Application of ICT tools in fisheries

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Introduction

Information has played an important role in adding value to all sections of society since the dawn of civilization. For communicating information requires various digital technology and tools to reach the ultimate beneficiaries of the respective field. In the initial years use of ICT was limited to academic and research institutes along with costly access. However, over time its reach has touched every stratum of society as it has become the most popular and cost-effective way of sharing knowledge and information. As we thought that what do fish and fishing have to do with computers, the internet, and communications? Information technology is playing a significant role in the modernization and growth of the fishing industry. This traditional industry is facing economic and environmental pressures, as well as ever-changing regulations. Such pressures have led the fishing industry to invest in information technology to maintain sustainability and streamline its operations and be more effective and efficient. The world is undergoing an Information Communication Technology (ICT) revolution, a revolution that has enormous socio-economic implications for developed and developing countries. ICTs play a vital role by adding value to the entire Indian fisheries at each stage of the fisheries supply chain starting from fish catch to reaching the ultimate consumer. The latest ICT application will transform the fishermen's lifestyle as well as their livelihood activities mainly for-profit motive by reducing the labor and also reduce the vulnerability by timely getting of information which paving the way for social equity and ultimately uplifting fishermen to the mainstream. Nowadays clearly seen that there is fast expansion and development in the fisheries sector through ICTs apart from GPS, Navigation devices, sonar, fish finders, and wireless communication at very high frequency (VHF), etc were significantly contributed to the field of the marine fisheries sector. Different initiatives in ICTs have been taken up which would also help in expanding and developing the fisheries technologies for the fisher communities.

It is vividly believed that ICT is a basic resource for development, several ICT tools used in fishing such as mobile phones, television, radio, GPS, and fish finder, can bring significant changes in the fishermen's livelihood and reduction in the level of poverty of different fishing communities (Kularatne, 1997). ICT plays an important role in linking the knowledge among all stakeholders such as researchers, fisheries officials, etc by improving the linkages between the researcher and clients. This will mainly save the cost, time, and energy of the fishermen especially through mobile used by the fishermen will provide the best price for their catch before being brought into the landing center. With the help of this technology, fishermen were moving farther into the deep sea to get better catch high-value fish. This will be highly helpful for the fishermen to decide on the various constraints such as higher operational costs, more investment, the decline in the fish catch rate, fewer infrastructure facilities, and low profitability. All these factors are affecting the overall performance or fishing efficiency. Using ICT applications in fisheries will be an advantage for the fishermen to reduce

their operational costs as well as increase their quantity of catch. But the rural communities in developing countries like India still lack basic communication infrastructure was seen.

Definition

Information technology (IT) is the use of any computers, storage, networking, and other physical devices, infrastructure, and processes to create, process, store, secure, and exchange all forms of electronic data. e.g., letter, Photograph, Digital sensor, GPS, or satellite.

Communication: It acts as a medium to transfer information from one to another eg: the internet, mobile network, local and wide area network.

Information communication technologies (ICT). As per the definition of UNESCO "Diverse set of technological tools and resources used to transmit, store, create, share or exchange information". ICT is a set of tools that assist in capturing, storing, processing, transmission, and display of information by electronic means of technologies. ICT play important role in the sustainable development of the fisheries sector by a timely collection of essential information, processing them, and distributing among various organizations

ICT Technologies applied in the fisheries sector

There are various ICT tools were used by marine fishermen to communicate and increase the fish catch such as What's up, Television, Radio, Mobile, Global Positioning System (GPS), GPRS, Echo sounder, Sound Navigation and Ranging (SONAR), Search and Rescue Transponder (SART), Automatic Identification System (AIS), Distress Alert Transponder (DAT), Internet-enabled PC, Radio Deduction and Ranging (RADAR), Community Radio, portal, Very High-frequency wireless sets (VHF).

Identity technologies used in the fisheries value chain

- **Barcoding:** A barcode is a method of representing data in a visual, machine-readable form. Initially, barcodes represented data by varying the widths and spacings of parallel lines. These barcodes, now commonly referred to as linear or one-dimensional (1D), can be scanned by special optical scanners, called barcode readers. 2D barcodes, although they do not use bars as such 2D barcodes can be read or deconstructed using application software on mobile devices with inbuilt cameras, such as smartphones. These barcodes were used in the seafood products to ensure the authenticity and the origin of fish and other information such as price, product packed date etc.

- **Vessel tracking devices** - Vessel tracking devices such as the Pelagic Data Systems (PDS) tracker can be used to establish locations in which fish are caught and landed. These data can serve as part of a digital record of seafood provenance.

- **Supply chain tracking software** - Several software systems are now available for tracking fish through the supply chain to reduce fish fraud and reliably transmit information about the seafood to buyers. First, the fish must be labelled with a unique identifier. For high-value products, a QR code, barcode or NFC-enabled labels (small passive electronic disks that encode information and are activated by the magnetic fields produced by smartphones) might be required to ensure sufficient security. For other products, text messages or app input fields that include information on where the fish was caught, how it was caught, how it was handled, where it was landed and other information can be validated by trusted entities.

- **Sensors:** It is highly used in many equipment's along the fisheries value chain and it is majorly used in the aquaculture farm and fish processing industries. Monitoring the various water

quality parameters and weather parameters of aquaculture farms using both wired as well as wireless sensor technology, embedded computing technology, MEMS technology (Micro-Electro-Mechanical Systems), distributing information processing technology and wireless communication technology to build the wireless network sensor network system. This system is a digital, networked, intelligent real-time dynamic for monitoring the aquaculture water quality. The system not only can deal with the normal detection of the aquaculture environment indicators (temperature, PH, dissolved oxygen, turbidity, ammonia, etc.) monitor in real-time.

- **Image processing:** Image processing-based technique used to find the freshness of the fish by capturing the segmentation of gill tissues from fish images. The segmented image of gills tissue is used for the assessment of fish freshness, which is the most required property from the consumers because of its strong relationship to taste and health. A number of sensorial inspection procedures have been introduced to point to the state of freshness. These procedures involve the use of the sight (to evaluate the skin appearance and the colour and the global aspect of the eyes). Eg: The FishAPP mobile application software enables smartphones and tablets to capture a photo of a fish, or to select one from the local device photo library, and connect with the FishAPP remote server. FishAPP mobile software has been developed with PhoneGap, a free and open-source framework that allows the creation of mobile apps using a set of standardized web APIs for the desired platforms. The photo must include the full fish and it needs to respect the following guidelines: The fish must be photographed sideway; The caudal fin must be arranged in a relaxed anatomical way; Other fins should be set in a close-fitting manner. Since lifeless fishes cannot keep the fins completely visible, we opted to consider only the caudal fin as an anatomical discriminative feature.

- **Data management:** Web-based Seafood export management software system that simplifies and helps you in a smarter way to increase your business productivity and profitability for data storing and easy access at anywhere and any point of time. Along the fisheries supply chain, inventory could operate in multiple warehouse locations. It calculates the true yield and margin on everything you cut and meets the unique challenges of weight, products where yields, collection hub, product accounting, settlement processing, catch weight, multiple freezer/warehouses, and Shipment.

- **Server Side:** Web server, Search Engines
- **Clients side:** Browsers, Apps
- **Cloud:** Google Drive, iCloud, Dropbox, SkyDrive
- **Access Devices:** Desktop, Laptop, Tablet, smartphone.

1. **Fisheries repository management:**
a. **Fish Base**

Fish Base is a global biodiversity information system on finfish. Its initial goal to provide key facts on population dynamics for 200 major commercial species has now grown to have a wide range of information on all species currently known in the world: taxonomy, biology, trophic ecology, life history, and uses, as well as historical data reaching back to 250 years. At present, Fish Base covers >33,000 fish species compiled from >52,000 references in partnership with >2,000 collaborators: >300,000 common names and >55,000 pictures. https://www.fishbase.de/home.html.

2. **Identity management:**

   AIS (Automatic Identification System)

   The Shipborne Automatic Identification System (AIS) is a vessel tracking system capable of communicating navigation information automatically between AIS-equipped vessels and coastal authorities. It is a collision-avoidance system that gives information on all the ships in your area, their speed and courses and how to contact them (name, callsign, MMSI). This information is publicly broadcast on VHF radio which can be picked up either by other ships or by shore-based receivers. The main purpose is to improve the safety of navigation by assisting in the efficient navigation of the ship, protection of the environment, and operation of Vessel Traffic Services (VTS), by satisfying the following functional requirements In a ship-to-ship mode for collision avoidance, As a means for littoral States to obtain information about a ship and its cargo and As a VTS tool, i.e. ship-to-shore (traffic management).

   Location recognition:

a. **GPS (Global Positioning System)**

   A network of satellites that continuously transmit coded information, which makes it possible to precisely identify locations on earth by measuring the distance from the satellites. As stated in the definition above, the satellites transmit very low-power radio signals allowing anyone with a GPS receiver to determine their location on Earth. The advantage is that the global positioning system (GPS) enables the fishermen to plot a course to the potential fishing area. A fisherman can plot his course from any location by using stand-alone GPS, which can work without a mobile network.

b. **Fish Finder:**

   It provides valuable information to help you locate rich fishing grounds and boost your catch the Bottom Discrimination Function - Analyse bottom structure Configurable Alarm function (depth, fish echoes, etc.) Post-processing Gain Control applied to all echoes displayed on the screen Share and display information on a chart plotter

c. **Very High-frequency wireless sets (VHF)**

   VHF has been retained for short-distance communications but the range is limited under normal circumstances to less than 20 nm. VHF channels at sea especially the distress, safety and calling Channels 16 (156.8 MHz) and 70 (156.525 MHz).

   Application of ICT solutions in the fisheries

   Advisories

   Indian Marine Fishery Advisory System: Dissemination of PFZ Advisories:

   SMS, IVRS, Helplines, Voice Messages, Information Kiosks, etc. through Location-Based, New Generation E.D. Boards, Door darshan, E.D. Boards, News Papers, Emails, Website with Web GIS Facility, Phones & Faxes.

   Web-based Dissemination

   Unique website for multi-lingual advisories. Provides information in eight local languages (Gujarati, Marathi, Kannada, Malayalam, Tamil, Telugu, Oriya, Bengali) as well as in Hindi and English. Web GIS Facility without any commercial package installation. Retrieve PFZ information about any area in the Indian EEZ of their interest by doing simple GIS operations.

Mobile phone

Using mobile phones, fishermen can keep themselves up to date about prices and quality of fish in surrounding markets which ultimately enhances their income (Jensen, 2007). In addition, mobile phones have provided easy access to fishermen to search for the best prices for their catches in different markets (Evoh, 2009). Mobile phone penetration in rural India has revolutionized information access as also connectivity between people, the mobile phones not only have provided information concerning market information to the fishermen but also have facilitated weather. Mobile phones allow fishermen to avoid potential losses to boats and nets as well as risks to personal safety. Emergency and safety benefits were consistently described as the most important impacts on their life (Mittal, & Tripathi, 2009). It has been also observed that coastal fishermen used to get information about weather conditions through SMS about before entering the sea.

Mobile applications are used to get alerts if fishermen cross the border respectively, fisheries inspectors used mobile applications for reporting cases of illegal, unregulated, or unreported (IUU) fishing. However, the use of mobile apps for fisheries catch landings is scarce and freely available, modifiable, fisheries apps were not available at the start of this trial. Instead of only consultancies offering their services apps, liaising with the following service providers for disseminating the PFZ, OSF, and Tsunami warnings through their Mobile Networks.

PFZ Advisory mobile application

Potential Fishing Zone (PFZ) advisories are useful to fishermen along the coastal areas. It also provides daily advisories to fisherfolk about the presence of chlorophyll, sea temperature, and water clarity and helps them easily locate areas of abundant fish in the ocean while saving on both fuel and time used to search for the same.

mKRISHI mobile application

mKRISHI® Fisheries is a mobile app developed by Tata Consultancy Services (TCS) Innovation Lab – Mumbai, in collaboration with ICAR- Central Marine Fisheries Research Institute and Indian National Centre for Ocean Information Services (INCOIS) Hyderabad. This app is a result of multi-dimensional research and fieldwork involving the best of the expertise of all the partner organizations. INCOIS generates Potential Fishing Zone (PFZ), a fish shoals' prediction information based on the remote sensing data received from NOAA satellites, sea surface temperature and the presence of phytoplankton which form the food of several fish species. mKRISHI® Fisheries app consolidates this information and presents advisories in a local language.
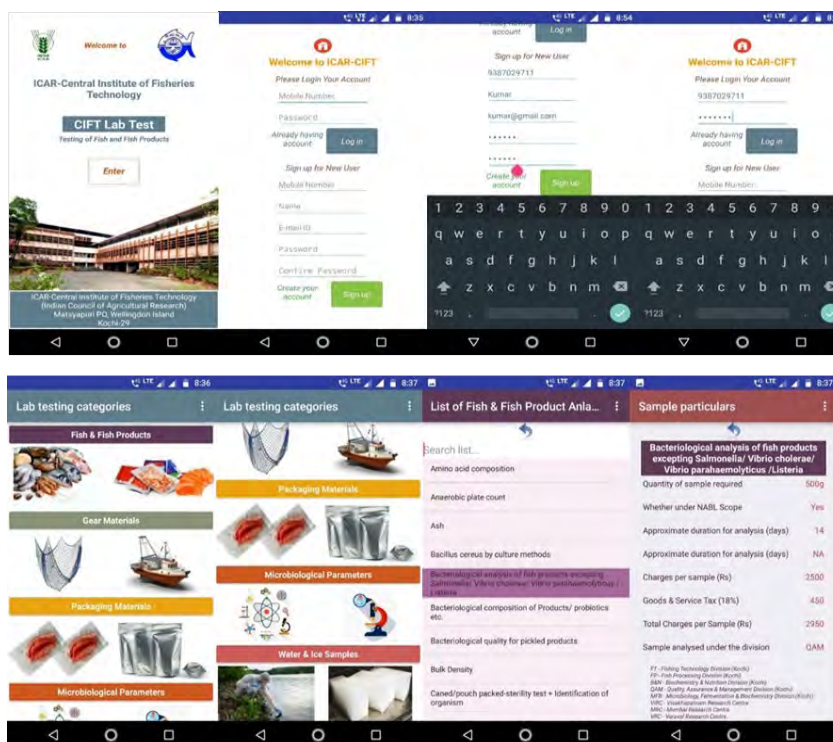
CIFT Lab Test mobile application

ICAR- Central Institute of Fisheries Technology, Cochin, an ISO 9001: 2008 certified organization has been recognized as a National Referral Laboratory for Fish and Fishery Products by the Food Safety and Standards Authority of India (FSSAI) under the Ministry of Health and Family Welfare, Government of India.

ICAR-CIFT has developed an innovative Mobile Application christened "CIFT Lab Test" intended for providing information related to different types of sample testing and analysis of various fish and fish-based products, fishing gear materials, packaging materials, microbiological parameters, quality parameters of ice and water samples, etc. This Mobile App may be useful for the aquaculture farmers, processing industries, and other stakeholders in the

sector to access the contents of different lab tests as per their interest online and get the desired information on the number of samples required, the time required for test report and cost particulars, etc. available at 24X7 times.

CIFT Lab Test

CIFTraining mobile application

ICAR-Central Institute of Fisheries Technology, Cochin has developed an innovative Mobile Application christened as "CIFTraining" that provides a complete package of information on ICAR-CIFT Training programs. This App is highly useful for the fisheries students, researchers, industry personnel, state extension personnel, fisheries-based entrepreneurs, fishers and other stakeholders in the sector to access the online information 24X7 times regarding different types of training programs in the field of Fishing Technology, Fish Processing, Biochemistry & Nutrition, Microbiology, Quality control, Engineering and Extension & Economics.

The "CIFTraining" Mobile App has embedded a total list of 68 types of clientele-based training programs available in ICAR-CIFT, which contain 60 regular training courses along with 2 comprehensives, 3 specialized and 3 certified courses covering the themes of seven divisions. The "CIFTraining" mobile app will help the stakeholders to search for the training of their interest and see the training program details like course contents, course fee, duration, eligibility, and other facilities at their fingertips so that the right stakeholder can opt for the right training program for improving the technical knowledge and skill in the concerned field. Finally applying for the training program through online registration mode.
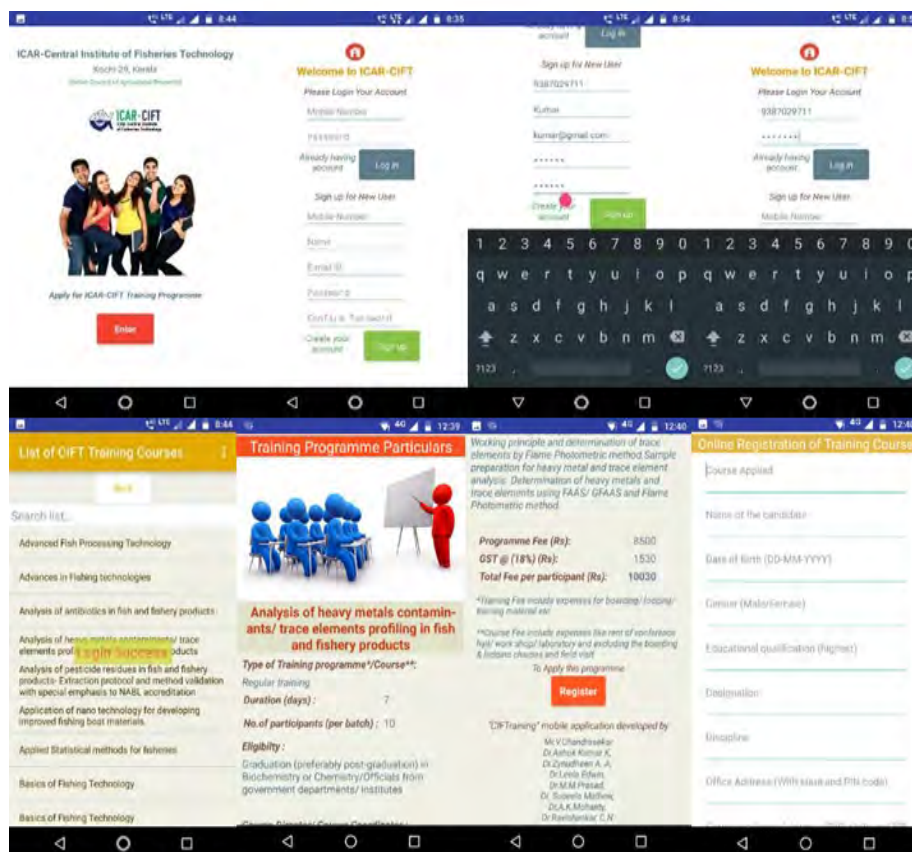
Fisher Friend Mobile Application

Developed on Android mobile platform which supports English, Tamil, Telugu, Odia and Malayalam languages.

FFMA provides following facilities to fisher folks:

Potential Fishing Zone	Weather Forecast
GPS facility	Government Schemes
International Border Line Alert	Market Information
Ocean State Forecast	News
Disaster Alert	Important Contacts

E-Commerce in fishery

www.marinefishsales.com is developed under the NICRA project of ICAR-CMFRI as innovative multi-vendor e-commerce. The platform is made available as an android application for mobile phones to facilitate direct sales between fisherfolk and the customers. The app envisions reasonable prices as a direct sale between fishermen/farmer to consumer is facilitated.

Daily fish: The voyage of your 'Daily Fish' from 'catch' to 'kitchen' has never been so world-class. Daily Fish, the online seafood store serves you ready-to-cook seafood that is 'As good as Live' with all the goodness of nutrients stored in it. This is in step with the vision of Baby Marine; promoters of Daily Fish and one of the leading exporters of marine products from India

to Europe, the US, South America, Japan, South East Asia, Gulf, South Africa and Australia for over four decades.

Decision support system

A decision support system (DSS) is a computer-based application that collects, organizes and analyzes business data to facilitate quality business decision-making for management, operations and planning along the fisheries value chain. A well-designed DSS aids decision-makers in compiling a variety of data from many sources: raw data, documents, personal knowledge from employees, management, executives, and business models. DSS analysis helps companies to identify and solve problems and farm-level make decisions.

Types of Decision Support Systems (DSS)

These can be categorized into five types: Communication-driven, data-driven DSS, document-driven DSS, knowledge-driven DSS, and model-driven DSS

Example: Aqua manager is a comprehensive, integrated software solution for improved efficiency in aquaculture industries. It is a complete fish farming software that supports all stages of fish production, from hatchery to harvest.

Supply chain

Integrating technology into a supply chain can be a challenge, and the seafood industry is no exception with the advent of traceability technology that monitors the catch from water to plate. As more consumers demand to know where the fish they eat comes from, companies have started developing high-tech solutions to capture, receive and transmit data across every component of the seafood supply chain, from fishermen to processors, transporters, distributors, and retailers.

Traceability

Traceability is linked to the validity of seafood labels that boast about a product's sustainability, authenticity, location and other factors important to consumers. Providing a socially responsible product can translate to higher profit margins, enhanced customer loyalty, and improved brand reputation. Suppliers are under increased pressure from consumers and retailers to provide traceability for their products. Traceability is seen as a way to soothe such worries. Traceability technology can mitigate risks and limit the impact of public health incidents.

A unique ID code for fisheries and its application in traceability and data-sharing. The unique codes for fisheries maintained as part of the Global Record for Stocks and Fisheries (GRSF) will save time and money for the seafood supply chain, traceability/technology companies, governments, and non-governmental organizations (NGOs).

The GRSF, the Global Record of Stocks and Fisheries, integrates data from three authoritative sources: FIRMS (Fisheries and Resources Monitoring System), RAM (RAM Legacy Stock Assessment Database) and Fish Source (Program of the Sustainable Fisheries Partnership).

Expert Systems

Expert systems are computer applications developed to solve complex problems in a particular domain, at the level of extraordinary intelligence and expertise. Development of Expert System for Shrimp Aquaculture (ESSHA) involved five steps viz., problem selection, knowledge acquisition, knowledge representation, system design, and development as well as system validation (Zetian et al., 2005).

Expert Systems in Fisheries Sector

Expert systems are rapidly becoming an integral part of applications in several domains ranging from traditional manufacturing processes to applications in outer space. Expert systems have been shown to improve traditional approaches by as much as an order of magnitude. There are several areas, including fisheries and aquaculture, in which the return on investment in an expert system can be tremendous.

Social networking

The penetration of the internet and subsequent usage of social media, especially among the youth is increasing day by day. In this context, a study was conducted to identify the internet and social media usage by students as well as their mode of accessing professional (fisheries) information through social media. social media has been classified into two types, namely social networking sites, and Instant messaging applications based on both form and content of the media

Social Networking Sites	Instant Messaging Applications
Instagram	WhatsApp
Twitter	FB Messenger
Pinterest	Yahoo Messenger
Google plus	Skype
Google groups	Google Hangouts
Research Gate	IMO
Google Scholar	Snap Chat
Wikipedia	Viber
Facebook	Hike
YouTube	Telegram
LinkedIn	We Chat
Bharat Student	

The Department of Fisheries through the following agencies serves this sector.

Information source exposure: Seminar, workshop, Training programme, scientific books/ Literature, Fisheries related magazine and other publications, radio programme, Television programme, Exhibition, Newsletter, Mobile help line communication, Newspaper, NGOs and others.

Fisheries related government organisation:
a. Fisheries Department
- Kerala State Cooperative Federation for Fisheries development Ltd (Matsyafed), http://www.matsyafed.in/
- Agency for Development of Aquaculture, Kerala (ADAK),
- Kerala Fishermen's Welfare Fund (KFWEB),

- State Fisheries Resource Management Society (FIRMA),
- Fish Farmers Development Agency (FFDA),
- Kerala State Coastal Area Development Corporation (KSCADC),
- National Institute of Fisheries Administration and Management (NIFAM),
- Society for Assistance to fisherwomen (SAF)
- Kerala Aqua ventures international limited (KAVIL)

b. MPEDA, Fisheries College, Research institute, CMFRI,

c. KVK, ATIC, AFCA, CIFNET, CIFT, NGO.

Mass media

Newspaper, Magazine, Newsletter, Farm Journals, Periodicals, Exhibitions, TV, Radio, Internet, Video lessons.

Social organization

Village panchayat, Co-operative credit, Co-operative group, Fisheries co-operative society, Fishermen Association, Community organization, Harbour mechanized boat association.

Initiatives in Fisheries Sector and aquaculture in India (CIBA 2012)

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

➢ E-learning courses on aquaculture
➢ The 'Phone-in Programme (PiP)
➢ Technology dissemination through mobile phones
➢ Village/ Rural Knowledge Centre
➢ Kisan Call Centre
➢ e-Sagu Aqua
➢ Aqua-Choupal
➢ e-TSA
➢ Decision Support Systems
➢ Farmer-friendly touch screen information kiosk on BMPs in shrimp culture
➢ One stop aqua shop
➢ Helpline

Latest technology used in the fisheries

1. **Blockchain technology in fisheries**

It is mainly used to addressing the traceability issue in seafood industries by integrate fish farmers with blockchain solutions and gathering specific data on the environmental impact, feed, growth and fish health as these contribute as key factors when raising fish sustainably this traceability technology monitors the fish catch from water to plate.

- Transparent resourcing for marine conservation,
- Reducing pollution from plastics,
- Reducing slavery at sea
- Sustainable fisheries management.

IoT: Smart aquaculture farming enhance the value chain.

IoT make a tremendous change in both monitoring and automation of highly helpful to the aquaculture sector to operate remotely anywhere in the world. useful to know the real-time water parameter of the pond such as dissolved oxygen (DO), Temperature, pH, and water level. microcontroller development kits such as Arduino, Raspberry Pi, ESP etc. It will generate big data consciously in frequent intervals which will be sent to the cloud storage, which will be processed and accessed through the web portal or mobile application.
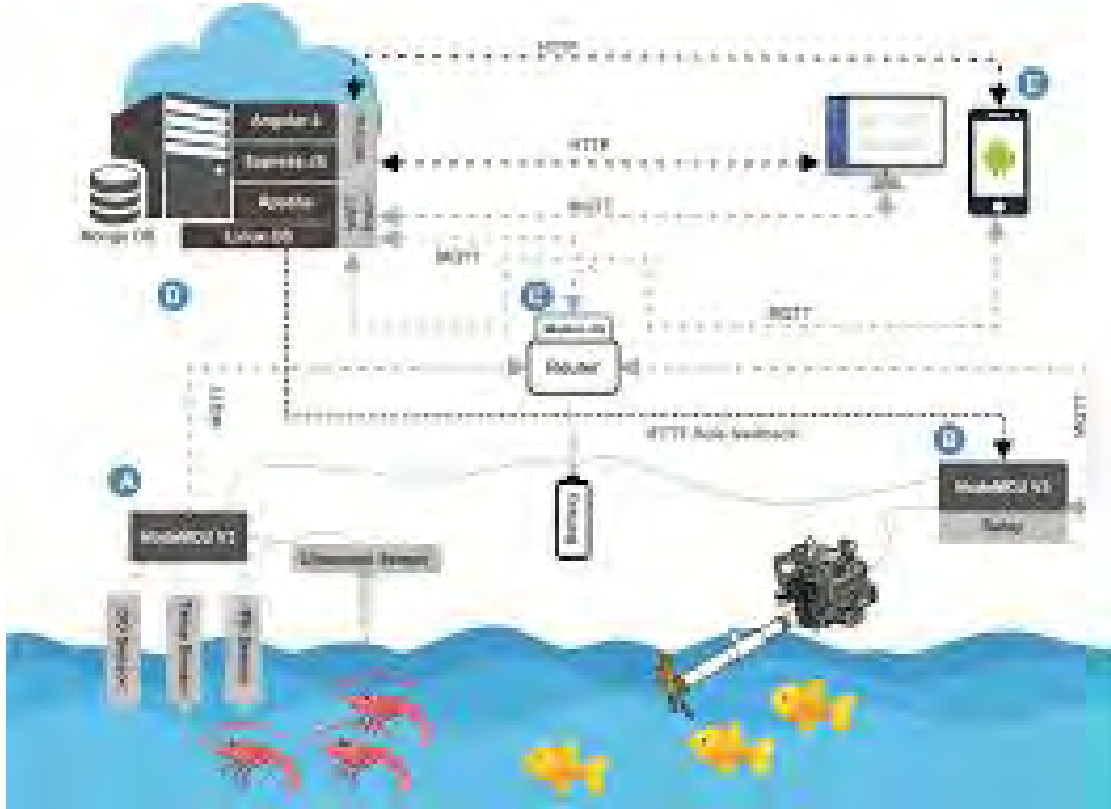
Artificial Intelligence in Fisheries

Artificial Intelligence (AI) by definition means 'the future made from the pieces of past'. These are programs that learn new solutions through experience. AI has been implemented in a variety of fields starting from agriculture to complete automation in industries. Through AI, fisheries sector can develop rapidly and production can be quadrupled within a short period as it makes aquaculture a less labor-intensive field. It can take the form of any labourers at work for example feeders, water quality control, harvesting, processing etc. In aquaculture feed costs itself nearly 60% of the total operation expenditure so reduce feed wastage increase profitability and also maintain water quality, hence AI feed dispenser releases right amount of feed at the right time, which will be remote control. Further AI read the fishes through vibration-based sensor and acoustic signals. Reduce cost of feed by about 21% measures and tracks the feeding pattern of stocks. AI programmed drones equipped with sensors can collect and analyze water quality data such as turbidity, temperature, dissolved oxygen.

AI in Fish Processing industries: Cutting, filleting, or cleaning the products can be done through programmed AI robots with much accuracy towards size, shape, and hygiene. Quality control and grading can be done through AI programs equipped with visual image sensors and

cameras. After grading, processed foods can even be packed and transported through AI robots. This makes zero labor cost and needs no human supervision.

References

- De, H.K., Saha, G.S., Srichandan, R. and Vipinkumar, V.P. 2008. New Initiatives in fisheries extension. Aquaculture Asia Magazine. July- Sept. pp 16-19
- FAO.2007. Information and communication technologies benefit fishing communities. New Directions in Fisheries- A Series of Policy Briefs on Development Issues, No.07.Rome.12pp
- Farell, C.O.2003. Theme paper presented for a seminar on ICT for improving agricultural productivity and competitiveness. 8-12 Sept. Indonesia.
- Jensen, R. 2007. The Digital Provide IT, Market Performance and Welfare in the South Indian Fisheries Sector. Quarterly Journal of Economics, 122(3), 879-924.
- Jensen, R. and E. Oster.2007. The Power of TV: Cable Television and Women's Status in India, NBER Working Paper 13305.
- Rasheed, S.V. 2003. Innovations in agricultural extensions in India. S.D Dimensions, FAO June 2003
- CIBA. 2012. Annual Report 2011-12. Central Institute of Brackishwater Aquaculture, Chennai. 164 pp.
- Kularatne, E. (1997). Information needs and information provision in developing countries. Information
- Development, 13(3), 117-121.
- Evoh, C. J. (2009). The role of social entrepreneurs in deploying ICTs for youth and community
- development in South Africa. The Journal of Community Informatics, 1 (5), 1-16.
- Jensen, R. (2007). The digital provide: information technology market performance and welfare in the

- South Indian fisheries sector. Quarterly Journal of Economic Cambridge Massachusetts, 122 (3), 879-924
- Mittal, S., & Tripathi, G. (2009). Impact on small farmers and fishermen through use of mobiles in India. In
- proceeding of EAAE-IAAE seminar on small farms 26th -27th June University of Kent, UK.
- Thangavel V, Shanmugam A. P, Inbaraj L. C. C. E-Coverage of Fisheries Ecosystem and Usage Pattern of Social Media. Curr World Environ 2019; 14(2). DOI:http://dx.doi.org/10.12944/CWE.14.2.10
- Zetian, F., Feng, X., Yun, Z. and XiaoShuan, Z. 2005. Pig-vet: a web-based expert system for pig disease diagnosis. Exp. Sys. Appl., 29: 93–103.