of fish are cultured intensively a large quantity of excrements accumulate in the area and cause a high BOD - also substances such as ammonia and other excreted materials, if not immediately removed/ recycled. They pollute the water and cause damages.

e) Rapid spread of diseases: For the same reason of high stocking density in an enclosed area, any disease beginning will spread very quickly and can cause immense mortality of stock and production decline.

f) Risk of theft: Since the fish are kept in an enclosed area, ‘poaching’ and thefts can take place more frequently than in natural waters, but perhaps less than those from cages.

g) Conflict with multiple use of natural waters: In locations where a pen is constructed, if the water is used for multipurpose like irrigation and recreational activities, such as swimming, boating etc. may lead to conflicts.

Importance of diversification (system/Species) in augmenting fish production

Dushyant Kumar Damle

LSPN College of Fisheries (DSVCKV), Kawardha -491995 Chhattisgarh
damledk@gmail.com

Current Production systems

Major carps contribute the largest part of farm produce from inland sector. From the ancient era to the present the farming system has gone through a long run of development. From collecting the seeds from natural resources to get the seed by artificial breeding in captive condition, the farming system has experienced the evolutionary patterns in production. Currently the following practices are followed by the farmers: -

Extensive culture System: - No inputs. Seeds grow in its natural capability.

Semi intensive Culture: - Only feed and manuring is added externally.

Intensive culture System: - Highly Scientific, High Density stocking, well balanced supplementary feeding, Aeration, maintaining Water quality parameters, mannuring and fertilization.

Monoculture system: - Single Species culture system like Tilapia culture, *Pangasius* Culture.

Composite Fish Farming: - Species with different feeding habit which do not competes with each other.

Example: Culture of Indian Major Carps and exotic carps

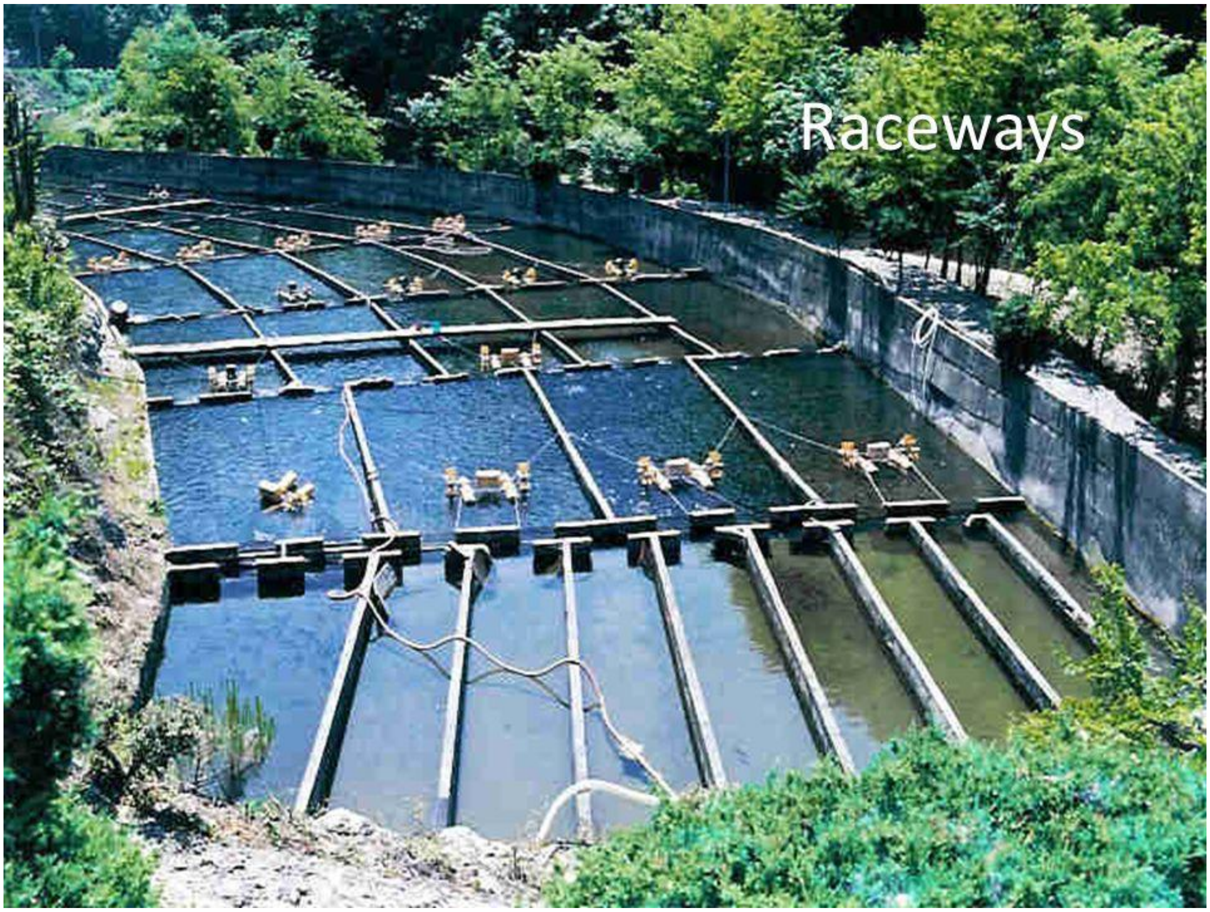
Integrated Fish farming system: - Farming of more two or more crops at same place and same time where one crop gets benefited with other

Example: - Integration of fish culture with Agriculture, Poultry, Duck, Animal Husbandry (Piggery, Dairy, Goat farming), Horticulture, Sericulture etc.

Picture courtesy: - Krishiseva.com

Cage culture;- Culture of fish species in cages made up different structures and installed in high depth and calm water is very popular for utilizing reservoir and sea water.

Flow Through Aquaculture System:- Flow through Aquaculture System also known as Raceways system where the aquatic organisms are reared in continuous flowing water through artificial rectangular channels. These raceways are provided with the inlets and outlets. The fish species like tilapia and trout’s are most common amongst the species being cultured in raceways system.



Picture courtesy – bbfishcountry.com

Reservoir Ranching: - Stocking of desirable fish species fingerlings in reservoirs and their culture. In reservoir ranching one should be aware of banned fish like Bighead (*Aristichthys nobilis*), African catfish (*Clarias gariepnus*), Tilapia etc. in open water resources like reservoir and rivers etc. as they harm the native fauna and destroy the biodiversity of the native habitat. They must be avoided for stocking in these resources.

Pen Culture: - Pens installed along the shore of river, lakes, reservoirs and lagoons are very much effective. Especially in Philippines the culture of Milk fish in these pens are popular all over the world.

Picture courtesy: - mofa.gov.gh

Recent Trends in Fish Farming Practices

Biofloc Technology:-

An intensified aquaculture practice pollutes the culture water and environment. To overcome the problem, new intervention like biofloc technology could be one of the solution. Biofloc technology is also called zero water exchange system, microbial soup and aerobic microbial floc technology. It is an eco-friendly aquaculture technique which converts the uneaten feed, faecal matter and other wastes into beneficial microbial biomass through addition of intensive aeration and viable carbon source. There are many carbon sources (Wheat flour, Corn flour, Soy flour, Rice bran and molasses) are available but cheapest carbon source would be economical. The carbon nitrogen ratio should be maintained within the range of 10 to 20:1 (C:N). The species like tilapia and shrimp are suitable for this technology.

Advantages

- Enhance the water quality
- Reduce the ammonia and nitrite problems

- Reduce the feed cost
- Act as live feed
- Enhance the immunity
- Resistance to disease
- Reduce effluent discharge
- Cost effective

Recirculatory Aquaculture System

Recirculatory system is technique in which a farmer can get maximum output by recirculating treated water after purifying the used water through different system to purify it. This system includes removal of solid particle through physical and mechanical filtration, conversion of toxic ammonia into relatively less toxic form through bioremediation or biological filtration followed by ozonisation and ultra violet treatment as well.

Waste from culture tanks-Screening – Primary Sedimentation- coagulation/ flocculation- Screening-Disinfection (UV treatment)-Ozonisation-supply to fish culture tanks.

Integrated Multi Tropic Aquaculture (IMTA)

IMTA is process of utilizing the available food within freshwater or marine water resources in such way that the leftover food, undigested faecal matter or even the dead decay of one species of a tropic level are converted in such way that it becomes available to be utilized by the other species of another tropic level.

Aquaponics:-

It is combination of aquaculture and plant crop (preferably leafy and less root containing plants). The water of fish pond which contains fish faecal matter, unused feed and manures is passed through the series of roots of these plants which absorbs the nutrients from this substances. The water purified in this manner is redistributed to the culture ponds for fish culture.

Advantages

1. Significant reduction in the usage of water (compared to traditional soil methods of growing plants) as all water is recycled through the system and it is not necessary to discard or change any water (under normal conditions).

2. Growth of plants is significantly faster than traditional methods using soil.
3. Aquaponics grown vegetables are bigger and healthier then when grown in soil.
4. There is no need to use artificial fertilizer to feed the plants.
5. There is no need to dispose of fish waste or provide an artificial filtration system.
6. Significant reduction in land is required to grow the same crops as traditional soil methods.
7. It's easier to setup for year-round use compared to traditional gardening methods.
8. It's organic.
9. Commercial setups have been used as tourist attractors in rural communities to provide and additional revenue source.
10. Reduced damage from pests and disease.
11. No weeding or bending down on the ground required.

Organic Aquaculture;-

Organic aquaculture is re-introduction of old practice of utilizing organic manure, slurry and compost for the purpose of feeding , fertilizing and even for maintaining the water quality of the culture ponds to protect the bioaccumulation of toxic chemical and antibiotics in the food chain specially in reference to mankind in association with modern culture system. The big thing in this type of introduction of aquaculture is that at any level the use of the chemical or antibiotic is avoided. To obtain the manures from the animals they are also fed with the organic food prepared or grown by organic agriculture farming.

Satellite Farming: - Satellite Farming System is a method in which a central farm provides best genetic seed and other input as well to the other farms of its surrounding locality which will then produce the marketable size fish for the consumers.

Compensatory growth Technology

Compensatory growth technology is associated with production of stunted fingerling followed by stocking for culture. As we know the stunted fingerlings can be produced through subjecting the fish seed in deprived condition especially with low feed and high stocking. Stunted fingerling on stocking and providing food in adequate quantity attains the faster growth rate.

Aqua-Mimicry

Aqua mimicry is a technique where an artificial environment is created just like natural estuarine condition where zooplanktons are used for the supplementary feeding and useful bacteria are used for maintaining water quality. A carbon source, probiotic is needed for creation. Approximately 1ppm fermented rice bran is applied per day.

Advantages of this system are that it doesn't required artificial food. Stocking density can be maintained @20nos./m^2.

Species Diversification

Aquamimicry is a concept that strives to simulate natural estuarine conditions by creating zooplankton blooms (mainly copepods) as supplemental nutrition to the cultured shrimp and beneficial bacteria to maintain water quality. This is done by fermenting a carbon source, such as rice or wheat bran, with probiotics (like Bacillus sp.) and releasing their nutrients. This method is in some ways similar to biofloc technology, but there are some key differences. Firstly, the amount of added carbon is reduced and not strictly reliant on ratios to nitrogen input. Secondly, rather than encouraging and suspending high amounts of bioflocs, sediments are removed in more intensive systems to be reused by other animals. Ideally, the water mimics the appearance and composition of natural estuarine water that includes microalgae and zooplankton. When such a balance is met, pH and dissolved oxygen fluctuations are minimized, and there is no need for antibiotics or chemicals because the rice bran provides nutrition for the zooplankton and bacteria (as a prebiotic) to create "synbiotics," which are dietary supplements or ingredients that synergistically combine pre- and Probiquamimicry is a concept that strives to simulate natural estuarine conditions by creating zooplankton blooms (mainly copepods) as supplemental nutrition to the cultured shrimp and beneficial bacteria to maintain water quality. This is done by fermenting a carbon source, such as rice or wheat bran, with probiotics (like Bacillus sp.) and releasing their nutrients. This method is in some ways similar to biofloc technology, but there are some key differences. Firstly, the amount of added carbon is reduced and not strictly reliant on ratios to nitrogen input. Secondly, rather than encouraging and suspending high amounts of bioflocs, sediments are removed in more intensive systems to be reused by other animals. Ideally, the water mimics the appearance and composition of natural estuarine water that includes microalgae and zooplankton. When such a balance is met, pH and dissolved oxygen fluctuations are minimized, and there is no need for antibiotics or chemicals because the rice bran provides nutrition for the zooplankton and bacteria (as a prebiotic) to create "synbiotics," which are dietary supplements or ingredients that synergistically combine pre- and probi On May 11, 2021, the World Food Prize Foundation announced that its 2021 laureate is Shakuntala Haraksingh Thilsted, a nutrition scientist who in my view has done more than anyone to draw attention to the essential but often overlooked role of aquatic foods in sustainable healthy diets. This USD 250,000 prize is often referred to as the Nobel Prize for food and agriculture. It was established by Norman Borlaug, winner of the Nobel Peace Prize in 1970 for his work in global agriculture. This year's award recognizes Thilsted's four decades of work to improve nutrition and health for millions of malnourished children and their mothers in Asia and Africa.

Species of future prospect

P. Gonionotus , Snakeheads (Chana striata, Chana marulius), Amblypharyngodon mola, Labeo calbasu, L. fimbriatus, Magur, singhi, *Anabas testudines*

POPULARIZATION OF CATFISH (MAGUR) BREEDING AND SEED PRODUCTION

Pabitra Barik

LSPN College of Fisheries (DSVCKV), Kawardha -491995 Chhattisgarh
damledk@gmail.com

Introduction:

Clarias batrachus (Linnaeus, 1758), popularly known as Asian catfish "Magur" as proposed state fish of Chhattisgar, India, has good consumer preference in various parts of the country especially in States such as Odisha, West Bengal, Bihar and North Eastern States due to its good taste, flavour and therapeutic values. It fetches high market price and is sold at Rs.400/kg. Magur is generally stocked at higher densities i.e., 5-10 times higher than the carps because of its hardy and air-breathing nature. The availability of magur seed is inadequate to meet the demand of the fish farmers and entrepreneurs, as there are very few Magur Hatcheries in the country. There are no stander breeding technique and milter are sacrificing their tastes through striping methods Breeding failure, early larval mortality, lack of suitable feed, infrastructure necessary for rearing or degree of involvement, etc. are some of the bottlenecks for its seed production.

Objectives:

- Standardisation of breeding and seed production techniques
- Production of quality seed through selective breeding
- Development of broodstock and seed bank

Broodstock Management:

- Brooders of 100-200 g are maintained in small ponds (100-200 m^2) or tanks at a stocking density of 3-4 fish per m^3
- Brooders require good water quality and proper feed to attain maturity under captive condition.
- Cement or concrete tanks, with 4-6 cm thick soil provided on the bottom, are recommended for raising brooders.

- Brood fish are stocked in the cisterns at least two to three months prior to breeding season to avoid problem of collecting from ponds during rainy season.
- Brooders are fed twice daily with fishmeal-based feed containing 30-35% protein @ 3-5% of the body weight.
- Water quality in brooder tanks should be maintained at optimum level by exchanging 20-30% water at fortnightly intervals.

Induced Breeding

- Synthetic hormones such as Ovaprim/ Ovatide/ WOVA-FH/ Gonopro and Carp pituitary gland extract have been successfully used as inducing agent in Magur.
- Successful induced breeding requires 1-1.5 ml/kg body weight synthetic hormone (Ovaprim/ Ovatide/ WOVA-FH/ Gonopro).
- The optimum dose of Carp pituitary gland extract is 30-40 mg/kg body weight.
- The females are stripped 17 h after injecting hormone to get ovulated eggs.

Hormone	**Dose**	
	Female	**Male**
Pituitary Gland Extract	**30mg/Kg**	**15 mg/Kg**
HCG	**4000IU/Kg**	**2000IU/Kg**
Ovatide	**1.2 ml/Kg**	**0.6mg/kg**
Ovaprime	**1.2 ml/Kg**	**0.6mg/kg**

Fig: dissection and removal of testes

Fig: Removal of testes

Sperm Suspension Preparation

- Male brooder of 100-150 g should be selected for breeding operation.
- As the male brooders do not respond to stripping, the males are sacrificed for collection of testis.
- The male with creamy white testis is selected for preparing sperm suspension.
- The sperm suspension can be prepared by macerating testis in normal saline solution (0.9% Sodium chloride, NaCl solution).
- The ideal sex ratio for higher fertilization rate is 1 male and 2-3 females.

Fig: preparation of milt suspension

Fig: Striping of female

Fig: Mixing of Eggs with milt

Fig: Fertilized eggs

Flow-through Hatchery

- The indoor flow through hatchery consists of a metallic stand or concrete platform on which plastic tubs of at least 30 cm diameter and 15 cm height are placed in a row, each under a water tap (see figure). Each tub usually accommodates 1000 to 1500 eggs.
- Each plastic tub has provision for an outlet at about 4-5 cm below the edge.
- The fertilized eggs are uniformly distributed in the incubation tubs and a feeble water flow is provided to maintain optimum oxygen level.
- After hatching, the larvae and egg shells are separated by washing the hatching tubs.

- Hatching of incubated eggs takes about 24-27 h at 27-30 °C
- The newly hatched larvae measure about 4-6 mm in length and weigh 2-3 mg and possess yolk sac, which gets absorbed at the end of 3rd day.

Fig: Flow through system

Fig: Larval feeding with egg yolk

Fig: Out door rearing of Magur

Economics of Magur Hatchery:

Sl. No.	Item	Cost in Rs. Lakh
A.	**Fixed/ Capital Cost**	
1	Pond construction (0.01 ha)	2
2	Hatchery shed (20x10m)	1
3	Flow-through hatchery and glassger hatchery	3
4	Electrical connection and fittings	1
5	Round rearing tanks (1x0.3m)X6 and Rectengular cemented pool size(3X2X1m)	6
6	Aerators/air blower/Venturi aerators	2
7	Operational equipment's	1
8	Overhead tank 20000L	5
9	Electric pump and pipe fittings in hatchery	1
	Sub-total	22
B.	**Variable Cost**	
1	Brood stock (50 kg @ Rs. 400/kg)	0.2

2	Feed (800 kg)@50/-	0.2
3	Inducing agent (synthetic)Ovatide @380/-X100=	0.38
4	Wage (one labour @ Rs. 9000 for 3 months) -	0.27
5	Miscellaneous expenditure	1
	Sub-total	2.05
C	**Total Cost**	
1	Variable Cost	2.05
2	Interest on fixed capital @ 13% per annum	22
3	Depreciation on fixed capital @ 10% per annum	2.2
	Grand Total	26.25
D	**Gross Income**	
1	Sale of seed(51-60mm)@4/-X10 lakh	40
E	**Net Income (Gross Income-Total Cost: D-C)**	13.75

ISBN: 978-93-91668-43-3

Late Shri Punaram Nishad College of Fisheries, Kawardha, Kabirdham Dist, Chhattisgarh

&

National Institute of Agricultural Extension Management, MANAGE, Hyderabad