DESIGN OF MOBILE APP PROTOTYPE FOR FISH FARMERS OF TELANGANA

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by

D. KIRANMAYI, B.F.Sc.

(FEX-MA6-02)

ICAR-CENTRAL INSTITUTE OF FISHERIES EDUCATION

(University Established Under Section 3 of UGC Act 1956)

Panch Marg, Off Yari Road, Versova,

Andheri (W), Mumbai – 400 061

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Dedicated to

my loving parents

RamaDevi & RamaKrishnaRaju

brother

RaghuRamaRaju

भा.कृ.अनु.प. केन्द्रीय मात्स्यिकी शिक्षा संस्थान
भारतीय कृषि अनुसंधान परिषद,
I.C.A.R. CENTRAL INSTITUTE OF FISHERIES EDUCATION
(A university Established Under Sec. 3 of UGC Act 1956)
Indian Council of Agricultural Research,
Ministry of Agriculture, Govt. of India

Dated: 30th June, 2018

CERTIFICATE

Certified that the dissertation entitled **"DESIGN OF MOBILE APP PROTOTYPE FOR FISH FARMERS OF TELANGANA"** is a bonafide record of independent research work carried out by **Ms. D. KIRANMAYI** during the period of study from August 2017 to June 2018 under our supervision and guidance for the degree of **Master of Fisheries Science (Fisheries Extension)** and that the dissertation has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or any other similar title.

Major Advisor

(Arpita Sharma)
Principal Scientist
FEES Division
ICAR-CIFE, Mumbai

Advisory Committee

(Shekhar Nath Ojha)	**(Rama Sharma)**	**(K. Pani Prasad)**
Principal Scientist & HOD	Senior Scientist	Principal Scientist
FEES Division	FEES Division	AEHM Division
ICAR-CIFE, Mumbai	ICAR-CIFE, Mumbai	ICAR-CIFE, Mumbai

DECLARATION

I hereby declare that the dissertation entitled **"DESIGN OF MOBILE APP PROTOTYPE FOR FISH FARMERS OF TELANGANA"** is an authentic record of the work done by me and that no part thereof has been presented for the award of any degree, diploma, associateship, fellowship or any other similar title.

Date: 30.06.2018

Place: Mumbai

D. Kiranmayi

M.F.Sc. Student

ICAR-Central Institute of Fisheries Education

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ABSTRACT

In the last few years, there is a tremendous improvement in the field of mobile technology. This improvement has made the smart phones and mobile apps an integral part of human life. Farming communities in different sectors realize that smart phones and mobile apps are easy, fast and convenient means of communication and get answers of respective problems. Realizing the need of mobile based solutions for fish farmers, a study was undertaken to design a mobile app prototype for fish farmers of Telangana. Objectives of the study were to conceptualize the features required in a mobile app, to aggregate scientific information for the relevant features and to develop mobile app prototype based on these features. To conceptualize the features required in the mobile app a questionnaire was designed with open ended questions in order to collect what specific features and information heads farmers would like to be included in the mobile app. The features listed by the farmers were shown to the expert group who added few more features to make the app more comprehensive. The features listed by both farmers and experts were compiled and relevancy test was done. The two groups were asked to rate the features on a four point likert scale. The features which had an average score of more than 2/4 were included in the mobile app and clubbed under 6 main features namely Culture practices, Management practices, Post harvest practices, Modern farming Techniques, Telangana fisheries information and Buy or sell. Mann Whitney U test was conducted to check if there was a significant difference between the scores given by farmers and experts. Results revealed that there was no significant difference. Kendall's Coefficient of Concordance (W) revealed a greater degree of agreement among the farmers and experts. To aggregate scientific information for each feature, content was collected from various information sources like books, articles, websites and research papers. Aggregated information was written in simple language, checked by grammarly software and plagiarism checker tool. The content along with the illustrations were finalized through a writeshop process with experts and Key Informant farmers. Thus the information aggregated and checked for its content at various levels was made ready to be included in the prototype. Content Validity Ratio was checked for each feature and was more than 0.75 establishing the content validity of the text and illustrations.The mobile app prototype has been developed on the android platform with minimum SDK version of API 17: Android 4.2 (Jelly Bean). Wire framing and Story board was created based on the selected features. Once the skeletal frame-work was designed it was decided to develop the app in the software. Feedback from farmers and students was taken on various parameters like design, information, functionality and others on likert scale, in which more than 70% of them responded that the app is very good on all parameters. Thus through this study a mobile app 'Matsya Kiran' was developed for fish farmers and can be used by students, fisheries professionals, and anyone interested in fisheries.

सारांश

मोबाइल फोन का प्रयोग एवम उसकी तकनीकियों में कई बदलावे आते जा रहे हैं । मोबाइल में जो सुधार हुए है उसके कारण स्मार्ट फोन एवम मोबाइल एप्प संचार का एक आसान, तेज और आसान माध्यम बन गए है । आज के परिवेश में मछुआरों को भी उनकी आवश्यकता के अनुकूल मोबाइल एप्प आदि की आवश्यकता है । इसको ध्यान में रखते हुए एक अध्ययन किया गया जिसका उद्देश्य था कि मछुआरों के लिए एक एप्प बनाया जाए जिसमें उनके लिए मछली पालन आदि की जानकारी एकीकृत रुप में उस एप्प में ही उपलब्ध हो । इस एप्प का निर्माण करने के लिए हमने तेलंगाना राज्य के किसानों, वहॉ पर कार्यरत मात्स्यिकी विभाग के अधिकारीगण, कृषि विज्ञान के अधिकारी आदि लागों से कई चर्चाएं की । उनसे हमने यह राय ली कि क्या किसानों को एक मोबाइल एप्प की आवश्यकता है । यदि है तो वे इस एप्प में क्या-क्या फीचर्स रखना चाहते हैं । चर्चा व प्रश्नावली द्वारा हमें जो परिणाम प्राप्त हुए उन्हें हमने फिर से विशेषज्ञों एवम कुछ किसानों से उनकी उपयुक्तता के बारे में शोध किया । सांख्यिकी ज्ञान का प्रयोग करके इस बात की भी जांच की कि किसानों और विशेषज्ञों की सोच में समानता थी या नहीं । जांच से यह परिणाम मिला कि उनकी सोच में समानता थी । इसके पश्चात् जावा कोड का प्रयोग करके एक उचित मोबाइल एप्प बनाया गया । इस मोबाइल एप्प में किसानों को मछली पालन हेतु कई जानकारी प्रदान की गई हैं । एप्प का पुनर्निवेशन (फीड़बैक) भी लिया गया । किसानों, विशेषज्ञों व मात्स्यिकी के युवा विशेषज्ञों ने भी मोबाइल एप्प के बारे में अपनी अच्छी राय दी । इस प्रकार इस अध्ययन में मछुआरों के लिए एक मोबाइल एप्प ‘‘मत्स्य किरण’’ बनाया गया है जिसमें उनके लिए मछली पालन की एकीकृत जानकारी प्रदान की गई है ।

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1.INTRODUCTION

Fisheries and aquaculture is one of the fastest growing subsectors of agriculture. It plays an important role in meeting out the food and nutritional security of the growing population. The sector makes crucial contributions to the global food production and prosperity. In the past five decades, the global supply of fish for human consumption has outpaced the population growth. The world per capita fish supply has reached 20 kg with total production of 167.2 million tonnes in 2014. The share of total capture fishery production was 93.4 million tonnes of which 81.5 million tonnes is from marine waters and 11.9 million tonnes from inland waters. It is estimated that 56.6 million people were engaged in capture fisheries directly or indirectly in the year 2014. Aquaculture production in the year 2014 was 73.8 million tonnes of which 47.1 million tonnes was from inland waters and 26.7 million tonnes was from marine waters (FAO, 2016). Amongst all the countries, India ranks second in aquaculture production and third in total fish production.

India has vast potential for fisheries as it is endowed with a coastline of 8,118 kms, 0.50 million sq. km of continental shelf, 2.02 million sq km of Exclusive Economic Zone (EEZ). Fish production has increased from 41.57 lakh tonnes in 1991- 92 to 114.10 lakh tonnes in 2016-17, of which 36.41 lakh tonnes are from marine and 77.69 lakh tonnes from inland fisheries. Fisheries sector of India has contributed about 0.92% of the National Gross Value Added (GVA) and 5.23% to the agricultural GVA in 2015-16 (DAHDF, 2017-18). The sector engages fourteen million people in different activities. The historical scenario of the Indian fisheries shows a paradigm shift from marine dominated fisheries to a scenario where inland fisheries has emerged as a major contributor to the overall fish production in the country.

In India, with reference to aquaculture, Andhra Pradesh is leading in fish production followed by West Bengal. The fish production in Andhra Pradesh in the year 2016-17 was 27.6 lakh tonnes. (DAHDF, 2017-18). However, the newly formed state, Telangana is not lagging behind. Telangana ranks third in India in fishing resources with 587,000 hectares of fishable area, and is ranked eighth in fish production, having produced 2, 20,000 tons of fish in 2016 alone. (DoF, 2016)

Fisheries sector in Telangana is a traditional and important occupation contributing about 0.6 percent to the State GVA in 2015-16. The Government aims at (i) increase in fish production and productivity through increasing fishery base, (ii) achieve self- sufficiency in fish seed, (iii) supply of fish at an affordable price and in hygienic condition and (iv) improve the living condition of people depending on fisheries through welfare programs (DoF). The resources include 78 reservoirs spreading about 1.85 lakh hectares, and 35,031 tanks spreading over an area of 4.01 lakh hectares, 474 ponds covering an area of 781 ha.

In order to strengthen the sector, Government has taken up a fishery development scheme to improve the productivity, reduce post harvest losses, increase livelihood support and welfare of fishers in capture and culture of fisheries. As a part of this scheme infrastructure and beneficiary oriented programmes such as Construction of Community Halls for Inland fishermen, Supply of Boats and nets to reservoir, Assistance for Retail Fish Marketing, Establishment of fish/prawn farm or Fish Seed Farm or Fish Hatchery etc. are undertaken. The state has also been implementing several centrally sponsored programmes that include strengthening the data base and network, registration of fresh water aquaculture, group accident insurance for fishermen, supply of fish seed and ice boxes under state plan.

Telangana is not only showing a significant development in fisheries but also in Information and Communication Technology (ICT) sector. There were several initiatives for promotion of ICT in Telengana, viz, RiceVocs, RKMP's, Digital Telangana Centres by women in 100 panchayats. Telangana has also registered the highest number of e-transactions in the year 2017 (Prasad, 2017). Telangana plans to be the first state in the country to provide proper broadband connection to every household. (Gupta, 2017).

ICT is one of the economic development pillars improving the quality of human life. The term ICT is used to include electronic and print media such as mobile phones, internet, telephone, computer, radio and television. It has provided new ideas, methods and techniques disseminating and improving the knowledge and information among people of different societies wherein, its use has also brought significant changes in agriculture development as per (Warren, 2002) and (Arokoyo, 2005). A few way forward measures can be seen in enabling ICT in

agriculture and allied sectors in India as available on internet such as Kisan Call Centre by IFFCO Kisan Sanchar Ltd which educates the farmers enabling them to use the best of the agricultural inputs to grow more food to the country, as well as, get a better income from farming. (De *et al*., 2008), e-Sagu Aqua which is an information and communication system consisting of the farm history, crop details, soil details, weather data, farmer details, case sheets, photo bank and a library. (Vimala *et al.,* 2009). Private sector too initiated a number of ICT applications viz., aAqua which is a multilingual online question and answer forum (Mondal *et al*., 2011) and eAgri Aqua, aquachoupal which offers the shrimp farmers all the information, products and services they need to enhance productivity, improve farm gate price realization and cut transaction cost. (De *et al*., 2008).

Amongst the ICT applications, mobile phones are gaining more attention with many benefits such as less price, easy portability, user friendly appearance. It has been reported that China will have highest number of smart phone users, 1300 million, in 2018, followed by India with 530 million users. India currently has in between 300-400 million smart phone users. There are about 650 million mobile phone users in India, and just over 300 million of them have a smart phone. Two out of three Indian mobile users or roughly 433 million people are planning to upgrade their phones in the next year as per the global smartphone statistics.

The mobile devices are not only used for the communication purpose, these devices has come up with a lot of handy tools known as ‘app’ that are widely used by the common people in their day to day life. There are thousands of mobile apps being developed world wide providing a good interface to user for different purposes such as from playing games to online ticket booking, from reading books to learning cooking, from online chatting with friends to online financial payments. The emergence of mobile apps has changed the definition of the mobile phone usage. These mobile applications provide an affordable way to access the internet and retrieve information related to any field. Mobile apps are becoming popular in agriculture and allied sectors too, with the potential for further advancement.

In a study conducted by (Ramaraju *et al.,* 2011) it has been reported that the most popular information gadget possessed and accessed by the farmers is

the Mobile Phone (82%) followed by Television (73%) and the Newspaper (67%). Mobile as a mode of dissemination of information is preferred by 25% of farmers, followed by Information centre/Kiosk (12%) and Television (8%). Mobile apps have given new thinking and approach to farmers for making a decision about getting the information of market and weather from concern person. Now the farmers can communicate with customers to sell their product at a good price and at the same time they can have up to date information about market as well as weather. (Bayes *et al.,* 1999), (Goodman, 2005), (Kwaku and Kweku, 2006).

Mobile apps from India, related to fisheries, are few. For this, search on internet was done and it was found that the apps available are Aqua Brahma, Vanamei shrimpapp, Sagar Vani, Fisher Friend Mobile Application, Search and Rescue Aid Tool. The Aqua Brahma Platform is the one of the only non-exclusive, open, and inter-operable platforms in the Indian Aquaculture. It helps to stay connected with hatcheries and suppliers and get educated day by day. Sagar Vani app developed by Indian National Centre for Ocean Information Services (INCOIS) provides information on potential fishing zone (PFZ), Ocean state forecast, High wave alerts, and Tsunami early warnings. Fisher friend mobile application has the feature of PFZ, Ocean State and Weather Forecast, Global Positioning System (GPS), Danger zone alerts, Disaster Alerts, Market realities, Emergency contact numbers developed by M.S. Swaminathan Research Foundation (MSSRF). Search And Rescue Aid Tool (SARAT) developed by INCOIS assist Indian Coast Guard , Navy and Coastal security police in searching for over 60 types of missing objects, including boats, ships and man-over-board.

Indian Council for Agricultural Research (ICAR) is also playing an important role in developing mobile apps to help the fisher to increase their income and catch. ICAR-CMFRI in collaboration with Tata Consultancy Services (TCS) & INCOIS developed the mkrishi@fisheries app. This app provides information on PFZ, cost of diesel, ice and labour.

With reference to the literature there are many studies on mobile application development in agriculture like (Singhal *et al.*, 2011) have reported about an android based solution for Indian agriculture - Krishi Ville, providing guidance in their farming activities. **(**Lantzos *et al.*, 2013) have reported about an

android application for the management of small farms- Farm Manager. (Patel *et al*., 2014) have reported about an android application for farmers to disseminate horticulture information. **(**Narechania 2015) reported about KisanVikas- Android Based ICT Solution in Indian Agriculture to Assist Farmers. Recently Agri-Media which is an agriculture video app for farmers has also been developed.

With the increase of mobile users it is expected that more user specific apps will be developed. However, there are lack of studies on mobile apps in fisheries and aquaculture. Thus there is a need to do comprehensive study on mobile apps. Accordingly, a study entitled “Design of Mobile App Prototype for Fish Farmers of Telangana” was undertaken with the following objectives

Objectives

- To conceptualize the features required in the mobile app for fish farmers
- To aggregate scientific information for relevant features to be included in the mobile app
- To develop mobile app prototype based on these features.

2. REVIEW OF LITERATURE

Review of literature is an integral part of the entire research process, as it not only gives an idea of earlier studies, but also provides clarity and focus to your research problem, improves the methodology broaden knowledge base in your research area and contextualize your findings. In this chapter the review is presented under the following broad headings.

1. ICT in Agriculture
2. ICT in Fisheries
3. Mobile application development and statistics
4. Mobile apps in agriculture
5. Mobile apps in fisheries
6. ICT initiatives by Government of India
7. ICT initiatives by Government of Telangana

2.1. ICT in Agriculture

Introduction of mobile technology as portable, wireless devices has led to the creation of innovative services and applications which are useful in agricultural chains in both developed and developing countries. One of the benefits of such connectivity and information flow is that it helps farmers make better land management decisions such as management of soil condition in conjunction with weather information in order to better plan the planting and harvest season, provides information on pasts and animal diseases and their prevention measures and other scientific information that is required by the farmer. There are studies which report that ICT initiatives have helped farmers like Singh *et.al*., (2017) reported that ICT based initiatives helps in dissemination of information, transfer of technology, purchasing of inputs and selling of outputs in a way so that farmers can be benefitted to adopt good agricultural practices, make better choices of inputs and to plan the cultivation properly.

Pandey (2017) had undertaken a study to know how ICT plays a role in agriculture development. He found that ICTs application such as mobile phones helping farmers to changes the existing attitudes by increasing interaction with market holders, Kisan Call Centres, and sharing information with friends, question

answer with extension officers and browse internet on smart phone all these help them to change the traditional pattern of cultivations.

Irungu *et.al.,* (2015) reported that most of the youth obtained information from the internet, they used internet and social media to obtain production technologies, market information and for information sharing. Hence the internet is the best platform to market and promote agriculture to the youth.

Lio and Liu (2006) reported that new ICT has a significantly positive impact on agricultural productivity. It was also stated that the adoption of modern Industrial inputs in agricultural production relies on the information and communication structure. They found that the ICT levels of adoption in developed countries are much higher than those of the developing countries and the returns from ICT in agricultural production of the developed countries are about two times higher than those of developing countries.

Davison *et. al*., (2005) reported that ICTs can help in enabling rural development workers to gather, store, retrieve, adapt, localize and disseminate a broad range of information needed by rural families.

Bertolini (2004) reported that knowledge and information were important factors for accelerating agricultural development through increased production and improved marketing and distribution. ICT could make the greatest contribution by reducing distances and reducing the cost of interaction between stake holders.

Advantages of ICTs are many and fisheries sector is not left untouched by this.

2.2. ICT in Fisheries

Alagappan and Kumaran (2016) conducted a study on status and scope of ICT aided tools for aquaculture extension service in India. They reported that though there are several initiatives made for use of ICT in aquaculture sector in India, its application is on a limited scale. They suggested that there is need to increase the use of ICT tools for aquaculture extension service, to make the information transfer more effective.

De *et. al*., (2012) has reported that the ICT mediated aquaculture extension is beneficial for all the stakeholders like fish farmers, researchers and extension workers. It was also said that successful ICT applications are to be replicated in other areas covering fish farmers across the country and thereby bridging the digital divide.

Kaushal (2010) identified many subjects that are appropriate for ICT and from which the aquaculture sector could benefit but to get success of the on the following criteria like clear and focused services, simple and user-friendly, accurate information, well organized and easy to find.

Vimala *et al.,* (2009) proposed a framework for ICT based aquaculture information extension and dissemination by integrating freshwater aquaculture and information technologies, called 'e sagu Aqua'. The system provides expert advice to the needy farmers in a timely and personalised manner to improve freshwater aquaculture productivity and also to increase the profitability of the farmer by increasing the efficiency of aquaculture inputs and reducing the cost of production.

In countries like Nigeria also role of ICT has been reported by Ejiogu *et.al*., (2016) for improved fish farming and production.

Role of ICTs in fisheries and aquaculture is immense. As explained in the chapter introduction there are few mobile apps developed in the field of fisheries. However, comprehensive information on mobile apps in fisheries and aquaculture is few. But it cannot be denied that ICTs and mobile apps have an important role in information exchange, knowledge sharing, promotion of education, monitoring illegal fishing and price information provisioning.

2.3. Mobile Application Development and Statistics

It is estimated that about 62.9 per cent of the world population owned a mobile phone and the number of mobile users in the world expected to cross the five billion mark by 2019. The mobile phone users are increase to 67 per cent by 2019 and in it is forecasted that the mobile users in India will increase to 1.1 billion in 2019 from about 1 billion in 2017 as per the website www.statista.com. Most of the statistical information on mobile apps is presented on different websites.

Research papers on this are few. Like it is reported on www.cxotoday.com (2018) that as the smart phone users in India increasing day by day the creation of mobile apps is necessary.

Realising the need of advancements in ICTs and mobile app Government of India has timely initiated ambitious Digital India initiative programme to promote digital infrastructure, digital literacy and delivery of service digitally. All the ministries are actively engaged in this.

With smart phone users increasing day by day, the craze for downloading mobile apps increased with the popularity of Smartphones. With the digital literacy initiative, the Government has plans to provide computer knowledge to the poor and rural population. The major goal delivery of the digital service is to offer feature-rich smartphone apps which will provide basic services to the citizens via e-governance. This is a very good initiative and will beneficial to all people.

Saifi (2017) reported that the revenue generated by the global mobile app industry has skyrocketed which was $35 billion in 2014, $45 billion in 2015, $58 billion in 2016, and a predicted $77 billion in 2017. Increasing number of Smartphone users in the global market has led to a tremendous increase in the number of apps that consumers use on their phones. The Apple App store boasts close to 2 million of these apps while Google play has over 2.2 million Apps. This number is expected to increase in the future.

However, some studies like Inukollu *et al.,* (2014) has also report that not all mobile apps are successful. They reported that the crucial factors which are responsible for failure include negligence by the developers, technical issues, inadequate marketing efforts, and high prospects of the users/consumers. As per the various surveys, the number of lamentable/failing apps is growing enormously, primarily because mobile app developers are not adopting a standard development life cycle for the development of apps.

Harrison *et al.*, (2013) introduced the PACMAD (People at the Centre of Mobile Application Development) usability model which was designed to address the limitations of existing usability models when applied to mobile devices. The PACMAD usability model identifies 7 attributes which reflect the usability of an

application: Effectiveness, Efficiency, Satisfaction, Learnability, Memorability, Errors and Cognitive load.

According to Islam and Mazumder (2010) the uses of mobile applications are increasing corresponding to the use of desktop applications. Mobile manufactured companies and mobile application developer companies are increasing the capacity, quality and functionality. So the modern mobile applications are more capable and more usable for the user and the global impacts of mobile applications are going high.

Jensen (2010) reported that the number of mobile phones per 100 people in developing countries often exceeds access to other information technologies, such as landlines newspapers, and radios.

Aker and Mbiti (2010) provide an overview of the mechanisms through which mobile phone telephony can affect economic development in sub-Saharan Africa, including improved access to market information and coordination among agents. The low search costs associated with mobile phones could increase farmers' access to information via their private sources, such as members of their social network.

Konig (2009) studied the challenges in mobile application development and he found that the challenges with respect to mobile application development were grouped into three main dimensions. They are architecture, data and context management, user interface.

With the increase in usage of mobile phones and mobile apps it is natural that agriculture related mobile apps also will be developed.

2.4. Mobile applications in agriculture

There are many apps in the field of agriculture. However, select few are being discussed here.

Pusa Krishi (2016) an android based mobile application developed by ICAR-IARI. The app provides information about new varieties of different crops, resource conserving cultivation practices as well as farm machinery.

Kisan Suvidha (2016) an android based mobile application developed to help Indian farmers by providing relevant and valuable information to them. It provides information about five important parameters such as weather, plant protection, market price of crops, details of input dealers and expert advisories. The information are available in both English and Hindi language in this application.

An app, riceXpert (2016) developed by ICAR- National Rice Research Institute (NRRI) will provide valuable and timely information to the Indian farmers on problems related to the disease attack in rice crop, major insect pests of the rice plant, major nutrients deficiencies, extensive weed growth in crop field, detailed information of rice varieties suitable for different ecologies, farm implements for different field and post harvest operations, information about the current technologies etc.

Narechania (2015) described the details of development of a mobile application 'KisanVikas' provide continuous information about weather forecast, market prices of crops, recent agricultural news, and an inventory database management system. The mobile application is connected to a wireless sensor network. The network comprises of some sensors like soil moisture, pH and temperature sensors, which in turn controls the water pumps used for watering the small fields. This mobile application 'KisanVikas' acts as a farmers assistant in the field in terms of irrigation.

Bandopadhyay (2015) illustrated the development of a mobile application named as 'KSUSoy YieldCalc' that facilitates the yield estimation before the harvest of soybean crop. It uses the traditional approach for estimation of yield and eliminates the uses of internet for this purpose. The application has been developed on the android platform to serve its different users like farmers, agronomists, consultants and also to deliver performance to save time and enhance confidence of the farmers. The application utilizes android SDK for development of the application with JAVA and XML coding.

Pavithra and Srinath (2014) stated that Global System for Mobile Communication (GSM) is a digital mobile communication system that is widely used in most parts of the world. GSM defines the standard to describe the protocols for

the 2G cellular technology used for transmitting voice and data services through the mobile devices. In this context, an android based application has been developed for maintaining the irrigation system in the crop fields based on the GSM technology. The application has been developed in JAVA programming language using the APIs provided by the Android SDK.

Tate *et al*., (2014) developed an interactive mobile application based on android platform for controlling drip irrigation system in the crop fields. Based on the data received through the observations, the mobile application sends some commands to the server to control irrigation system. Different sensors are used like temperature, light etc. for the detection purpose. These sensors send real time values to microcontroller and the microcontroller sends these values to the server via serial communication. According to the sensor values, graph will be displayed on the mobile screen and by using this graph user can on or off the drip irrigation devices. The threshold values for each sensor have been recorded in the server. Mobile devices can control the drip irrigation from anywhere and can also change the threshold values of sensors via the mobile devices.

Patel *et al.,* (2014) described about the development of an android application for horticultural crops has been given. Using the concept of Horticulture and Android introduced a “Farmer Helping Service” system that will provide the detail information of fruits, vegetables and flowers in audio format to the farmers. This system can provide information using android smart phone from anywhere and anytime without using internet and at free of cost in Gujarati language.

Lantzos et al., (2013) developed ‘Farm Manager’ an android based application which overleaps the high difficulties of management requirements in the small farms. This application creates the farm management knowledge base for recording or browsing of ground fields, field relations (occupied or rented land), cultivation and its tasks, equipment, employees and cultivation reports.

Delgado *et al*., (2013) developed ‘Nitrogen Index’ mobile application that works as a mobile nitrogen management tool for assessing the risk of nitrogen loss from crop field to environment. It has been developed on the android platform using Java and XML as programming environment. The ‘Nitrogen Index’ application

has been developed by adapting and modifying the 'Nitrogen Index 4.4' software, which is a web based application for desktops and laptops. This mobile application allows nitrogen leaching simulations to be conducted virtually anywhere.

Kongsombut and Chaisrichaoen (2013) reported that lack of adequate technical knowledge and timely environment supervision are the major problem in case of orchid production. For solving this problem an advisory service has been developed for orchid management that interacts with the users in real time. The advisory service utilizes an android based mobile application, cloud computing technology and push notification service. The mobile application provides the client side interface to the users. The cloud computing technology provides different services such as servers, storage and APIs through the Internet. The server sends the notification to the application as the push notifications in android phones about the early notification, technical knowledge and environment management in the orchid fields. This advisory service manages to enhance the decision making proficiency of a nurseryman in orchid production.

Intaravanne and Sumriddetchkajorn (2012) proposed a mobile application called 'Baikhao' for rice leaf color analysis The nitrogen status of the rice plant during the cultivation can be analysed by the color level of the leaves in field. A leaf color chart also known as LCC is used by the farmers to analyze the color level of the leaves and based on these observations they estimate the dose of N fertilizer before applying in the rice crop field. But the inability of the farmers and degeneration of the LCC declining the accuracy of analyzing the color level of the rice leaves. In this context 'Baikhao' android application has been developed to correctly identify all the important leaf color levels of rice plants during cultivation.

Singhal *et al.*, (2011) in his paper illustrates a mobile based applicatiom that is being developed for the farmers for providing guidance in their farming activities. The application is developed on the android platform and named as 'Krishi Ville'. The application has been developed for helping Indian farmers. This application deals with the following: updates of the different latest agricultural commodities, weather forecast information and recent agricultural news relating to any aspect of India farming.

In the field of agriculture apps have been developed as per commodities and also to provide weather, market and other information. Similarly in the field of fisheries too there must be mobile apps. A search was done to locate the mobile apps in fisheries. To locate the mobile apps in fisheries and aquaculture mapping of different types of apps in fisheries sector was done. Virtual information was used in ambit of compiling different mobile apps in fisheries sector using google search. A methdology called as Virtual Product Snowball Sampling (VPSS) was used as devised by Sharma (2018) to analyze mobile apps available in fisheries sector. Virtual information was collected using standard keyword typology method using google search engine and mobile app store. But, in this standardized methodology by key word search, many apps are missed. In VPSS when search for apps is done on the internet or mobile app store product page is visited, the widget of the products usually bought together, customers also bought, related apps are displayed. One search leads to another and so on. Usually this method is used by customers and retailers but VPSS method is a virtual snowball method where one app search leads to many other and so on. As per Fabiola and Ignasi (2012) when social networks are used, then this technique is called virtual sampling. However, in this study it was not the use of social networks.

2.5. Mobile applications in fisheries

Vanami shrimp app (2018) the ICAR-Central Institute of Brackish water Aquaculture (ICAR-CIBA) has developed an Android based mobile application for the dissemination of technical information among the stakeholders of shrimp farming sector. The app provides information on the Best Management Practices for *Penaeus vannamei* farming, inputs and sampling calculations, probable disease diagnosis, on-farm risk assessment, Government guidelines and regulations, updates and advisories. The users can also post their queries through 'post a query' option and it will be answered within two working days.

SagarVani (2017) ESSO-INCOIS under the ministry of Earth sciences developed a software platform called SagarVani for timely dissemination of Ocean Information and Advisory Services that includes Potential Fishing Zone (PFZ) advisories, Ocean State Forecast (OSF), High Wave Alerts and Tsunami early warnings. This includes Multi Lingual SMS, Voice Call / Audio Advisory, Social

Media (Facebook, Twitter, etc.), Email, GTS, Fax, Digital Display Boards, Radio / Television broadcast units, IVRS, Cloud Channels, etc. The app also has facility to provide access to various stakeholders (NGOs, State Fishery Departments, Disaster Management Authorities, etc.) so that they also will be able to further disseminate these ocean information and alerts to the user community.

mKrishi@fisheries (2017) Central Marine Fisheries Research Institute (CMFRI) along with Indian National Centre for Ocean Information Services (INCOIS) and the Tata Consultancy Service (TCS) under the National Agriculture Innovation Project (NAIP) developed mKRISHI@AFisheries. The android based app provides information on Potential Fishing Zone (PFZ), sea surface temperature, weather and the presence of phytoplankton which form the food of several fish species.

Search and Rescue Aid Tool (SARAT) (2017) Indian National Centre for Ocean Information Services (INCOIS) developed SARAT mobile app to save lives and property at sea. It is a versatile tool that can assist with searching for over 64 types of missing objects, including boats, ships and man-over-board.

Aqua App (2017) was developed by two aqua farmers for Andhra Pradesh which helps to improve yields and quality of produce. The apps is developed for both android and iOS systems. It also provides information about the weather, latest information in the aqua industry and market prices, giving the farmers visibility of the complete ecosystem.

Rossi et.al., (2016) proposed a cloud-based infrastructure for fish species recognition called FishAPP for the Android and the iOS mobile operating system, it enables the user to shot pictures of a whole fish and submit them for remote analysis and a remote cloud-based processing system to analyze and to perform classification into predefined fish classes.

m-KRISHI Aqua Service (2015) Marine Products Export Development Authority (MPEDA), developed an android based mobile application called m-KRISHI aqua which will help shrimp farmers in stocking, pond management, feed and water test management and sampling in addition to providing weather forecast and graphical records.

Fisher Friend Mobile Application (2014) MSSRF in partnership with Tata Consultancy Services developed the application which provides vulnerable fishermen immediate access to critical, near real-time knowledge and information services on weather, potential fishing zones, ocean state forecasts, and market related information. The application is available in English, Tamil and Telugu.

Akanmu Semiu *et.al.*, (2013) designed a mobile application called Aqua Friend which is principally usable by fishermen of Malaysia. He also gathered the functional requirements of mobile applications from the fishermen and presented a requirement model which showed the validated functional requirements as fishing tips, real time market price and weather updates.

Amrita and Karthickumar (2016) explained the significance of mobile application in fishing – PFZ, GPS, weather information. Using mobile application, sea fishermen are able to make the job of fishing enjoyable, and easier.

Ayobami and Osman (2013) studied the functional requirements of mobile applications using a Qualitative-based users participatory design methodology and the result of the study reveals that fishermen's ability to get weather updates, water safety information, track of storm and rain intensity, advertizing fish catch, real time market price and general fishing tips are functional requirements of a mobile application for fishermen.

A comprehensive search as reported by Sharma (2018) had resulted in 85 mobile apps in the field of angling, aquaculture, aquarium management, marine fisheries governance, marketing and fish biology. Out of this, 17.65% of the apps were of Indian origin. She has reported in her study that apps for fish farming are few and with software market for precision farming tools expected to grow, there is a need for fisheries organisations to partner with Information Technology providers and come out with sustainable solutions.

2.6. ICT initiatives by Government of India

Digital India is a very good initiative by Government of India. Opportunities provided by the campaign include enhancement of public accountability, reduced corruption, lesser paper work, higher financial inclusion and

efficient public policy implementation. Challenges that may emerge while implementing the project include cultural and linguistic diversity of the country, different internet protocols in different states, lack of coordination among the concerned departments, poverty and illiteracy, cyber security issue. Goswami (2016) in his study focused on the challenges and opportunities in Digital India initiative.

On the official website of Ministry of Electronics and Information Technology (2015) it is stated that the next five years are going to witness extensive creation of broadband infrastructure with numerous services and applications. It also stated that over 70% of the population resides in rural and remote areas. It is important that technologies/products are specifically targeted at this segment of the population on priority basis.

Digital India (2015) is a flagship program of Government of India and has a vision to transform India into a digitally empowered society and knowledge economy. Broadband Highways, Universal Access to Mobile Connectivity, Public Internet Access Programme, e-Governance: Reforming Government through Technology, e-Kranti - Electronic Delivery of Services, Information for All, Electronics Manufacturing, IT for Jobs, Early Harvest Programmes are nine key pillars of Digital India programme.

Danish International Development Agency (DANIDA) report (2012) stated that the benefits of using ICT for governance are enhanced accessibility, affordability and innovation. ICT provides tools and capacity for greater involvement of citizens in enlarging and strengthening the democratic space.

Many ICT-based initiatives have taken place over the last decade and some positive effects have resulted. ICTs are potentially important contributors towards development in India but only through their integration in wider socio-technical interventions.

2.7. Initiatives of Telangana Government in ICT

As per Telangana IT Department (2018) the state has been ranked number 1 in digital transactions based on the number of e-transactions per 1,000

population for the period of June 2, 2014 to December 31, 2017. The Government has launched an m-Governance mobile application called ‘T App Folio’ to help citizens with one point access to government services like MeeSeva services, RTA services, fee payments and bill payment services etc.

Telangana Government is taking a number of initiatives to become leader in the field of ICT. A number of start ups events, hackathons are organized for the youth to develop leadership and culture of entrepreneurship amongst the youth.

It is expected that there will be more number of initiatives by Government and private sector to bring the ICT sector forward. This will be beneficial to other sectors as well like agriculture and fisheries.

3. RESEARCH METHODOLOGY

Research is a scientific and systematic search for pertinent information on a specific topic. It is done with the help of study, experiment, observation, analysis, comparison and reasoning. The procedures used in performing the research operations are called as research methods. Hence, research methodology is a science of studying how research is done scientifically. It is a way to systematically solve the research problem (Kothari, 1990). The present chapter deals with the methodology adopted in carrying out the study.

3.1 Locale of study

For the study, state of Telangana was selected purposively. Telangana is a newly formed 29th state in the south of India. The state is situated on the centre-south stretch of the Indian peninsula the high Deccan Plateau. It accounts for 3.5% of India's total geographical area. It is the twelfth largest state with 112,077 Sq km and the twelfth most populated state with 350.04 lakhs. It is a semi arid area and has a predominantly hot and dry climate. Telangana is bordered by 4 states i.e., Maharashtra, Chhattisgarh, Karnataka and Andhra Pradesh. The state has 31 newly formed districts. The religious makeup of the state is about 85.1% Hindu, 12.7% Muslim, 1.3% Christian and 0.9% others. Telangana's literacy rate is 66.46% with 74.95% and 57.92% male and female literacy respectively as per the 2011 census.

Agriculture is the chief source of income for the state's economy. Hyderabad is its historic permanent capital, with other major cities including Karimnagar, Khammam, Warangal, Nizamabad. The state is one of the top Information Technology (IT) exporting states of India. (Government of Telangana, 2015).

The rationale for selecting Telangana, lies in the fact that the state has a great potential of ₹4,500 crore to ₹5,000 crore in fisheries sector under reservoirs, tank and ponds and ranked 8th in fisheries production with approximately 2,60,010 metric tonnes of production during 2014-15 as per Department of Fisheries (DoF), Telangana (2016).

3.2 Fisheries of Telangana

The state fisheries has a vast fishery potential with 74 reservoirs having water spread area of 1.77 Lakh Ha, 23874 tanks having water spread area of 5.92 Lakh Ha., 474 ponds having water spread area of 781 Ha., and 4818 Kms of rivers and canals. The fishermen population is 27,14,255 and there are 3930 fishers cooperative societies with a membership of 2,39,365. The fisheries sector contributes considerably for food security, nutrition and health, livelihood security to rural population and welfare of fishers. The vision of the state is optimal utilization of natural resources for fish production, promote freshwater aquaculture, supported by infrastructure and trained human resources. (DoF, 2017).

3.2.1 Water Resources and Statistics of Telangana

As per the DoF, Telangana the average fish productivity of tanks is 300 to 400 kgs per ha of water spread area. In reservoirs, the productivity is 30 kg per ha of water spread area as compared to the actual potential of 150 kg per ha. Hence more focus has to be given to reservoir and tank fisheries of Telangana to improve the productivity. Information about the water resources and statistics of fisheries department is presented in table 1 below.

Table 1: Water resources of Telangana

S. No	Description	No.	T.W.S.A. (in Ha.)
1	Reservoirs	74	177607.60
2	Tanks		
A	Departmental Tanks	4324	262187.55
B	Gram Panchayath	19476	155408.69
	Total	**23874**	**595203.84**
3	Aqua culture ponds	**No.**	**Area in Ha.**
		474	781.30
4	Rivers and canal	-	4818 Km

Source: DoF, Telangana Government (2017)

Table 2: Fisheries information of Telangana

Fish seed farms	No.	Fish seed Production (**in Lakhs)**
Government	28	1090 (Fry)
Private	10	1830 (Fingerlings)
Fishermen Cooperative Societies	**No.s**	**Membership**
Fishermen Coop. Societies	3422	2,55,128
Fisherwomen Coop. Societies	396	21093
Fishermen Marketing Coop. Societies	7	3632
District Fishermen Coop. Societies	10	2736
Total	**3930**	**2,82,589**

Total Fishermen Population	27,14,255
Total Rural Households	6,16,577
Total Rural Population	21,98,799
Active fishermen	3,07,234
No. of Fish Markets (Sanctioned)	55
No. of Community Halls (Sanctioned)	244

Source: DoF, Telangana Government (2017)

There is a continuous growth in the sector and fisheries is contributing about 0.6% to the state Gross Value Addition (GVA) in 2015-16 (DoF, Telangana Government, 2016). This is presented in figure 1.

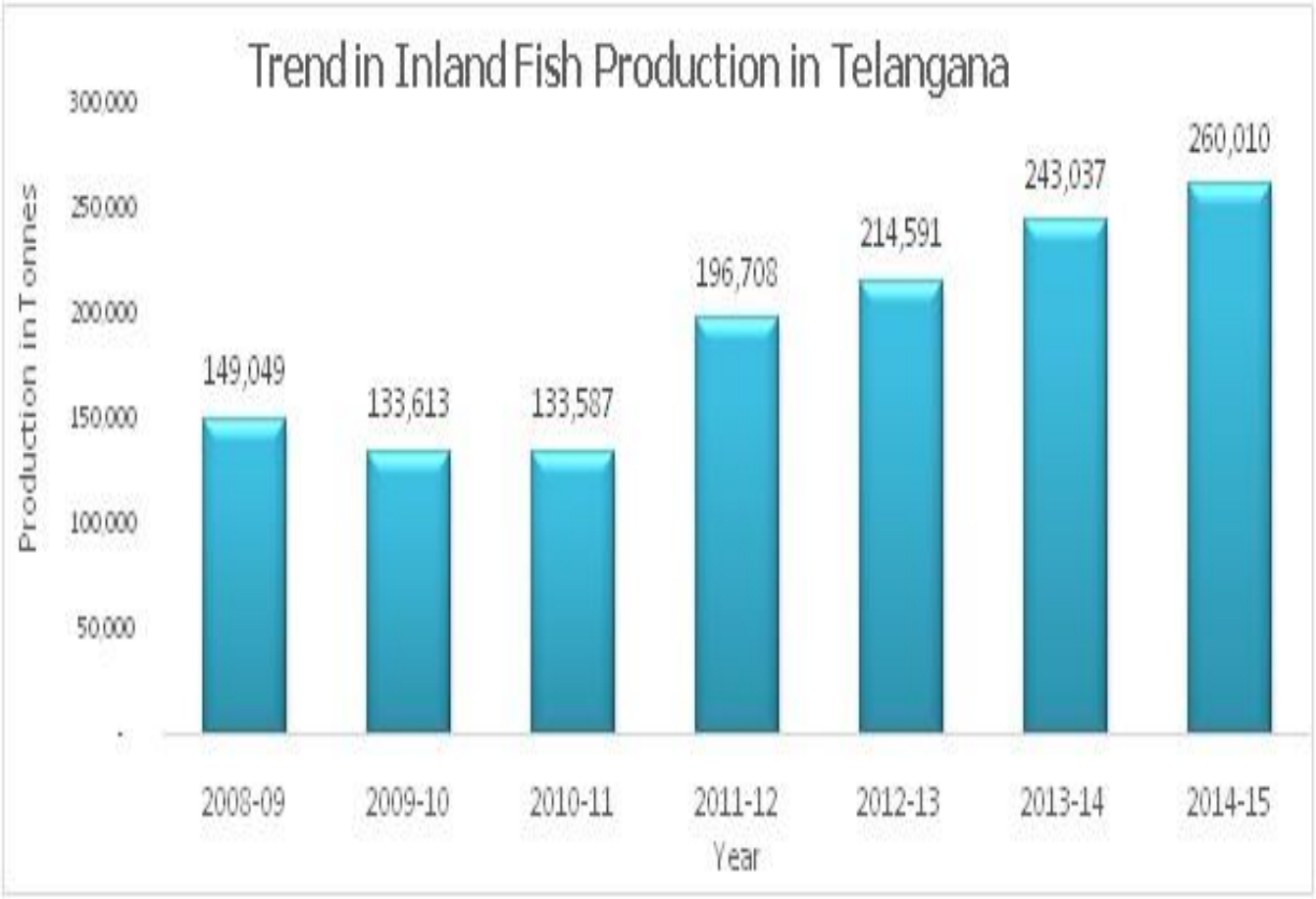


Figure 1: Trends in Inland Fish Production in Telangana

3.2.2 Information on Fisheries of Karimnagar and Khammam

Among all the districts of Telangana, Karimnagar and Khammam are important with reference to fisheries with highest fish and seed production and also relatively higher number of aquaculture farms. Hence these two districts were selected for the present study and its map is presented in figure 2. A total of 60 farmers from these two districts were selected as respondents. Information about fisheries of these 2 districts is given in table 3.

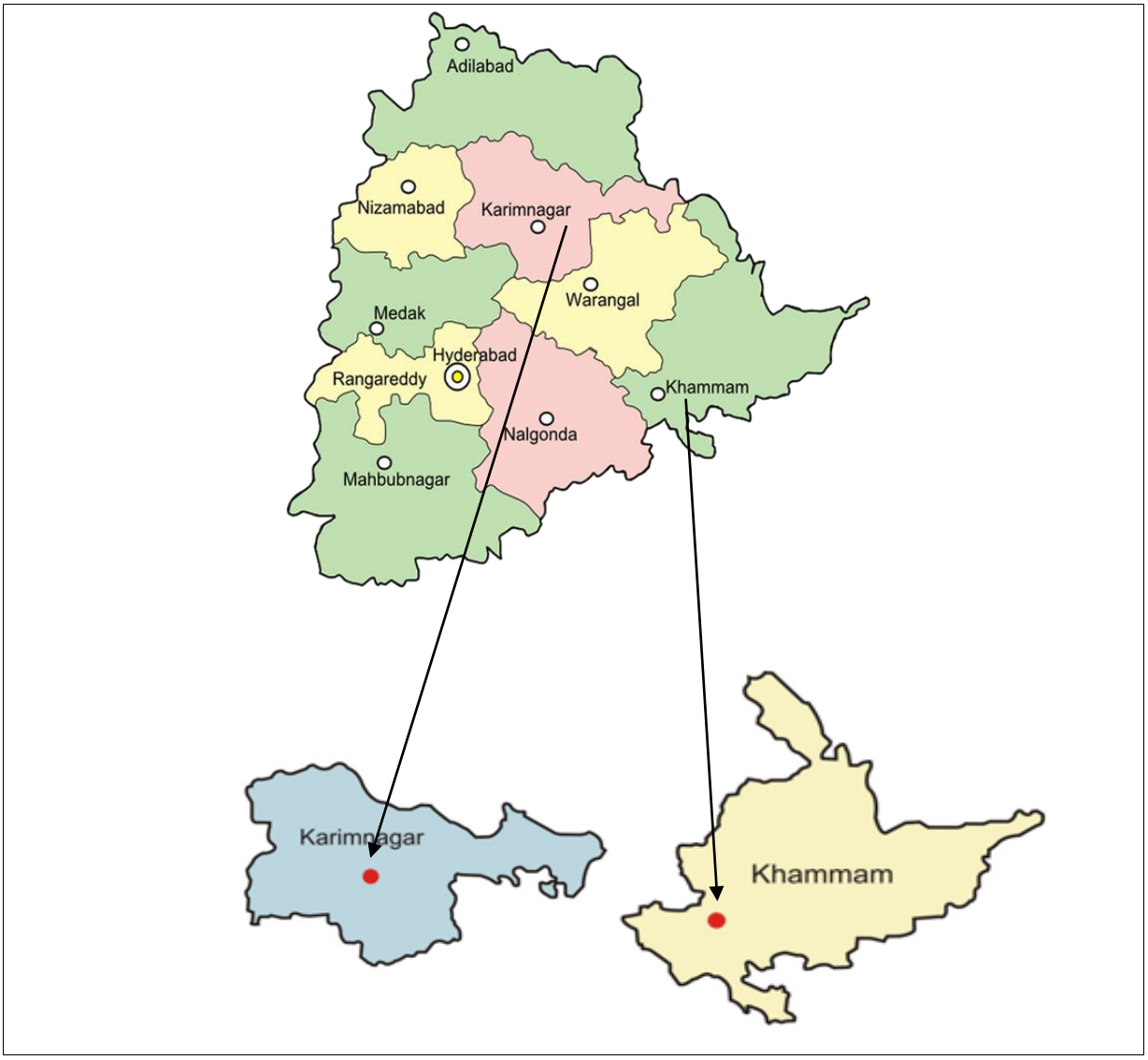


Figure 2: Map of Telangana

Table 3: Fisheries information of Karimnagar and Khammam district, Telangana.

Details	Karimnagar	Khammam
Fish and prawn production (in tonnes)	20841	15567
Fish rearing tanks/ Reservoirs (nos.)	444	1156
Water spread area (in ha)	31,094	26561
Fishermen cooperative societies	155	149
Members	7972	13653

Source: DoF, Telangana (2017)

Sample information is presented in figure 3

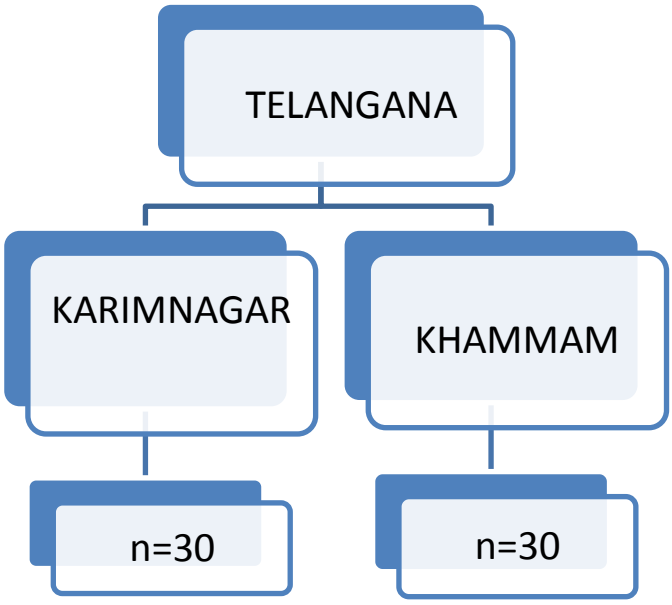


Figure 3: Information about farmers

3.3 Methodology used for first objective

As explained in the introduction, first objective of the study was to conceptualize the features required in the mobile app for fish farmers.

To achieve this objective a questionnaire was designed to elicit information on farmers' profile like age, income, fisheries experience, farm size, species cultivated, production and constraints faced. (Annexure 1)

For gathering information about mobile phones enquiry was done regarding usage of phones/smart phones by farmers, most common apps available/downloaded by them, frequency of usage of these apps, awareness/usage of any apps related to agriculture/fisheries, sources of information related to fisheries and their attitude towards app on fisheries. (Annexure 1)

After collecting profile of farmers and information on mobile phones, percentage analysis was done and enquiry was done if there was a need of a mobile app having fisheries related information for the farmers.

All farmers reported that they were interested in using a mobile app which provided information on fisheries which they were looking for. They reported that they need information on several parameters which were noted down. They also reported that it would be better if at all the steps of app development they are

consulted so as to have the features which will be useful for them. Thus a decision was taken to develop a mobile app by participatory approach i.e., by involving them in the process of app development.

On basis of the positive response, an interview schedule was designed which had open ended questions in order to collect what specific features and information heads they would be interested to be included in the mobile app (Annexure 2).

Farmers reported that they needed information on culture practices, water quality management, feed management, bacterial, parasitic, viral, fungal and environmental diseases, fish seed suppliers and fish markets. These heads were grouped in to 6 heads. Simple percentage analysis was done to analyse Yes/No response for inclusion of these heads.

After this a discussion was held with 25 experts with an objective of conceptualizing the features required in the mobile app for fish farmers. Constitution of the experts was as follows: Advisory committee Scientists Dr. Arpita Sharma (Principal Scientist) and Dr. S.N. Ojha (Principal Scientist) from Social Science Discipline, Dr. K. Pani Prasad (Principal Scientist) from Aquatic Animal Health Management discipline, Dr. Rama Sharma (Senior Scientist) from Statistics discipline, Dr. Modadugu Vijay Gupta, World Food Prize Laureate and Expert in Fisheries Sciences, Two Scientists Dr. G. Balaji and Dr. Prabhakar working in Krishi Vigyan Kendra, Telangana, 2 Subject Matter Specialists form Fisheries Shri. D. Narshivudu and Shri. P. Ramesh working in Krishi Vigyan Kendra, 1 Fisheries Development Officer Shri R. Avinash from Department of Fisheries, Telangana and 15 Key Informant farmers from Telangana.

Experts were shown the list of features suggested by the farmers and these features were discussed for which all experts agreed. But in addition, the experts suggested that information on additional features should be added. These additional features were Cage culture, Recirculatory Aquaculture System, Fish cum Agriculture, Fish cum Horticulture, Fish cum pig, Fish cum duck, Fish cum poultry, Fish cum cattle, Fishermen cooperative societies, Fishermen population and Farm registration guidelines.

Following this, all features suggested by Farmer Group and the Expert Group were compiled. As now the list had many features, a decision was made to do a Relevancy Test for the compiled features.

Relevancy in this study is defined as “The degree to which something is related or useful”. To conduct a relevancy test Farmers and Experts were asked to rate each listed feature on a four point scale of Relevancy (Annexure 3). The points were ‘High Relevant’ with score 4, ‘Relevant’ with score 3, ‘Moderately Relevant’ with score 2, and ‘Less relevant’ with score 1. All features which had an average score of more than 2 were included in the prototype of mobile app. Features with average scores less than 2 were few and were not included. The features included were grouped in 6 broad heads. These were Culture practices, Management practices, Post harvest practices, Modern farming techniques, Telangana information and Buy and Sell. Based on the 6 broad information heads, decisions were taken about the subheads as follows by the advisory committee.

Culture Practices: Carp culture, Murrel, Tilapia, Fresh water prawns and GIFT tilapia, Pangassius culture in cages were included.

Management Practices: Under this head, Water quality, Feed and Health management were included.

Post Harvest Practices: Handling, Transportation, Processing, Preparation of value added products were included.

Modern Farming Techniques: Cage Culture, Recirculatory Aquaculture System and Integrated Fish Farming were included.

Telangana Information (T-fish info): In this the registration guidelines for fresh water aquaculture, fish seed suppliers, schemes, fish markets were included.

Buy or Sell: In this a form was given to post the details of the person or farm who want to buy or sell, type (fish or prawn), variety, size or count, price and quantity they want to buy or sell and the dates till which they want to buy or sell the farm produce. The posted details of the buyer and seller will be displayed under different heads of buyer posts and seller posts respectively.

Relevancy Test was done again for each sub heads (Annexure 3). All subheads which had an average score of more than 2 were included in the prototype of mobile app. Features with average scores less than 2 were few and were not included.

Statistical analysis

3.3.1 Mann- Whitney U test: This test was performed to test the hypothesis if there was a difference between the relevancy scores given by farmer group and expert group and conclusions were made as per the result. The hypothesis were:

H_0 = There is no significant difference between relevancy scores of farmer group and expert group.

H_1= There is significant difference between relevancy scores of farmer group and expert group

All the scores are normalized using the formula:

$$\text{Dimension Value} = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

3.3.2 Kendall's coefficient of concordance: This was calculated to check if the farmers and experts were in agreement. This non- parametric test was used to assess the agreement among the raters i.e., farmers and experts. Kendall's *W* ranges from 0 (no agreement) to 1 (complete agreement).

$$W = \frac{\sum_{i=1}^{n} (\dot{R}_i - R)^2}{N\,(N^2-1)/12}$$

Where,

W = the degree of association among farmers and experts

R_i = average of ranks assigned to the features

R = the average of ranks assigned across all features

N= number of features

k= number of farmers or experts

$N(N^2-1)/12$= Maximum possible sum of the squared deviations, i.e the numerator which would occur if there were perfect agreement among the k farmers or experts.

3.4 Methodology used for Second Objective

The second objective of the study was to aggregate the scientific information for relevant features to be included in the app.

To achieve this objective it was necessary to collect information for each feature and its sub head. There were various sources of information available in books/websites/articles/research papers. It was a challenging task to collate only relevant information and then rewrite the information in a simple language which farmers would be interested in.

Thus first for each head and subhead information was aggregated. The information sources were papers/books/organizational websites like Food and Agriculture Organization (FAO), National Fisheries Development Board (NFDB), ICAR institutes like Central Rice Research Institute (CRRI), Central Institute of Freshwater Aquaculture (CIFA), Krishi Vignan Kendra (KVK), Central Inland Fisheries Research Institute (CIFRI) etc. The collected scientific information under each head, was collected from different sources and the same was written in a simple language. It was checked for its content by the advisory committee. Grammarly software was used for checking for plagiarism and grammar. The percentage of plagiarism was found negligible for the contents and suggested corrections were done for grammar.

Once the contents were finalised the same was validated by writeshop process in three drafts by advisory members. A writeshop is a process where participants from diverse groups along with illustrators produces a publication in a very short time. Writeshops are an excellent way of bringing together experts with different perspectives on the subject. Thus written materials can be produced in a short time. With suitable preparation, it was thus possible to produce content material ready for the app at the end of the Writeshop itself. The process enabled

comments and revisions from participants which is said to be analogous to the peer review. (Sharma *et.al.,* 2017)

Before the process of writeshop was done, it was thought that photos available on internet would be used by providing credits for each photo. But later this decision had to be changed. Decision was taken to include relevant hand drawn illustrations as well as photos taken from the field with due credits. Few photos which were not available in the field conditions were to be taken from internet with due credits.

Thus artist Shri. S.K. Sharma Technical Officer from ICAR-CIFE, Mumbai was explained about the illustrations to be made. Illustrations were first made as pencil drawings. These were shown during the second draft discussion of the contents during the writeshop process. These were further improvised as per the inputs of the experts. Based on all inputs, pen drawings were made and scanned and included in the contents. A few photos were taken from internet for fish diseases so that farmers can easily identify the symptoms of disease. In the last draft of the writeshop process contents along with illustrations and images were finalized. Thus in this manner scientific information for relevant features were aggregated for the mobile app prototype. Decisions were also taken to have different screens for each information head. After this content validity was measured by the experts regarding how essential each information head/content was (Annexure 4)

3.4.1 Measurement of Content Validity

Content validity is essentially a method for gauging agreement among raters or judges regarding how essential a particular item is. (Lawshe,1975). If more than half the experts indicate that an item is essential, that item has at least some content validity. Greater levels of content validity exist as larger numbers of experts agree that a particular item is essential. Content Validity Ratio (CVR) values range from +1 to -1. CVR across items was used as an indicator of overall test content validity.

Content Validity Ratio Formula

The content validity ratio is calculated using the formula given below

$$CVR = (ne - N/2)/(N/2)$$

Where,

CVR = content validity ratio
ne = number of experts indicating "essential"
N = total number of experts

Through this process content validity was established.

3.5 Methodology used for Third Objective

The third objective of the study was to develop a mobile app prototype.

To achieve this objective, a course on Android Application Development was done during the training period from 21-8-17 to 16-10-17 in Hyderabad. Based on the skill achieved from internship the mobile app was developed. First wire framing and story board was created based on the selected features, as this helps as the back end structure of the app. Once the skeletal frame work was designed it was decided to develop the app in the software.

Decision was taken to develop the application using the Android Studio IDE an interactive environment for developing the android apps with support of JDK-8 (Java Development Kit) installed in the developing computer system. Android studio provides a facility of in built gradle, app preview, testing and compiling of the app etc. Every single screen of the application is considered as activity to the user, which is the important component of the application. The major steps used to develop the prototype were as follows.

- A new project was created with the minimum SDK (Software Development Kit) version of API 17 : Android 4.2 (Jelly Bean).
- The Splash Activity or the welcome screen has been designed in the XML which is the first screen in the app and has been implemented using JAVA programming language.

- The main activity has been designed using the dashboard to make it attractive and user friendly also. All the main heads are displayed in main activity using the dashboard design.
- The subheads under the main heads are displayed using the Custom layout ListView to display the image and Text.
- The images that are to be used in the app are saved in the drawable folder.
- The text that has to be placed in the app is saved in the strings.xml file.
- Text Views and Image Views are used in the XML to display the text and images.
- All the activities and the logics of the application are implemented by the JAVA programming language. There are several classes, packages, interfaces in the android SDK manager that are used in the application development.
- The mobile application is connected with the Firebase database to store and maintain the input data by the users.
- The fire base provides libraries that will allow the data base to integrate with the android applications. These external libraries are added in the gradle and synced to use the services provided.
- Fire base storage library is used to store the uploaded images by the user. The stored data and images are retrieved using the Recycler Views and Card Views.

Thus a prototype of this app was developed using the above mentioned method. The prototype was tested at four levels by CIFE committee with scientists from genetics, aquaculture, post harvest technology, then by the fisheries professionals from aquaculture, pathology and social science, then by the mobile app developer and finally by five progressive fish farmers in the field. The feedback provided in field conditions was positive and few modifications suggested were included.

In order to take feedback of the mobile app prototype, the prototype was displayed by screen mirroring on the screen using cast screen app to 30 young fisheries professionals comprising 17 males and 13 females to take initial feedback and review of app.

Feedback was taken using a questionnaire which consisted parameters like design, information, functionality and others (Annexure 5). Design included color, font, imagery, simplicity, visual, clarity of icons, layout and interface. Information included quality, quantity, technical content, relevant, appropriate, clarity, ease of learning. Functionality included performance, navigation, ease of use, gestural design, consistency, name of the app. others included information on whether the app is likely to increase awareness, knowledge and motivate people to take up fish farming. The respondents were asked to rate the various parameters on a 3 point scale i.e., very good with score 3, good with score 2 and fair with score 1. Some parameters were rated as yes with score 3, no with score 2 and undecided with score 1. Average of all the scores was done to analyse the feedback scores. Finally decisions were made to decide name of the app based on suggestions provided by the respondents.

4. RESULTS AND DISCUSSION

4.1 Conceptualization of features required in mobile app

The first objective of the study was to conceptualize the features required in the mobile app for fish farmers. To achieve this objective; i.) profile of farmers, ii.) information on usage of phone by farmers and iii.) attitude and need for a mobile app were studied in addition to iv.) conceptualizing the features required in the mobile app. The results are presented below.

4.1.1 Profile of farmers

To achieve this objective first the profile of the 60 farmers was studied through a questionnaire from which information was collected about their age, income, fisheries experience, farm size, species cultivated, production and constraints faced. The results are presented in figures below.

Age

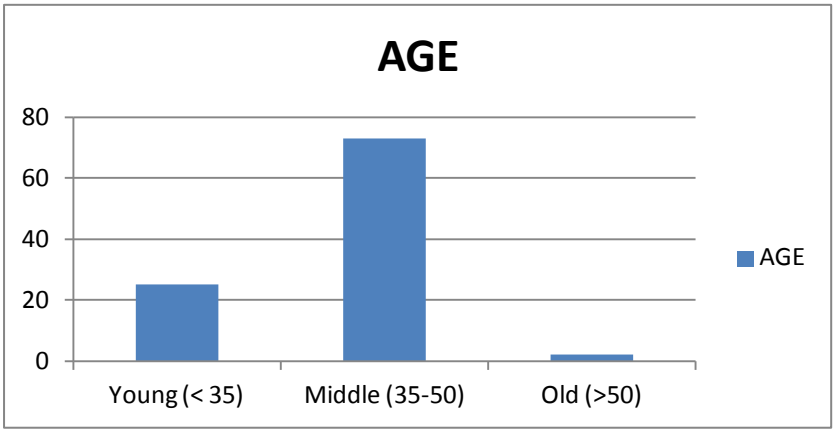


Figure 4: Age profile of farmers

The farmers' age ranged from 35 to 50 years and average age was 42 years. Majority of the farmers (73%) were found to be in the middle age group (35-50), followed by young age group (25%). Only few farmers were found to be in the old age group, constituting 2% of the total farmers.

Income

Information on annual income (in Rupees) of the farmers was collected and is presented in figure 5.

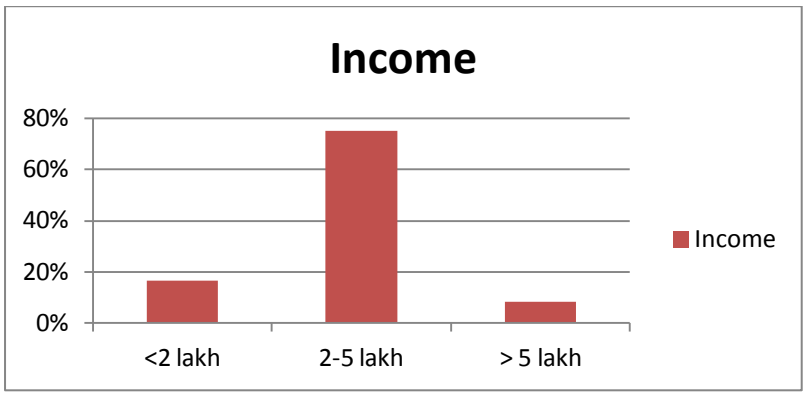


Figure 5: Income of farmers

Average income of farmers was found to be Rs. 2.5 lakhs per annum with 75% of them earning between Rs. 2-5 lakhs. Range of income was Rs. 1,00,000 to Rs. 10,00,000/- They are involved in fisheries activities during culture period i.e. about 8 months.

Fish Farming Experience

Information on fish farming experience was collected from the farmers and this is presented in figure 6.

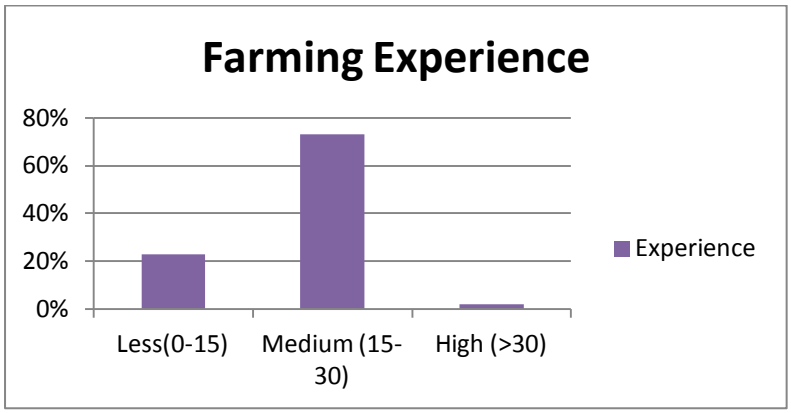


Figure 6: Farming experience

Average fish farming experience was found to be 22.5 years with a range of 0 to 32 years. Maximum farmers had fishing experience in the range 15 - 30 years.

Pond size

Information on pond size was collected from the farmers and this is presented in figure 7.

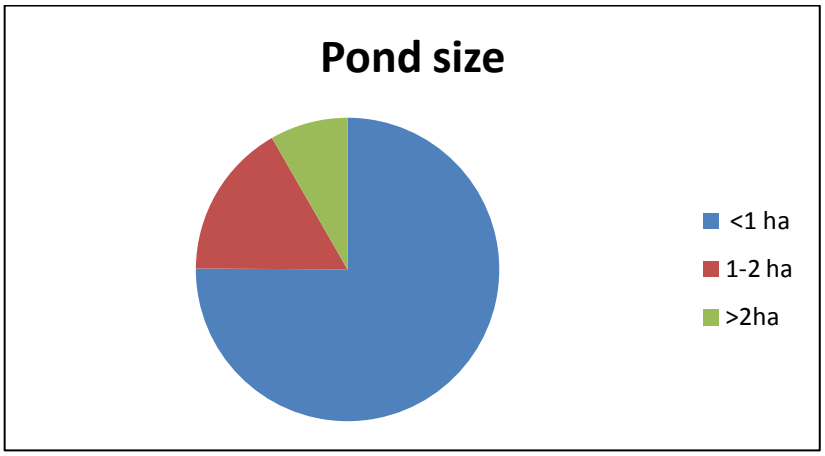


Figure 7: Pond size

Majority of the farmers (75.1%) had pond size of <1 ha, 16.6% of the farmers had 1-2 ha pond size and 8.3% of the farmers had >2 ha pond. Average size of the farm was found to be 0.12 ha.

Species cultivated and fish production

As reported by farmers the fish species which were cultured by them, were Catla, Rohu, Mrigal, Common carp, Grass carp, Murrel and Fresh water prawn. Majority of the farmers reported that the fish production is around 1-2 tonnes per acre.

Constraints faced by fish farmers

The major constraints faced by the farmers as reported by them were

- Lack of scientific knowledge on culture management and modern farming methods
- Lack of knowledge on fish processing

- Lack of knowledge on feed management
- Availability of quality fish seed of different varieties
- Low fish yields
- Lack of marketing facilities

Kumari and Arpita Sharma (2015) also have reported similar kind of constraints by aqua farmers.

4.1.2 Information on usage of mobile phones

With reference to the information on mobile phones enquiry was done regarding the usage of smart phones by farmers, most common apps available or downloaded by them, frequency of usage of these apps, usage of any apps related to agriculture/fisheries, sources of information related to fisheries, attitude towards app on fisheries and need of app on fisheries.

Usage of smart phones and most common apps

Information was collected regarding usage of smart phones by farmers, most common apps available or downloaded by them. This information is presented in figure 8.

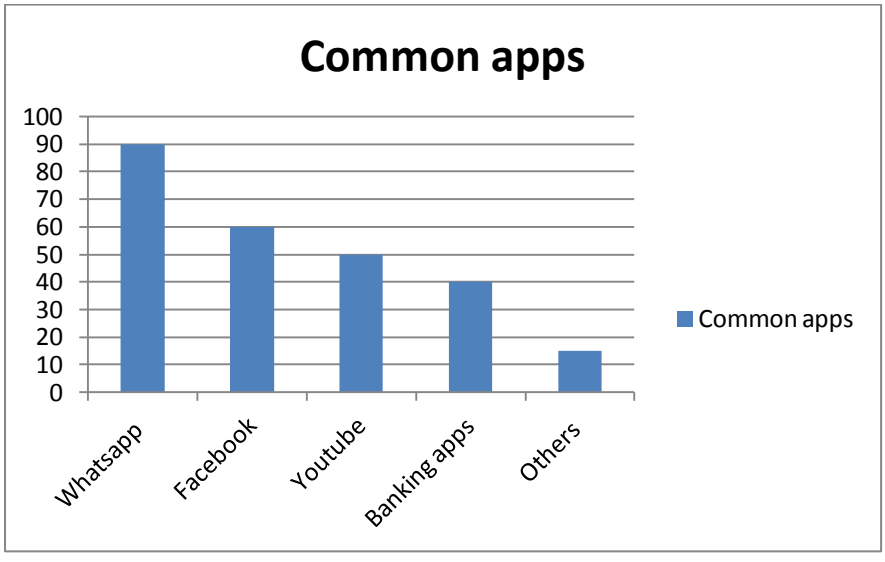


Figure 8: Common mobile apps used by farmers

It was found that all the farmers used smart phones. Most common apps used by farmers were Whatsapp, Facebook, Youtube and SBI personal banking app.

Frequency of usage of apps

Frequency of usage of apps was categorized into three groups i.e., More frequently, frequently and less frequently. This information is presented in figure 9.

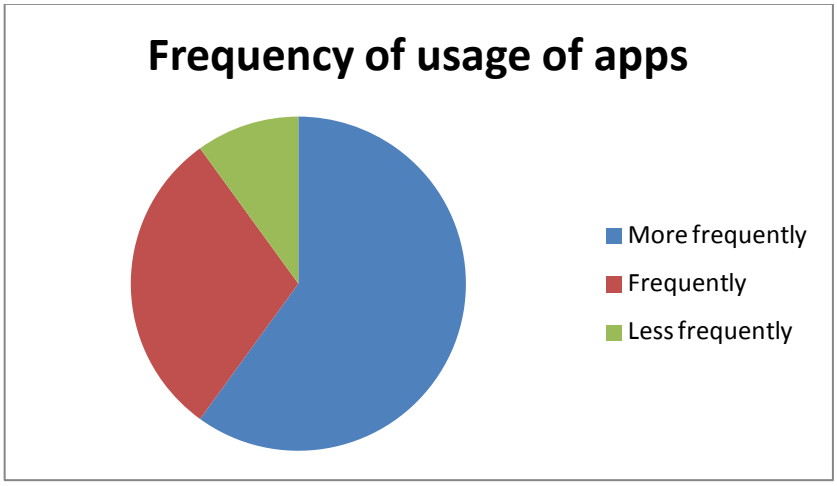


Figure 9: Frequency of app usage

It was found that 60% of the farmers use the apps more frequently followed by 30% using frequently and 10%of them use less frequently.

Usage of apps related to agriculture and fisheries

Information was collected regarding usage of apps related to agriculture and fisheries by the farmers. It was found that no farmers used any agriculture/fisheries related app and were not even aware of any such app. Corroborating this an empirical research reported in the field of agriculture have shown that a very small number of apps is available in relation to the significance of agriculture worldwide. The study proposed that the development of mobile apps should support agricultural activities by providing accurate, certified and validated content and services that would take into account the peculiarities of geographical areas. Also, the successful spread of mobile apps requires the active involvement of public agencies and ministries. (Constantina *et.al*., 2016)

Sources of information related to fisheries

Information was collected regarding sources of information related to fisheries. Farmers reported that Internet, Krishi Vigyan Kendra and officials from

Department of Fisheries (DoF) were the source of information. However, other researches like (Rajak and Sharma, 2005) have reported that the source of information are fish feed companies. In this study however, feed companies were not a source of information.

Attitude and need of mobile app in fisheries

All the farmers showed positive attitude towards the mobile app in fisheries. They responded in positive that there is a need of a mobile app which provides any information on fish culture, post harvest, marketing, cage culture, integrated farming etc. All the farmers reported that this kind of app will be highly beneficial for them. Kafetzi (2015) too have reported that farmers use less apps related to farming but show interest.

4.1.3 Features to be included in mobile app

Based on the positive response from farmers, an interview schedule with open ended questions was designed to collect specific features which they would like to be included in the app and the information heads to be included. Responses were collated and conceptualizing of the information heads/features was listed. Simple percentage analysis was done and this is presented in table 4.

Table 4: Responses of farmers for the features to be included in mobile app

Sl.no	Feature	Percentage of farmers
1.	Culture Information	100
2.	Disease management	100
3.	Market facilities	91.6
4.	Fish seed suppliers	91.6
5.	Feed management	93.3
6.	Water quality management	100
7.	Schemes	90

From table 4, it is clear that almost all the farmers were in agreement towards the inclusion of above mentioned features in the mobile app.

Following this, a discussion was held with expert group (expert group composition has been explained in methodology chapter) where thefeatures listed by farmers were presented.

Opinions were taken from experts to add more features if required. Members of the expert group agreed to the features listed by the farmers. However to make the mobile app more comprehensive, they added more features namely, Registration guidelines, Modern farming techniques, Water quality management, Buy and sell option, Processing, Transportation, Value added products, Fisheries statistics, and Water resources.

The features listed by farmers and expert group were clubbed under different heads as presented in table 5.

Table 5: Features listed out by farmers and expert group

Sl.no	**Farmers**	**Experts**
1.	Culture information	Value added products
2.	Disease management	Modern farming practices
3.	Fish seed suppliers	Buy and sell
4.	Market facilities	Processing
5.	Feed management	Transportation
6.	Water quality management	Fisheries statistics
7.	Schemes	Water resources
8.		Registration guidelines

It is clear from table 5 that a total of 15 features were suggested by experts and farmers. To make the findings more robust Relevancy test as explained in materials and methods section was done thereafter. Relevancy of each feature was scored on a 4 point scale. Results are presented in table 6.

Table 6: Relevancy scores for mobile app feature

Features	Farmers	Experts
Imc culture	4	4
Composite culture	4	4
Murrel culture	3.9	4
Tilapia	3.9	4
GIFT tilapia (Cage)	3.5	3.7
Pangasius (Cage)	3.5	3.7
Fresh water prawn	3.8	4
Water Quality management	4	4
Feed management	4	4
Bacterial diseases	4	4
Viral diseases	4	4
Fungal diseases	4	4
Parasitic diseases	4	4
Environmental diseases	4	4
Handling	3.5	3.8
Transportation	3.8	4
Drying	3.5	3.9
Salting	3.5	3.9
Freezing	3.5	3.9
Smoking	3.5	3.9
Canning	3.4	3.8
Fish balls	3.6	4
Fish cutlet	3.6	4
Fish fingers	3.6	4
Fish pickle	3.8	4
Prawn pickle	3.8	4
Site selection (cage culture)	3.4	3.7
Species selection (cage culture)	3.4	3.7
Cage maintenance	3.4	3.7

Buy or sell	4	4
Water quality (RAS)	3.5	3.7
Feeding (RAS)	3.5	3.7
Integrated Fish Farming	3.7	4
Registration guidelines	3.5	4
Fish markets	4	4
Seed suppliers	4	4
Water resources	1.5	1.8
Fishermen population	1.4	1.5
Fishermen cooperative societies	1.5	1.7
Fish production	1.4	1.5

It is clear from the table 6 that features namely IMC culture, composite culture, murrel culture, tilapia culture, GIFT tilapia and pangassius culture in cage, fresh water prawn culture, bacterial diseases, parasitic diseases, fungal diseases, viral diseases, environmental diseases, water quality management, feed management, fish seed suppliers, market facilities, registration guidelines, cage culture, recirculatory aquaculture system, integrated fish farming, buy and sell, handling, transportation, value added products, processing scored between very high to medium relevancy. However fish production, fishermen cooperative societies, fishermen population and water resources scored low on relevancy. Accordingly, decision was taken to include those features which were scored 2 and above. No such study on features to be required in a mobile app for fish farming could be found in the literature so the same could not be corroborated.

Based on these 21 features 6 broad heads were finalized. These features were as follows:

- Culture practices
- Management practices
- Post harvest practices
- Modern farming techniques
- T- fish info
- Buy and sell

In order to know if there was a difference between relevancy scores given by farmers and experts Mann Whitney U test was performed.

The (P) value was 1.00 and thus conclusion was made that there is no significant difference between the relevancy scores of farmers and experts. The results are given in table 7

Table 7: Mann Whitney *U* test results

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of RELEVENCY_SCORE_CODED is the same across categories of RESPONSE.	Independent-Samples Mann-Whitney U Test	1.000	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Kendall's coefficient of concordance was also calculated to check if all the judges (experts and farmers in this study) were in agreement or not. The results of this are presented in table 8.

Table 8: Kendall's coefficient of concordance

Correlations

			farmers	Experts
Kendall's tau_b	Farmers	Correlation Coefficient	1.000	.807**
		Sig. (2-tailed)	.	.000
		N	29	29
	Experts	Correlation Coefficient	.807**	1.000
		Sig. (2-tailed)	.000	.
		N	29	29

**. Correlation is significant at the 0.01 level (2-tailed).

It is clear from the table 8 that the farmers and experts were in agreement with each other as well as amongst the group.

The next step was to include the sub heads in each of the features which were included. For each subhead the list was prepared and after discussion with Experts and Farmers these were listed. Relevancy test was done for each subhead by farmers and experts and all which scored above 2 were included as a feature and respective subheads. The relevancy scores for all the listed subheads was more than 2 as presented in table 4 and thus in this way conceptualization of features required in the mobile app prototype was performed through a participatory process i.e., by involving farmers at each level. The features and the sub features in the mobile app prototype are as follows

1. Culture practices
    - Carp culture
    - Composite culture
    - Murrel culture
    - Tilapia culture
    - GIFT tilapia in cage
    - Pangassius in cage
    - Fresh water prawn culture
2. Management practices
    - Water quality management
    - Feed management
    - Health management
3. Post harvest practices
    - Handling
    - Transportation
    - Processing
    - Products
4. Modern farming techniques
    - Cage culture
    - Recirculatory aquaculture system
    - Integrated fish farming

5. T- fish info
    - Registration guidelines
    - Fish seed suppliers
    - Fish markets
    - Schemes
6. Buy or sell
    - Seller posts
    - Buyer posts
    - Add post

4.2 Aggregation of scientific information for relevant features to be included in the mobile app.

To achieve this objective contents were aggregated and finalized as explained in the chapter of materials and methods. The same is presented in text below along with the illustrations. The finalized content with illustration are as follows:

4.2.1. Culture practices

Under the major head Culture Practices, the content was validated on IMC culture, Composite culture, Murrel, Magur, Tilapia, GIFT tilapia, Pangassius and Fresh water prawn.

4.2.1(a) Indian Major Carp / Carp culture

In carp culture information on site selection, prestocking, stocking and post stocking are given

Site selection : Land should be non rocky with 2 meter deep soil. Land should be level or gently sloping. Physical quality of soil -Loamy or clay loamy. Soil fraction is about 90% of the whole soil, stone and gravel Not exceeding 10%. pH should be near neutral - 6.5 to 7.5. Total nitrogen contents of soil - 30-50 mg/ 100 gm soil. Total phosphorous contents - 6.0- 16 mg/ 100 gm soil. Organic carbon - 1.0- 2.0%. Rate of fall in water level- Should not be less than 1 meter per annum in pond. Water table -Should not be below the pond bottom if soil is porous. Water supply -There should be a source of perennial water supply nearby. Biological

productivity- Average plankton production per m3 should be 1-2 ml in plankton net test tube.

Prestocking: Weeds and unwanted weeds have to be removed from the ponds. Mahua oil cake is an effective fish toxicant at 200 -250 ppm in 3-10 hrs. Toxicity of this in water lasts for 20-25 days. Hence no spawn stocking should be done before at least 30 days. Anhydrous ammonia at 20-25 ppm is also very effective and effect last for 30-35days. Bleaching powder at 25-30 ppm is also equally effective in killing fishes. Toxicity lasts for 7-8 days. 300- 400kg/ha of lime is sufficient for rearing pond based on pH. Cattle dung can be applied at 2500kg/ ha in monthly intervals and the first dose has to be applied 6-7 days after liming and 15 days prior to stocking fry in the pond. Di ammonium phosphate (100 kg/ha) and single super phosphate (100 kg/ ha) can be applied in monthly intervals (totally three times) to increase productivity. The first installment generally applied after 2-3 days of stocking and subsequent installments after one month.

Stocking: The proportion of catla, rohu and mrigal can be 2:5:3. Generally the government supplies 22-25mm fry. These must be grown up to 75-100mm in 20mx5mx1m size ponds for 2 months. Then the fingerlings are stocked @7000/hac. The photo used for seed stocking is given in figure 10.

Figure 10: Seed stocking

Post stocking : Feeding should be followed after the stocking of fish seeds.Initially only groundnut oil cake Juice for one week at 10 kg per Ha then supplementary feeding at the ratio of 1:1 should be prepared by Rice Bran and oilcake (Mustard oil cake or Ground nut oil cake) and if possible vitamin-mineral

mixture can be added. Feeds are supplied in the pond in powdered form at the beginning and then in a pellet form after 2 months of stocking. The feed should contain 25-30% protein , 3-5% with dietary energy at 3.5 -4.0 Kcal/g of feed. Feed should be given at the rate 2-3% of the body weight. Feed must be broadcasted in the pond during the first two months of stocking, then the feed is given in a feeding basket/tray/basket fixed at two positions. Feeding has to be applied in a fixed time of the day. Mostly morning hours feeding good. Fish attains table size (750g to 1 kg) within one year of growout period. Based on demand, harvest is done by gill net and Final harvest is done by drag net either during summer months when the water level drops or during monsoon depending on the demand of the market.

4.2.1(b) Composite fish culture

In composite fish culture the content is added on prestocking, stocking, poststocking and harvesting

Pre stocking: The soil should be water retentive. Adequate supply of water is assured and that the pond is not in a flood prone area. Removal of weeds by Manual/Mechanical or through Chemical means. Removal of unwanted and predatory fishes and other animals by repeated netting or using mahua oil cake @ 2500 kg/ha metre or by sun drying the pond bed. Lime is used to bring the pH to the desired level. The normal doses of the lime desired ranges from 200 to 250 Kg/ha. The pond is required to be filled with canal water or water from other sources after liming in case it is a new pond. Organic manure to be applied after a gap of 3 days from the date of liming. Cow dung @ 5000 kg/ha or any other organic manure in equivalent manurial value. Inorganic fertilisation to be undertaken after 15 days of organic manuring.

Stocking: The pond will be ready for stocking after 10-15 days of application of fertilizers. Fish fingerlings of 50- 100 gm size (approx) should be used for stocking @ 7000 nos. per hectare. However, if fingerlings of smaller size are used, suitable allowance may be made accounting for mortality. Depending on availability of seed and market condition, stocking can be of 3, 4 or 6 species combination in the following ratio.

Species combination:

3 species - (catla:rohu:mrigal) - 2:5:3

4 species - (catla:rohu:mrigal:common carp) -2:4:1.5:2.5

6 species - (catla:rohu:mrigal:silvercarp:grass carp:common carp): 1.5:2:1.5:1.5:1.5:2

Post stocking: Fishes can be fed with a mixture of rice bran and oilcakes in the ratio 4:1.Groundnut oil cake(GNC) and cotton seed oil cake can be mixed in equal proportions and fed to the fish and is reported to give almost the same growth rate as that of GNC. The feed should be placed on a feeding tray or in feeding bags and lowered to the pond bottom or it can be dispersed at the corners of the pond. After some time, the fishes will get used to this type of feeding and aggregate at the same place at particular time for regular feeding thereby reducing the feed losses. The recommended feeding rate is 5 - 6 % of the body weight up to 500 gm size of fish and then reduced to 3.5% of body weight from 500- 1000 gm size. The feeding is supplementary in nature. Inorganic fertilization may be done at monthly intervals alternating with organic manuring. However, the monthly rate of fertilization will depend on pond productivity and the growth of the fishes. It should be ensured that excess fertilization does not take place which may result in eutrophication.

Harvesting: Harvesting is generally done at the end of 1st year, when the fishes attain marketable size of 800 gm to 1.25 kg. With Proper management a production of 4 to 5 tons/ha can be obtained in a year. Harvesting is done by partial dewatering and repeated netting. The photo used for harvesting is given in figure 11.

Figure11: Harvesting

4.2.1 (c) Murrel culture

In murrel culture content was added on pond preparation, nursery, growout culture and feeding

Pond preparation: Murrel culture is oriented to shallow waters of 2-3 feet. For effective management, the pond should not be more than 0.1-0.2 ha in size. In case of perennial ponds, care should be taken to remove or to kill existing predatory fishes by application of mahua oil cake @ 2500 kg/ha meter of water area. If the bottom silt is very heavy, lime treatment @ 300 kg/ha will reduce toxicity in the pond. The presence of optimum oxygen value in water (5 to 6 ppom) leads to higher growth rate. Murrels usually breed, in tanks, rivers and swampy beels during April to June with the onset of monsoon. The seed are collected by operation of small meshed cast net. Fry and fish lets of air-breathing fishes are generally transported without ,oxygen packing. Presence of weeds in air-breathing fish culture pond not only provides protection from poachers but is also conducive to the occurrence of a variety of insects to be utilized as food for these fishes. Limited presence of water hyacinth in about 1/3 portion of the water surface helps in controlling algal bloom.

Nursery: The fry rearing phase in murrels is a littile complex due to cannibalism. The cannibalism can be reduced with sufficient supplementary feeding. Nurseries having a water column of 50 cm are stocked with 0.2 to 1.5 million fry/ha. Prior to stocking, manuring is done with cowdung alone @ 500 kg/ha. Sometimes soap oil emulsion has also been applied to keep the nurseries free from insects. Murrels have to be trained to accept artificial feed in the nursery ponds before stocking. The fry and fingerlings of Murrel have been found to be affected with dropsy and fin rot in nursery. This can be controlled by giving a bath in 1% acriflavin or 0.3% formalin solution for about 10 minutes or till the fry and fingerlings show sign of distress. The operation may be continued for a week or so. The parasites most commonly seen in murrels are Lernaea sp. and Argulus ,sp. and can be controlled by application of lime @ 300 kg/ha, Sanitizer BKC, Formalin and iodine, chemical Deltametrin @ 100ml/acre.

Growout culture: Giant murrel may be stocked for monoculture @ 15,000 fingerlings/ha the stripped and spotted murrels @ 20,000 fingerlings/ha and 25,000 fingerlings/ ha respectively for monoculture. For mixed culture, the latter two

species may be stocked @ 20,000 fingerlings/ha in the ratio of 1 : 1. Uniform size fingerlings raised in nurseries and trained to accept artificial feed are recommended for stocking. Before stocking, the fingerlings should be given a dip in 200 ppm formalin solution for 40 seconds as a prophylactic measure. During periodic check on growth, the wounded fish may be treated with 0.3% acriflavin for 5 minutes.

Feeding: The pond must be rich in animal food source like frog and tadpoles and trash fish. Dried marine trash fish also used in murrel fish culture. The feed may be distributed in the pond in small amounts or may be given in feeding baskets. Feeding schedule for murrel stock (per hac) with dried trash fish soaked in water(kg/day) or any other commercial feed. The feeding schedule for murrel culture is given in table 9

Table 9: Feeding schedule of Murrel culture

Month	Feed (Kg/ day)
1st month	2.5
2nd month	5.0
3rd month	10.0
4th month	12.0
5th month	15.0
6th month	20.0
7th month	25.0
8th month	25.0

4.2.1 (d) Tilapia culture

In tilapia culture content on pond preparation, growout and feeding are given.

Pond preparation: A month before stocking tilapia seed, drain the pond and expose it to sunlight; Inspect the whole pond area and repair any damage in good time. Clean up weeds at the bottom and around the dike; Level the pond bottom; Maintain the water inlet, outlet as well as the ditches and screens; Set twine or net above the pond to prevent hunting. Disinfect the pond with either quicklime or chlorine; Fill the pond with water to 6 – 10 cm deep; Put quicklime lumps into the

pond water to dissolve; these should all over the pond bottom before the lime cools down. Dosage of quick lime: 200gm/m2 if the pond water is with 0.5m depth. A day after pond disinfection, fill the pond with water to a depth of 1.2m. Five days before stocking seed, fertilize the pond with chicken manure at 200g/m2.

Growout culture: In one pond, tilapia fingerlings to be stocked must be of uniform size. Tight oxygenated plastic bags were used for transportation of fingerlings. only male fingerlings are to be stocked. Male tilapia are stocked at 1-3 fish/m2 and grown to 400-500 g in 5-8 months, depending on water temperature. The photo used for growout culture is given in Figure 12

Feeding: Fish Size in (gm) and Total Feed (%) is given in table 10.

Table 10: Feeding schedule for Tilapia culture

Fish Size (gm)	Total Feed (%)
0.1	10.0
5	10.0
10	8.0
20	7.0
70	5.0
100	4.0
200	3.5
300	3.0
400	2.5
500	2.0
600	1.5
>600	1.0

Figure 12: Growout culture

Figure13: Feeding

4.2.1 (e) GIFT Tilapia in cage: The content on GIFT tilapia culture in cages is given**.**

Size of the cage should be - 5m x 5m x 4m. Mesh Sizes are-16 mm, 20 mm, 24 mm. Stocking Density is 40/m3. Cage should be changed fortnightly. Nursery is not permitted in Reservoirs; minimum stockable size is 50 grams.

Body weight, Feed Pellet Size and Protein Content is given in table 11.

Table 11: Feed requirement for GIFT Tilapia Culture in cage

Body weight	Feed pellet size (mm)	Protein content (%)
50-150	2	28
150- 500	3	28
500-600	4	25
>600	5	22

4.2.1 (f) Pangassius culture in cage:

Information on pangassius culture in cage is given

The seed should be quarantined and acclimatized and bathed in 3 mg/L KMnO4 (as prophylactic treatment on need basis) before stocking. Stocking density for P. hypophthalmus range from 500 to 700 nos./m3 of 20 mm size fry for rearing to fingerlings. For grow-out, the stocking density is in the range of 60 to 100 nos./m3 of fingerlings (50-60 mm size).The stocking material is better transported to the cage site in water loaded open tank with frequent stirring. The culture period of P. hypophthalmus is generally 7-8 months. The cage fish farming being purely based on supplementary feeding. only quality floating feed is selected. Sinking feed is totally unsuitable for cage fish farming as it accumulates at the base and fouls the cage/reservoir environment. Fry to Fingerling, Crumble Floating Feed (0.5 -1.0 mm) is given with 30 to 35% protein and feeding rate is Less than 10% body wt., 4-5 times a day. Fingerling to Table Fish, Pellet Floating Feed (Above 1.0 mm) is given 25 to 30% protein. First 2 months 5% body wt., twice a day. From 3rd to 5th month 3% body wt., twice a day or as required. From 6th month onward 2% body wt., twice a day or as required

4.2.1 (g) Prawn culture

In prawn culture information on site selection, pre stocking, stocking and poststocking are given.

Site selection: The site should have Supply of good quality, pollution free freshwater for at least 8 months, Soil having a pH of more than 6.0 and good water retention capacity. Ponds should have an inlet and an outlet. Pond bottom should have a gradient slope towards the outlet (1:2). Pond bottom should have a suitable slope (1:2,1:3). Ensure water exchange. Recommended Pond size - 0.2 - >2 ha (0.2-0.5 ha) or any pond size can be used. Shape - Rectangular with their long axis oriented in the direction of prevailing wind is most suitable. Pond depth should be 2 mts. Clay loam, sandy loam soils are preferred. Water quality requirements are given in table 12.

Table 12: Water quality requirements for prawn culture

Temperature	28-31^{o}c
pH	7.0- 8.5
Total hardness	40-100 mg/lit
Dissolved oxygen	>4ppm
Calcium	50-100mg/lit

Prestocking: Unwanted species, aquatic vegetation should be removed. Poison of plant origin such as Mahua oil cake, tea seed cake or Derris root powder are preferred as they also act as fertilizer after a period of time. Bleaching powder and urea @ 300 and 100 kg/ha respectively can also be applied to kill all predatory species in the pond. For this first urea and after six hours bleaching powder has to be applied. Stocking with prawn seed can be done two weeks after eradication of pests and predators. Lime is applied @ 200-1000 kg/ha depending on the soil pH. Fertilizers both organic and inorganic can be used. Cow dung @ 1000-2000 kg/ha or poultry manure @ 500 kg/ha and super phosphate @ 100kg/ha may be applied to initiate a plankton bloom. After the initial fertilization water can be filled up to the desired level (4-5 feet). Hide outs should be provided using cut branches of trees nylon screen, earthen pipes etc.

Stocking: After preparing the ponds and laying the hide outs the ponds can be stocked with post larvae or juveniles as the case may be. Prior to stocking the pond water quality should be tested and necessary correction should be made. For stocking seed can be collected from natural collections or from hatchery. Natural seed may contain unwanted species and its availability is restricted. On arrival to the farm site care should be taken to acclimatize the post larvae to the temperature of the pond by floating the transport bags in the ponds for 15 min. After opening the bag some pond water should be allowed into the container and slowly the post larvae should be released in to the pond. Early morning and late evening are considered ideal period for stocking the seed. The density of stocking depends on the market size desired and intensity of management. For semi-intensive culture a stocking rate of 5-8/sqm is desirable. In poly-culture stocking density of prawn is reduced to 50% and compatible carp species such catla, rohu, silver carp and grass carp are also stocked @ 3000/ha.

Post stocking: Pellet diets are preferred to maintain the water quality in the ponds. Prawns require 25-30% protein and 8-10% fat in their diet. Feed should be spread evenly along the peripheral area of pond @3-5% of body weight per day. Use of check trays placed at different locations in the pond will be help to check the consumption rate and for managing the feeding rate. Prawns are more active during night feeding should be done during late evening and early morning. At low water temperature (less than 24°C) the feeding rate drops to less than half and at less than 20°C they almost stop feeding. Monthly sampling should be done using cast net to know the average body weight of prawn to adjust the feed quantity. Periodic harvesting is always preferred. After four months bigger size prawns (> 30g) can be removed by using a seine net of suitable mesh size.

4.2.2. Management practices

Under the second head called management practices the sub heads are water quality management, feed management and Health management. The content finalized under each sub head were as follows

4.2.2 (a) Water quality management

Information on different water quality parameters that are to be maintained in pond with acceptable, desirable, risk ranges and measure to be followed to correct them. The water quality parameters are given in table 13.

Table 13: Water quality parameters for fish culture

Parameter	Acceptable	Desirable	Stress
Temperature (^{0}C)	15-35	20-30	<12 or >35
Turbidity (cm)		30-50	<12 or >80
Water color	Pale to light green	Light green to light brown	Clear water, dark green
DO (mg L-1)	3-5	5	<5 or >8
Biological Oxygen Demand (mg L-1)	3-6	1-2	>10
Carbondioxide(mg L-1)	0-10	<5, 5-8	>12
pH	7-9.5	6.5-9	<4 or >11
Alkalinity	50-200	25-100	<20 or >300
Hardness	>20	75-150	<20 or >300
Ammonia	0-0.05	0 - <0.025	>0.3
Nitrite	0.02-2	<0.02	>0.2
Nitrate	0-100	0.1 – 4.5	>100, <0.01
Phosphorous	0.03 -2	0.01 – 3	>3
Primary productivity	1 – 15	1.6 – 9.14	<1.6, >20.3
Plankton	2000- 6000	3000 – 4500	<3000, >7000

Measures to be taken for maintaining the water quality are given for each parameter

1. Temperature: Water exchange, planting shady trees or making artificial shades during summer. Mechanical aeration can prevent formation of ice in the pond
2. Turbidity: Addition of more water or lime (CaO, alum at a rate of 20 mg per litre and gypsum on the entire pond water at rate of 200 Kg/ 1000m3 of pond can reduce turbidity

3. Water color: Application of organic and inorganic fertilizers in clear water ponds may increase productivity.
4. Dissolved oxygen: Avoid over application of fertilizers and organic manure to manage DO level (ii) Physical control aquatic plants and also management of phytoplankton biomass (iii) Recycling of water and use of aerators. (iv) Artificially or manually beating of water. (v) (NaHCO3) (iv) Application of potassium permanganate at the rate 250 g for 0.1 hectare
5. pH: Add gypsum (CaSO4) or organic matter (cowdung, poultry droppings etc.) and initial pre-treatment or curing of a new concrete pond to reduce pH levels. 2. Use of quicklime (CaO) to rectify low pH of aquatic body.
6. Alkalinity: 1. Fertilize the ponds to check nutrient status of pondwater 2. Alkalinity can be increased by calcium carbonate, concrete blocks, oyster shells, limestone, or even egg shells depending upon soil pH and buffering capacity.
7. Hardness : Add quicklime/alum/both and add zeolite to reduce hardness. During heavy rainfall avoid the runoff water to bring lot of silt into the fish pond.
8. Ammonia: 1. Increase pond aeration. 2. Addition of liming agents such as hydrated lime or quick lime decreases ammonia and this technique is effective only in ponds with low alkalinity. 3. Formaldehyde and zeolite treatment. 4. Regular water change out.
9. Nitrite: 1. Reduction of stocking densities, Improvement of feeding, biological filtration and general management, Increase aeration to maximum, Stop feeding, regular water change out.
10. Nitrate: Dilution by water change (water used for change should have lower nitrate level)
11. Phosphorous: Use inorganic fertilizers to increase phosphorus level (N: P=15:30).
12. Primary productivity: 1. Productivity can be improved by use of organic/inorganic fertilizers in ponds. 2. In case of plankton bloom feed/manure application can be suspended for some time.
13. Plankton: Water circulation should be proper to avoid the large sized phytoplankton species. 2. Biological control of phytoplankton scum using herbivores (plankton feeding fishes such as silver carp) is more beneficial 3.

When plankton scums appear, DO should be measured daily to ensure that oxygen is present in depths below 1.3 m. Light penetration and distribution of DO in ponds can be facilitated with copper tetraoxosulphate (CuSO4) in one or two applications, a week. The quantity of CuSO4 in waters with 25ppm hardness is 800 g/ha surface area.

4.2.2 (b) Feed management

Daily feeding amount = total weight of all feeding fish x feeding rate. Select high quality feeds that contain adequate but not excessive, nitrogen and phosphorous. Store feed in well ventilated dry room. Apply feed uniformly throughout the pond. Do not apply more feed than fish will eat. Maintain adequate dissolved oxygen concentration in ponds to prevent fish stress and enhance the capacity of pond to assimilate metabolic wastes. Daily feed application should not exceed 13kg/acre in unaerated ponds. In ponds with 2hp of aeration per acre, daily feed application usually can be increased up to 45-55 kg/acre. These feed amounts are the maximum amounts to be applied in a given day. they are not annual averages.

Annual feeding amount calculation: The following formula can be used: Q=PrKA,
Where :

Q= Annual amount of a certain feed (kg)
P= Yield of the feeding fish in the pond (kg/m2)
R= Proportion of this feed (%), K= FCR of the feed
A=Total area of the pond (m2)

4.2.2 (c) Health management

In the health management, information on bacterial, parasitic, fungal and viral diseases are given. The content validated along with the images are presented. Some images are taken from the internet and the credits were given for each under the image. Causative agent, syndrome and measures of bacterial, viral, parasitic, fungal are given from table 14 to 17.

Bacterial disease: The causative agent, syndrome and measures for bacterial diseases are given in table 14.

Table 14: Bacterial diseases

Disease	Causative agent	Syndrome	Measures
Eye disease	*Aeromonas liquefaciens*	Cornea of eye vascularised and becomes opaque; eye ball gets decayed, leading to death.	Treat affected ponds with 0.1 ppm KMnO4, followed by 300 ppm lime.
Ulcer	Aeromonasspp.; Pseudomonasspp.	Ulcerations; exophthalmia; abdominal distension	Destroy badly infected fish; disinfect affected ponds with 0.5 ppm solution of KMnO4; add sulphadiazine (100 mg/kg) or terramycin (75-80 mg/kg) to feed for 10-12days.
Columnaris	*Flavobacterium columnaris.*	Cause external lesions over the body surface	Dip treatment with 500 ppm $KMnO_4$
Dropsy	Aeromonas sp.	Accumulation of fluid inside body cavity,scale protrusion, exophthalmic condition	Disinfect affected ponds with 1 ppm KMnO4; dip treatment of 5 ppm KMnO4 for 2 minutes.
EUS	Aphanomyces sps	Ulcers on skin	200 kg/ha quicklime or 0.1 ppm CIFAX

Images used for bacterial diseases with credits are given from figure 14 to 18.

Figure 14: Eye disease

Figure 15: Ulcer

Figure 16: Columnaris

Figure 17: Dropsy

Figure 18: EUS

Image sources for bacterial diseases:

Columnaris: https://en.wikipedia.org/wiki/Columnaris#/media/File:VHS.png

Dropsy: https://biology.homeomagnet.com/carp-disease

EUS:https://www.researchgate.net/post/Why_Epizootic_Ulcerative_Syndrome_EUS_was_called_as_a_Syndrome_no_Disease

Fungal diseases: The causative agent, syndrome and measures for fungal diseases are given in table 15.

Table 15: Fungal Diseases

Disease	Agent	Syndrome	Measures
Saprolegniasis	Saprolegnia parasitica	White hair like out growth,	3-4% NaCl bath; KMnO4 bath for 5

		haemorrhages	days at 160 mg/litre bath for five days; 1- 2 mg/litre malachite green bath for 30 minutes to 1 hour; add formalin at 20 ml/litre to affected ponds.
Branchiomycosis	Branchiomyces demigrans	Yellow-brown discolouration and disintegration of gill tissues	Addition of quick lime (50-100 kg/ha) to affected ponds; in case of limited infections, use 3-5% NaCl bath for 5-10 minutes,or 5 ppm KMnO4 bath for 5-10 minutes.

Images used for fungal diseases are given in figure 19 and 20

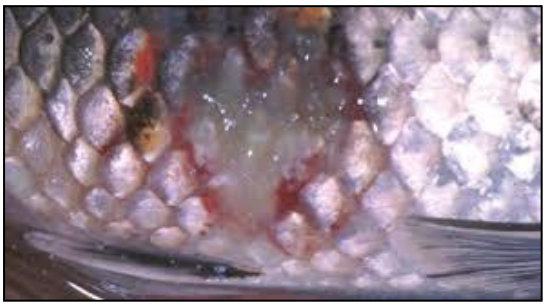


Figure 19: Saprolegniasis

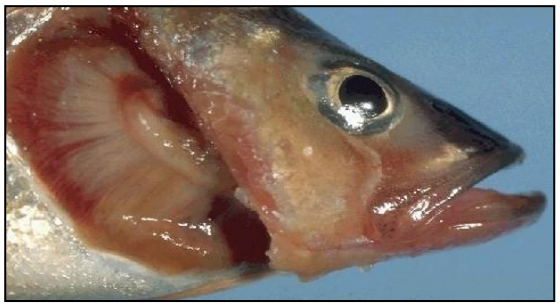


Figure 20: Branchiomysis

Image sources:

Saprolegniasis:

https://www.adfg.alaska.gov/static/species/disease/pdf/fishdiseases/saprolegniasis.pdf

Branchiomycosis: http://aquafind.com/articles/Fungal-Diseases-Of-Fish.php

Viral Diseases: The causative agent, syndrome and measures for viral diseases are given in table 16.

Table 16: Viral Diseases

Disease	Agent	Symptoms	Measures
Viral Heamorrhagic septicaemia	VHS virus	Anaemia, pale discolouration of gills,swelling of eyes and belly.	Prevention is best approach. no known cure, contaminated water should be thoroughly disinfected
Carp pox	Herpes virus	Fish skin is effected	The only way to prevent the viral infection from spreading is to destroy the infected fish

Images used for Viral diseases are given in figure 21 and 22.

Figure 21: Viral Heamorrhagic Septicimia

Figure 22: Carp pox

Image sources:

VHS:http://mediad.publicbroadcasting.net/p/michigan/files/styles/medium/public/201705/vhs_01.jpg

https://pondinformer.com/wp-content/uploads/2018/01/koi-carp-pox-pictures.jpg

Parasitic diseases: The causative agent, syndrome and measures for parasitic diseases are given in table 17.

Table 17: Parasitic diseases

Disease	Agent	Syndrome	Measures
Ichthyoptheriasis	Ichthyophthirius multifilis	Skin, fin rays and operculum covered with white spores; sick fish keep rubbing against hard substratum	Dip in 1:5 000 formalin solution for 1 hour for 7-10 days or in 2% NaCl for 7- 10 days; affected ponds should be disinfected with quicklime at 200 kg/ha
Trichodiniasis	Trichodina sps	Invasion of parasites in skin and gill region	2-3% NaCl bath for 5-10 minutes or 4 ppm KMnO4 batch for 5-10 minutes;
Dactylogyrosis and Gyrodactylosis	Dactylogyruss pp.;Gyrodactylusspp.	Gill, fin and skin affected; excessive mucus secretion	3-5% NaCl dip treatment for 5-10 minutes; 100 ppm formalin bath; treat affected ponds with 25 ppm formalin or 4 ppm KMnO4
Blackspot	Diplostomum pigmentata	Infects eye and causes blindness	Remove resident molluscan population
Argulosis	Argulus sp.	Parasites visible to naked eye attached to head and fin rays	Drain and dry ponds showing severe Argulus infection; short duration 5 ppm KMnO4 dip; treatment with 'Butox' three times at 35 ml/ha-m at weekly intervals

Figure 23: Ichthyoptheriasis

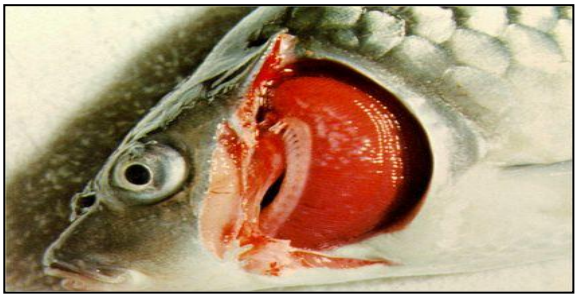


Figure 24: Dactylogyrus

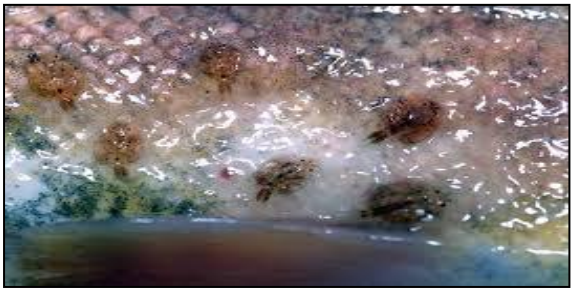


Figure 25: Argulosis

Image sources:

Icthyoptheriasis: http://farm8.staticflickr.com/7236/7189117838_a10451ff13_b.jpg
Dactylogyrus: http://farm8.staticflickr.com/7236/7189117838_a10451ff13_b.jpg
Argulosis: :
https://encryptedtbn0.gstatic.com/images?q=tbn:ANd9GcQS9dCgLn41VYUT8FRq9sVUE2HNc5i7G_ev8pwwHdMdNCw-3xJg

Environmental diseases

1. Changes in water depth “Sunburn disease
   If the water depth becomes less than 1 m and more than 2 m.
   Symptoms: Loss of appetite, reduction in growth and fish becomes lethargic. Sudden mortality may be occur due to increase of stress by pollutants.
   Measures: Maintain the water depth in the pond in an around 2 meters. If the water depth is less than 2 m then fill up the required.
2. Changes in water temperature “Thermal shock”
   Symptoms: Affected fish comes to the surface, loss of appetite, less growth and fish becomes weak.

Measures: Supply water from a nearby source. Cut the quantity of feed supply. Turbulent the water with the help of a split bamboo. Harvest the table size fish and reduce the density of fish in the pond.

3. Changes in water PH “Acidosis and alkalosis”

   Symptoms: Pond water becomes acidic or alkaline. Affected fish shows-growth retardation, excessive, mucus secretion etc. Fish will be susceptible to the infection of other diseases.

   Measures: Apply lime according to PH of water. Apply lime at the rate of 270, 140, 70 and 25 kg/ ha for PH values ranges between 4.0-5.0, 5.1-6.5, 6.6-7.5 and 7.6-8.5 respectively.

4. Reduction in dissolved oxygen (D.O.) concentration (Anoxia)

   Symptoms: Affected fish comes to the surface. Died fish mouth remains open and gill colour become pale.

   Measures: Apart from taking the control measures cited in case of changes in water temperature cut application of feed and fertilizer temporarily. Reduce the stocking density of fish by harvesting the table size fish. Repeated netting may be done. $KMnO_4$ (Potash) may apply at the rate of 1-2 mg/ lit. of water in the pond. Liming can be done at rate of 27 kg/ ha water spread area.

5. Increase in dissolved oxygen (D.O.) concentration (Gas Bubble Disease)

   Symptoms: Fish fry and fingerlings are mostly affected. Due to entry of gas bubble in the arteries of fish body fish may die. Normally it is seen in the noon and afternoon hours of a day.

   Measures: Supply water from the nearby source. If there is any mechanical aeration instruments then that should be stopped. Affected fish should transfer to a nearby pond.

6. Increase in dissolved carbon dioxide (CO_2) concentration

   Symptoms: Affected fish secrete excessive mucus and suffers from asphyxiation.

   Measures: Take the corrective measures given in case of reduction in dissolved oxygen concentration Increase in hydrogen sulphide(H_2S) concentration in water.

   Symptoms: Effected fish pond mud will smell like rotten egg and bottom dwellers like- mirika, common carp, etc. will die first.

Measures: Remove the died fish and take the corrective measures give in casof changes in water PH

7. Increase of turbidity of pond water

   Symptoms: Small fish and eggs are effected first. Growth of fish retarded, dissolved oxygen concentration is reduced and fish dies from asphyxiation.

   Measures: Apply aluminium (filter alum) sulphate at the rate of 10-40 mg/ lit. of water Actual quantity can be determined by putting alum in a glass of turbid water. After applying alum liming should be done as per the water PH as mentioned in corrective measure of water PH.

8. Red or green or brown coloured layer over the pond water surface (Algal toxicosis disease)

   Symptoms: Bad smell of effected fish pond water. The thickness of layer may increase from morning to noon hours. Surfacing of fish in the effected pond is seen from late night to dawn and fish may die.

   Measures: Supply of feed and fertilizer to the pond should be stopped temporarily. If possible remove the coloured layer with the help of free hand or by using a split bamboo. Copper sulphate ($CuSO_4$) at the rate of 0.1-0.5 mg/ lit. of water can also be apply.

9. Increase in the concentration of unionized ammonia

   Symptoms: Affected fish gill become reddish and effected fish may die also.

   Measures: Control the water temperature, PH and also the concentration of phytoplankton in the pond and for that purpose take the renovative measures given in case of changes of water PH and temperature.

10. Traumatic injuries

    Symptoms: Effected fish shows biting sign of predators on body surface and other external organs like- fins. In acute cases some lesions may be seen on the body surface.

    Measures: Remove predators from the pond. Apply $KMnO_4$ (Potash) at the rate of 4-5 mg/lit of water to the effected pond.

11. Acute anaphylaxis

    Symptoms: Body colour become very dark and body become very rigid.

    Measures: Effected fish should not be disturbed and they usually recover automatically before the next meal.

12. Deterioration of water quality by pollutants

Symptoms: Affected fish shows- haemorrhagic eyes, sudden mass mortality, etc.
Measures: Fish from the effected pond should be removed and buried under soil. Water of the effected pond should be drained out and pond bed should be dried. After that pond bottom mud up to 1 ft. depth (minimum) should be removed. Then pond should be disinfected with lime depending on PH as mentioned in the case of change in water PH. Afterwards the pond should be refilled with water and a new stock of fish can be cultured.

4.2.3 Post Harvest Practices

Post harvest practices included the following validated content on handling, transportation, processing and Value added products.

4.2.3 (a) Handling : Work on fish as quickly as possible. Sort fish properly before packing. Cover the fish to protect from heat. Drain fish before icing**.** Avoid brushing the fish**.** Don't throw or kick the fish**.** Use plenty of ice. Put additional layer of ice on top, bottom and side of fish in boxes or shelves. Don't over-fill a box . The next box on top will damage the fish below. Lay the fish belly downward – this prevents entry of dirty water into the fish. Don't pack fish so tightly. Fish is cooled more quickly when ice cold water is poured on them. Fish spoils easily when allowed to stay in stagnant water, blood or slime. Store fish in ice as quickly as possible. Make sure the fish room is always kept clean.

4.2.3 (b) Transportation: Fresh fish transported to far distances must be packed with ice to ensure freshness when they reach the consumers. Proper packing of fresh fish with ice means arranging the fish and ice alternately in the container to maintain chilling temperature. The ratio of ice: fish is 1:1Almost any clean, waterproof container may be used.

Figure 26: Transportation

4.2.3 (c) Processing

Drying

Sun drying is the most common processing method practiced in India. It is also the simplest and least expensive way to preserve fish. The steps in drying fresh fish are

1. Split the fish into butterfly fillets along the backbone with a sharp knife.
2. Remove the gills and internal organs or the entrails.
3. Wash fish to remove all traces of blood.
4. Immerse split fish into a brine solution of 1 part salt to 3 parts water for 30 minutes to 1 hour depending on the size of fish.
5. Drain the fish and dry under the sun for 1 to 2 days.
6. Store dried fish in a cool, dry place.

Salting

Salt is applied to fish by the following basic methods:

1. Brine salting - the fish are immersed in a solution of salt in water.
2. Dry salting - granular salt is rubbed into the surface of the fish.
3. Kench salting - granular salt is rubbed into the surface of split fish and the fish are stacked with a sprinkling of salt between each layer of fish. The liquid (pickle) which forms is allowed to drain away.

Freezing

1. Remove the guts and thoroughly clean the fish soon after catching.
2. Prepare the fish as you would for table use. Cut large fish into steaks or fillets.
3. Freeze small fish whole.
4. Wrap the fish in heavy-duty freezer bags.
5. Separate layers of fish with two thicknesses of packaging material for easier thawing.
6. Store at 0° F or lower. When ready to use, thaw in the refrigerator.

Smoking

1. Remove the gills and entrails.
2. Wash and soak in brine solution (1:3 salts to water) for 30 minutes to one hour depending on the size of fish.

3. Boil in 10% brine solution (1 part salt to 9 parts water) for 10 to 20 minutes.
4. Smoke for 30 minutes at 43-66°C.
5. Pack in plastic bags and refrigerate.

Canning

1. Remove head, tail, fins and scales. Wash and remove all blood. Split fish lengthwise, if desired.
2. Cut cleaned fish into 3-1/2 inch lengths.
3. Fill pint jars, skin side next to glass, leaving 1 inch headspace.
4. Add 1 teaspoon of salt per pint, if desired. Do not add liquids.
5. Adjust lids and process.

4.2.3 (d) Products

Fish balls: Ingredients required are Fish mince-1000gm, Chilli powder (kaaram)-30gms, Coriander powder (Dhaniyala podi) - 10gms, Turmeric powder(pasupu) - 1 spoon, Vanaspathi - 150gms, Onion - 200gms, Bread powder - 30gms, Salt -To taste, Beaten egg – 1

Procedure

1. Minced fish meat. Thaw the minced fish meat – if frozen.
2. Mix the minced fish meat with fried onions (cut the onions into very small pieces, fry it in Vanaspathi) and chilli powder, turmeric powder.
3. Add beaten egg, bread powder, salt, aginomotto.
4. Mix homogeneously. Prepare balls of about 3cm diameter
5. Steam for 10-15 minutes or cook in 1% brine for 5-10 minutes, alternatively can be fried in vegetable oil till golden brown colour
6. Cool the cooked / fried fish balls.
7. Packed in thermoformed trays and stored .
8. Alternatively can be served warm

Fish cutlet: Ingredients required are Cooked fish meat : 1000g, Salt : 25g (approx - to taste), Oil : 125 ml, Green chilli : 15 g, Ginger (allam) : 25g, Onion : 250 g, Potato (cooked) : 500 g, Pepper(miriyalu) (powder): 3 g (to taste), Clove (powered)(vellulli) : 3 g, Cinnamon (powered)(dalchina chekka podi) : 2g (to taste), Turmeric : 2 g, Eggs : 4 Nos, Bread powder : 200 g

Procedure:

1. Cook fish mince in boiling water for 20 min.
2. Drain off the water. (In case of whole fish, dress the fish and cook for 30 min. and drain.
3. Remove skin, scales and bones and separate the meat
4. Add salt and turmeric to the cooked meat and mix well
5. Fry chopped onions in oil till brown. Fry chilli and ginger. Mix these with the cooked meat
6. Add mashed potato and spices and mix well with the meat.
7. Shape 40 g each of this in oval or round form, dip in beaten eggs, roll in bread powder store in deep freezer.
8. Thaw and fry in oil before use.

Fish fingers: Ingredients required are Fish mince -1000gm, Chilli powder (optional) -10gm, Salt -10gm, Batter mix : Wheat flour - 30gm, Rice flour - 30gm, Chilli powder - 1gm, Salt - 3gm, Water- 180ml, Beaten egg, Bread mix : Fried wheat flour 50gm, Toast powder - 50gm

Procedure

1. Minced fish meat
2. Thawing – if frozen
3. Mixing with salt and sodium tripolyphosphate
4. Slabbing, by spreading to a thickness of 3mm height in aluminium trays.
5. Freezing at -40^{0}c for 2 hours
6. Frozen slabs are cut into fingers of uniform size
7. Batter the fingers by dipping in the batter solution
8. Breading, by rolling over bread mix powder
9. Flash fried at 175-180^{0}c for 20 or at 160-170^{0}c for 4 minutes
10. Drain on brown paper and serve warm

Fish pickle: Ingredients required are Fish (dressed and cut into small pieces) – 1000g, Oil–400ml, Sugar–10gm, Curry leaves – 10gm, Ginger– 80gm, Garlic – 80gm, Green chilli – 60gm, Mustard (aavalu) – 25gm, Cumin seeds (gelakarra) – 25gm, Fenugreek (mentulu) – 15gm, Asafoetida (inguva) –15gm,

Vinegar –300ml, Salt –60gm, Turmeric powder –10gm, Citric acid (nimmauppu) – 5gm, Garam masala–15gm, Chilli powder –60gm, Sodium benzoate – 0.5gm

Method of preparation

1. Raw material – good quality fish with few bones
2. Washing to remove mud, slime, etc.
3. Fillets are prepared from whole fish and skin removed
4. Skin free fillets are cut into small cubes by 3cm size
5. Fry fish meat cubes in oil (50%) & keep them aside
6. Mince the peeled garlic, ginger, cleaned green chilies into paste in a mixer
7. Fry fenugreek, cumin seed, mustard, asafetida and make powder
8. Mixing :
    - Add sugar and curry leaves to the hot oil (50%) in the frying pan
    - Add garlic, ginger & green chilli paste into the hot oil & fry for a while
    - Add the fenugreek, cumin seed, asafetida & mustard powder &continue to fry until characteristic odour
    - Add vinegar & salt – boil it till characteristic smell emerges
    - Add turmeric powder under low flame
    - Add garam masala for good flavour and odour
    - Add citric acid and Mirchi powder under low flame
    - Add sodium benzoate when the temperature of the contents is little higher than the room temperature and mix thoroughly
    - Add fried meat and mix with the gravy
9. After cooling completely, keep it overnight for maturation
10. Pickles are packed in sterilized glass bottles (washed in hot water & dried)
11. Bottles are sealed airtight; ensure that a layer of oil floats on the surface of the pickle
12. Label the bottles having all the statutory matters printed on it
13. Storing at room temperature

Prawn pickle: Ingredients required are Prawns (peeled) – 1000g, Oil – 400ml, Sugar– 10gm, Curry leaves – 10gm, Ginger – 80gm, Garlic – 80gm, Green chilies – 60gm, Mustard (aavalu) – 25gm, Cumin seeds (gelakarra)– 25gm, Fenugreek (mentulu) – 10gm, Asafetida (inguva) – 15gm, Vinegar – 300ml, Salt –

60gm, Turmeric powder – 10gm, Citric acid (nimmauppu) – 5gm, Garam masala – 15gm, Chilli powder – 60gm, Sodium benzoate – 0.5gm

Method of preparation

1. Peel the prawns, remove heads and extract meat, if it is whole
2. Add little salt & turmeric and wash them
3. Heat oil and fry the prawns till they attain golden brown colour
4. Mince the peeled garlic, ginger, cleaned green chillies into paste
5. Fry fenugreek, cumin seed, mustard asafetida and make power
6. Mixing :
    - Add curry leaves to the hot oil (50%) in the frying pan
    - Add garlic, ginger & green chilii paste into the hot oil & fry for a while
    - Add the fenugreek, cumin seed, asafetida & mustard powder & continue to fry until characteristic odour
    - Add vinegar & salt – boil it till characteristic smell emerges
    - Add turmeric powder &chilli power under low flame
    - Add garam masala for good flavour and odour
    - Add citric acid and sodium benzoate when the temperature of the contents is little higher then the room temperature and mix thoroughly
    - Add fried meat and mix with the gravy
7. After cooling completely, keep it overnight for maturation
8. Pickles are packed in sterilized glass bottles (washed in hot water & dried)
9. Bottles are sealed airtight; ensure that a layer of oil floats on the surface of the pickle
10. Storing at room temperature

4.2.4 Modern Farming Techniques

Under the major head Modern farming techniques, validated content on Cage culture, Recirculatory Aquaculture System and Integrated Fish Farming are given below.

4.2.4 (a) Cage culture

Site selection : Cage culture shall be allowed in water bodies having a surface area 1,000 ha or more at FRL. Cage culture shall be allowed in reservoirs with an average depth of 10 m. The cage site at the reservoir should have at least 10 m depth round the year. The ideal locations for siting cages in large and medium

reservoirs are the protected bays/coves to avoid damage due to strong wind action. cage culture should not be attempted in any water body having total phosphorous and total nitrogen concentration in the water in excess of 0.02 mg/L and 1.2 mg/L, respectively. The sites to be avoided are: places with turbulence and excessive wave/wind action, bad water quality, water bodies with obstructions and heavy weed infestation, low depth, difficult to access the site and logistic considerations and near to dense human habitation, dams, tourist spots, industries and polluting industries. Areas of fish nursery and breeding grounds, sensitive areas like wildlife habitat including birds nesting, socio-culturally important areas like pilgrimage centres, water bodies for public use like drinking water, cleaning, navigation, etc, and protected aquatic reserves, sanctuaries, etc. are also to be avoided.

Cage maintenance: Anti-corrosive paint should be applied to prevent rusting and to increase the durability. Cage should be cleaned at 15-days interval to avoid net clogging. After shifting the stock to another cage, each cage is taken out, sun-dried and cleaned thoroughly by scrubbing/ water-jet wash to remove debris and fowling organisms. Additional hapas/nets may be maintained for this purpose or to meet other emergency situation. The physico-chemical parameters of water should be recorded regularly as a part of water quality monitoring.

Species cultured: Economically viable cage culture is practiced in inland water bodies of India by growing the exotic pangasius (Sutchi Catfish), Pangasianodon hypophthalmus, GIFT tilapia. A genetically improved strain of Oreochromis niloticus has been allowed subject to certain conditions such as: only all-male seed, sourced from authorized agencies can be used.

The illustrations used for cage culture are given in figure 27 and 28.

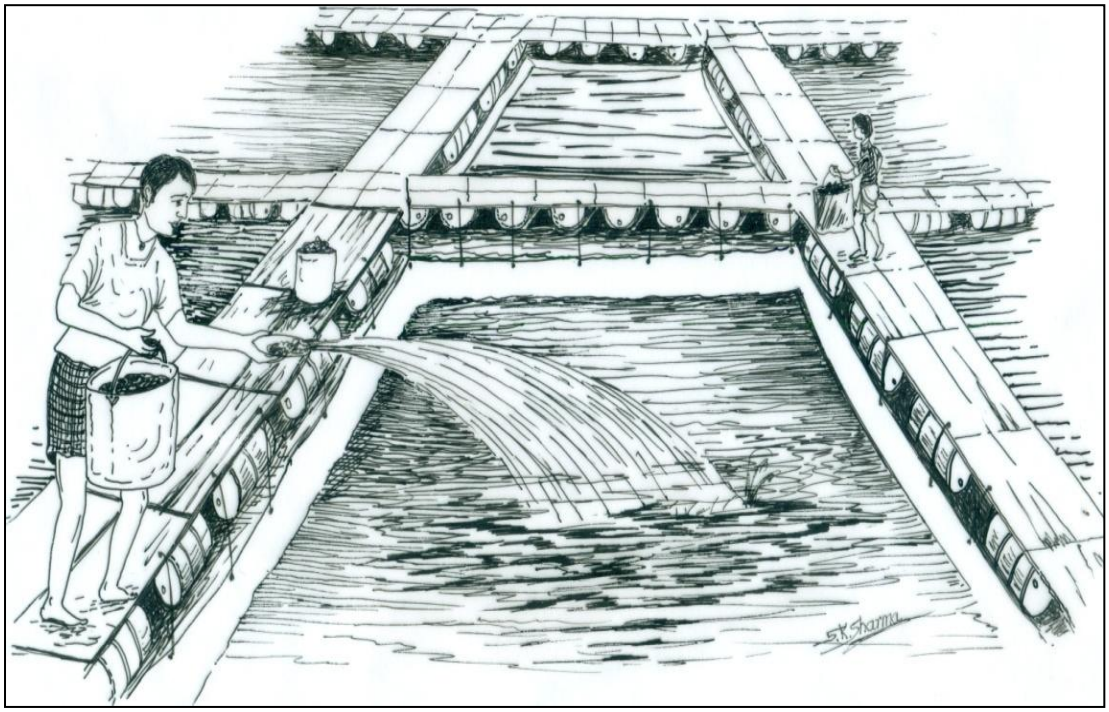


Figure 27: Illustrations for Cage culture

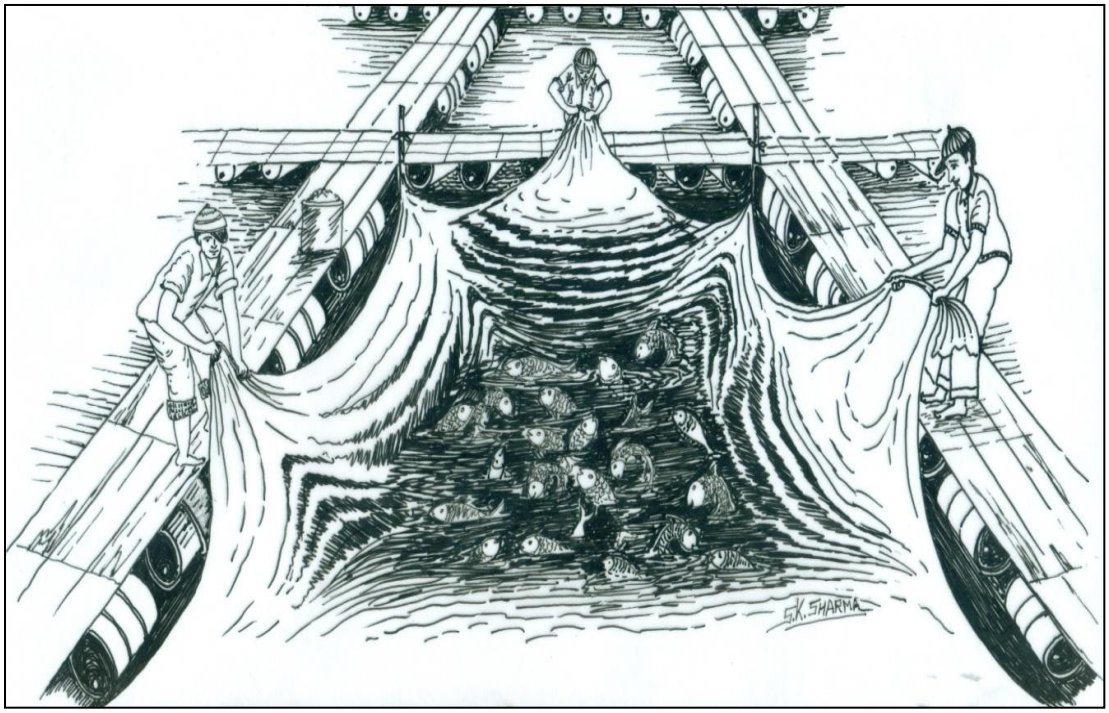


Figure 28: Illustrations for Cage Culture harvesting

4.2.4 (b) Recirculatory Aquaculture System

In recirculatory aquaculture system information on feeding and water quality parameters that are to be maintained are given.

Feeding: Only formulated dry floating feed can be recommended for use in a recirculation system. Amount of feeding depends upon stocking density and type of species cultured. Cultured fish generally fed 3-5% of its body weight. Over feeding should be avoided. Refusing of feed indicates high level of ammonia and low oxygen or other problems. The use of trash fish in any form must be avoided. Fish feeding several times in a day at same time advantageous. Uniform distribution of feed is recommended to prevent uneven growth and stunting. The composition of feeds should aims at maximising the uptake of protein in the fish.

Water Quality: The water quality requirements in RAS are given in table 18

Table 18: RAS water quality requirements

Sl.no	Water quality parameter	Range
1.	Temperature (ºc)	Depending on species
2.	Oxygen (%)	70-100
3.	Nitrogen (% saturation)	80-100
4.	Carbondioxide (ppm)	10-15
5.	Ammonium (ppm)	0-2.5
6.	Ammonia (ppm)	<0.01
7.	Nitrite(ppm)	0-0.5
8.	Nitrate (ppm)	100-200
9.	pH	6.5 -7.5
10.	Alkalinity	1-5
11.	Phosphorous (ppm)	1-20
12.	Suspended solids (ppm)	25
13.	COD (ppm)	25

4.2.4 (c) Integrated Fish Farming

In integrated fish farming content on fish cum agriculture, fish cum horticulture, fish cum dairy, fish cum duck, fish cum poultry and fish cum pig are given.

Fish cum Agriculture: For simultaneous culture, rice fields of 0.1 ha area may be economical. Normally four rice plots of 250 m2 (25 x 10 m) each may be formed in such an area. In each plot, a ditch of 0.75 m width and 0.5 m depth is dug. The dikes enclosing the rice plots may be 0.3 m high and 0.3 m wide and are strengthened by embedding straw. The ditches have connections with the main supply or drain canal, on either side of which, the rice plots are located, through inlet-outlet structures of the dikes. The depth and width of the supply or drain canal may be slightly smaller than that of the ditches. Suitable bamboo pipes and screens are placed in the inlet and outlet structures to avoid the entry of predatory fish and the escape of fish under culture. The water depth of the rice plot may vary from 5 to 25 cm depending on the type of rice and size and species of fish to be cultured. Species such as Catla, Rohu, Mrigal, Common carp, Milk fish, Tilapia, Mugil spp., Magur, Murrels have been widely cultured in rice fields. Five days after transplanatation of rice, fish fry (1 cm) are stocked at the rate of 5,000/ha or fingerlings (8-10 cm) at the rate of 2,000/ha. To control the insects, the insecticide Furadon (Carbofuran) may be used at the rate of 1 kg/ha. The insecticide is mixed with basal fertilisers and applied once during the final harrowing. After a period of 10 weeks (if stocked with fry) or six weeks (if stocked with fingerlings), the rice fields are slowly drained off and the fish are harvested. The harvesting of fish may be done about a week before the harvest of rice. Individual growth of 60 g and a per hectare yield of 500 kg have been reported under the simultaneous culture practice. Illustration for fish cum agriculture is given in figure 29.

Fish cum Horticulture : Mango, banana, papaya, coconut and lime are suitable, While pineapple, ginger, turmeric, chilli are grown as intercrops. Flower bearing plants like tuberose, rose, jasmine, gladiolus, marigold and chrysanthemum provide additional income to farmers. Ideal management involves utilization of middle portion of the dyke. Residues of vegetables cultivated could be recycled into fishponds,particularly when stocked with fishes like grass carp. Grass carps can be

stocked @ 1000/ha and addition of common carps are beneficial for utilizing feacal debris. In mixed culture of grass carps along with rohu, catla and mrigal, in 50: 15: 20: 15 ratio at a density of 5000 fish/ha. Banana or coconut is cultivated in rows in wetlands, the ditches made between such rows act as supply or drainage canals. These canals serve as fish culture systems owing to their round-the-clock supply of water and rich insect populations. Larvivorous air-breathing fish species such as snakeheads C. marulius and C. striatus and tilapia, O. mossambicus are ideal species for culturing in this system. This integrated system fetched 20-25% higher return compared to aquaculture alone. Illustration for fish cum horticulture is given in figure 30.

Fish cum Dairy: Fish-cum-Dairy Farming is considered as an excellent innovation for the use of organic wastes. Use of cow/buffalo manure in fish farming is a commonly prevailing practice. On an average, one cow/buffalo excretes 12000 kg of dung and 8000 litre urine per year. The cattle faeces and urine are beneficial to the filter-feeding and omnivorous fishes. On an average, 3-4 cows/buffaloes can provide sufficient manure to fertilize one-hectare pond. In this system, farmer gets milk, fish and calf as well, which increases revenue and reduces input costs. Illustration for fish cum dairy is given in figure 31.

Fish cum Poultry: The stocking rates vary from 8000 - 8500 fingerlings/ha. A species ratio of 40 % surface feeders, 20 % of column feeders, 30 % bottom feeders and 10-20 % weedy feeders are preferred for high fish yields. For 1 hac of fish pond 500-600 birds are required. It has been estimated that one ton of deep litter fertilizer is produced by 30-40 birds in a year. Final harvesting is done after 12 months of rearing. Fish yield ranging from 3500-4000 Kg/ha/yr and 2000-2600 Kg/ha/yr are generally obtained with 6 species and 3 species stocking respectively. Every bird lays about 200 eggs/year.The birds are sold after 18 months of rearing. Illustration for fish cum poultry is given in figure 32.

Fish cum Duck Culture: Ponds are prepared and stocked with 6 species of IMC and exotic carps @ 6000 fingerlings/ha. Stocking ratio of surface, column, bottom feeders and grass carp is 40:20:30: 1 0 respectively. fingerlings of over 10 cm size are stocked because smaller seed may be preyed by ducks. The local variety "Indian Runner" (hardy,suitable) and "Khaki Campbell" (Good layer)

ducks are used. 200-300 ducks Iha are sufficient to fertilize I ha water area under polyculture. About 2-4 months old ducklings are kept on pond after providing necessary prophylactic measures.In addition to natural feed, supplementary feed is applied. A mixture of poultry feed and rice bran in the ratio of 2: 1 @ 100 gm/bird/day is given. Ducks attain maturity at the age of 24 weeks and start laying eggs and continue for two years. Fish yield from this system is 3,500- 4,000 kg/ha/y in addition to the eggs and meat of surplus, old drakes (0) ducks. Illustration for fish cum duck is given in figure 33.

Fish cum Pig: After the preparation of ponds, 6 species of IMC and exotic carps are stocked @ 8,000 -9,000 fingerlings/ha in ratio of 40:20:30:10 of surface, column, bottom feeder and grass carp respectively. Partial harvesting is done as and when fish attain marketable size as rate of stocking is on higher side. About 2 months old weaned piglets @ 30-40 pigs/ha are kept in the vicinity of fish farm. They are fed with pig mash @ of I kg.mash/pig/day in addition to the green grass grown on embankments. To overcome mineral deficiency "Sod" is provided one a week. If more green or "Swill" (Kitchen waste) is provided, quantity of pig mash can be reduced. In this system about 15,000 - 20,000 kg pig dung is recycled from 30-40 piglets in a year. After 6 months mature pigs are sold and new batch of piglets is introduced. In this system 2 crops of pigs and one crop of fish is produced. Fish yield in this system varies from 6,000-7,000 kg/haJy. apart from pigs. Illustration for fish cum pig is given in figure 34.

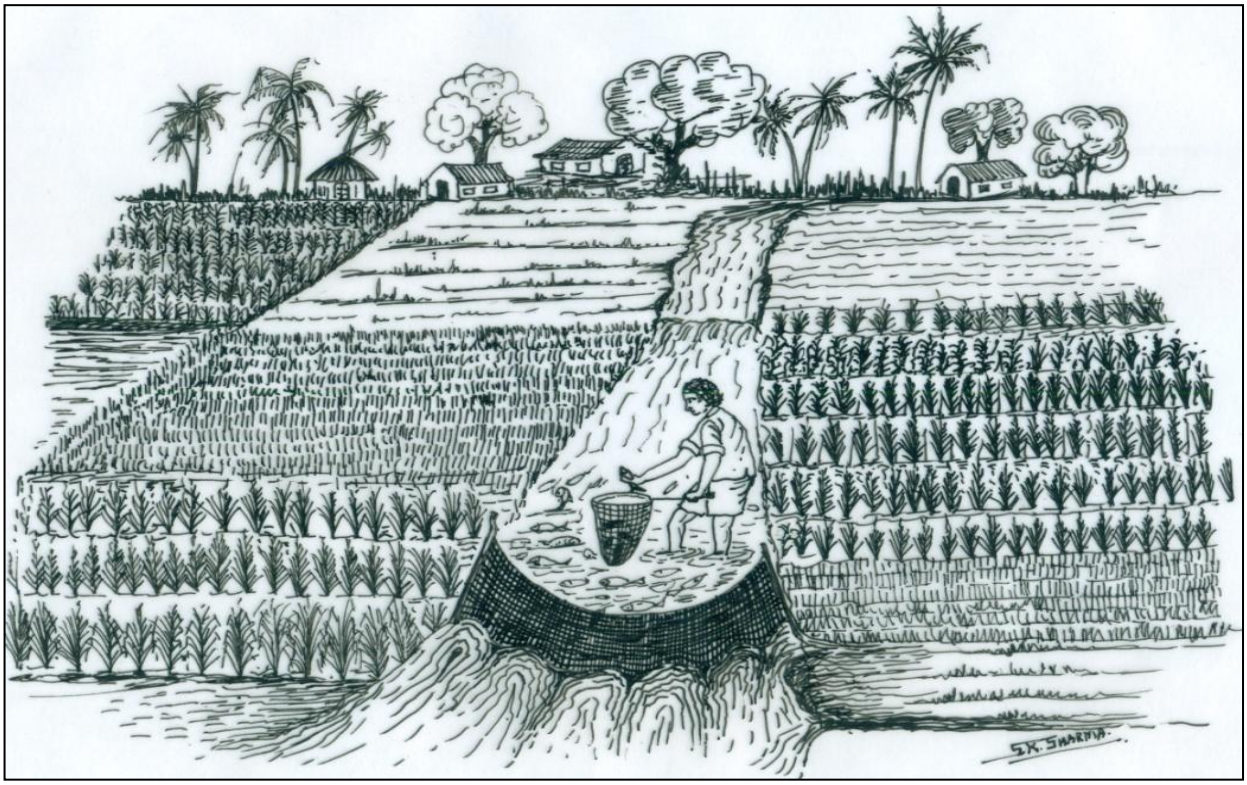


Figure 29: Illustration for Fish cum agriculture

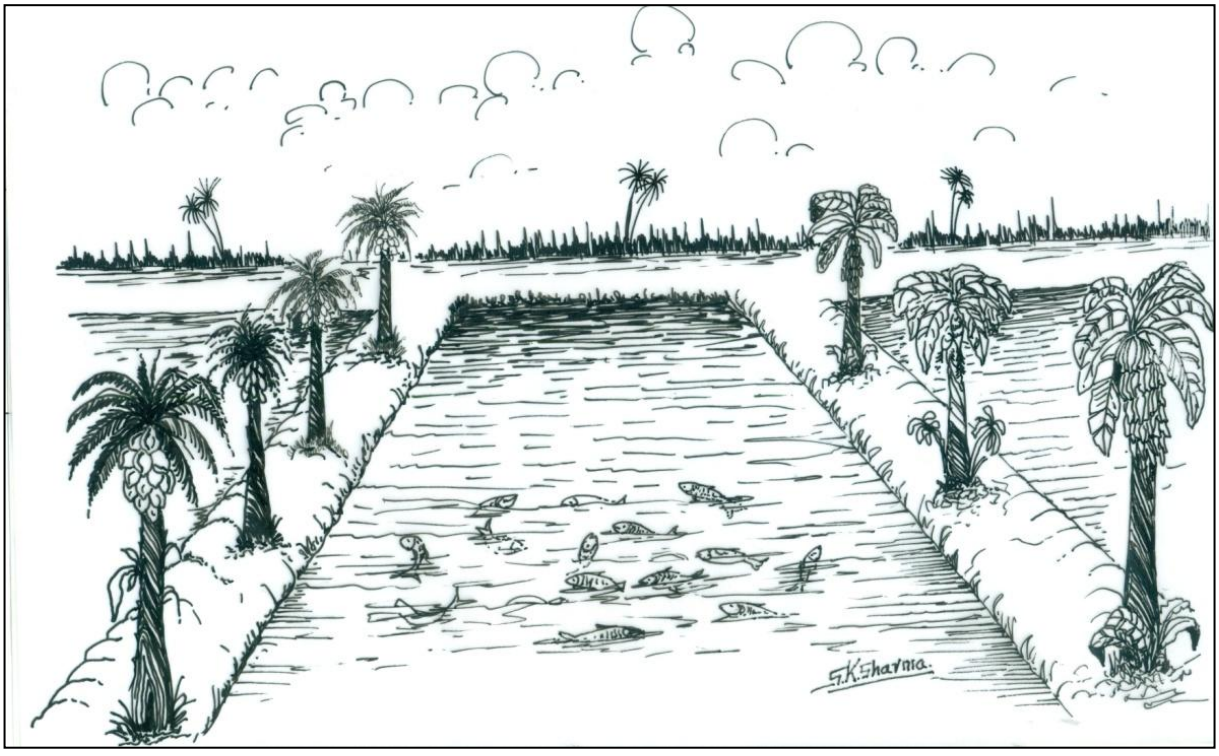


Figure 30: Illustration for Fish cum horticulture

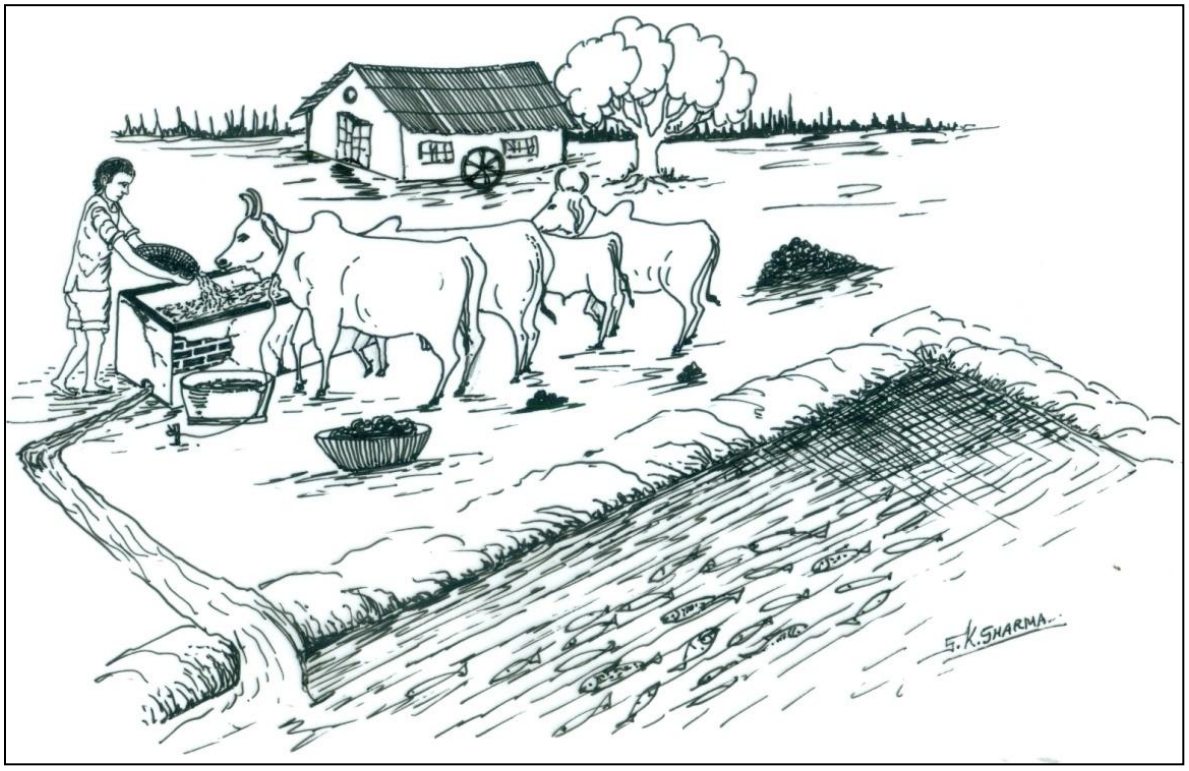


Figure 31: Illustration for Fish cum dairy

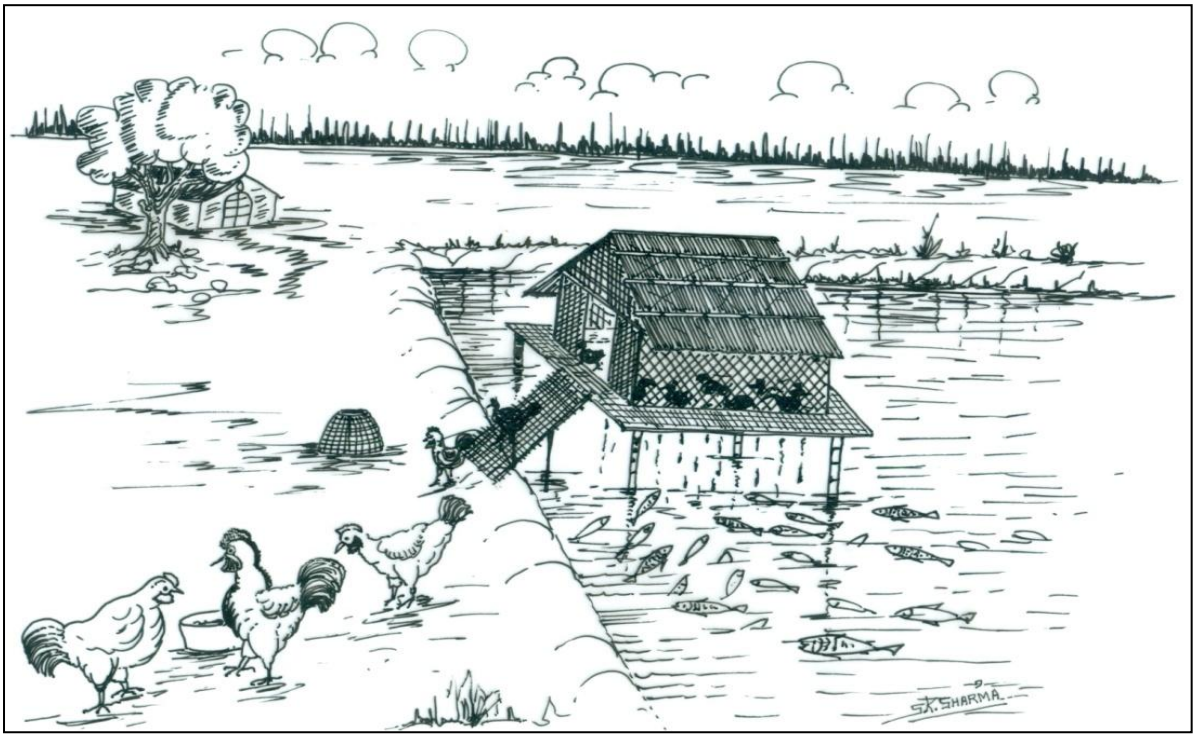


Figure 32:Illustration for Fish cum poultry

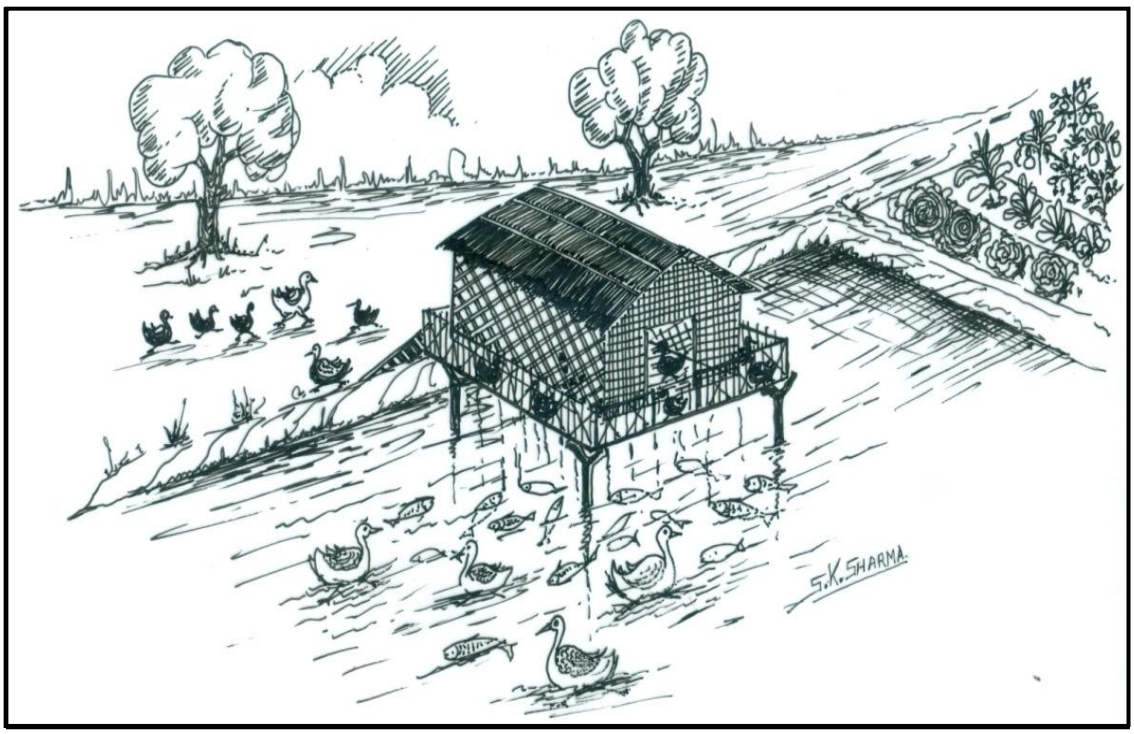


Figure 33: Fish cum Duck culture

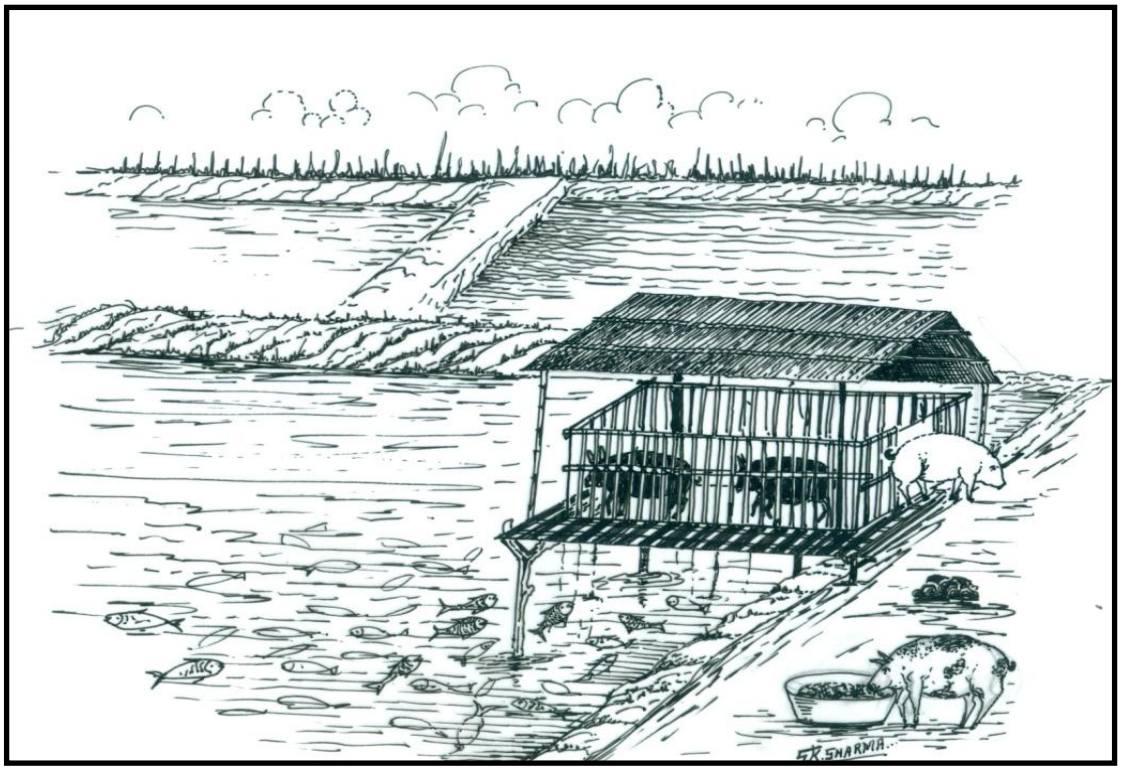


Figure 34: Illustration for Fish cum pig culture

4.2.5 T- fish Info

In T- fish info the validated content on Registration guidelines, Fish seed suppliers and fish markets in Telangana are given

4.2.5 (a) Registration Guidelines:

Information on guidelines and procedure for registration of freshwater aquaculture farms are given.

Guidelines for Registration of Fresh Water Aquaculture in the Telangana State

1.1 Water Aquaculture in the Telangana No person shall carry on fresh water aquaculture without registration in accordance with this order.

1.2 The farmers need not pay Land conversion fee (as per the sub clause (f)of Clause 7 of the Andhra Pradesh Agricultural Land (Conversion for Non-Agricultural purpose Act 2006 and its amendments by Act 16 of 2012).

1.3 The District Level Committee with the following members shall be the Competent Authority to permit fresh water aquaculture by registration.

1.4 The Member-Convener will invite the District Forest Officer for the District Level Committee meetings whenever forest lands are involved.

1.5 The applicant shall have a clear title of land in his name or shall be a lease holder of the land for a minimum period of five years.

1.6 Aquaculture is permissible in agriculture lands having less productivity, fallow, low lying, prone to water logging and also permissible in dilapidated small kuntas by undertaking reclamation to hold rain water required depth and period.

1.7 Fresh water aquaculture is permissible by using water from irrigation canals, drainage channels (notified or non-notified), field channels, etc. by paying Water Cess.

1.8 To prevent groundwater depletion, no fresh water aquaculture farm shall be permitted to use water drawn from bore wells except for supplementing the losses from evaporation, seepage, etc.

1.9 Antibiotics and other pharmacologically active substances which are banned by Government of India and published in Gazette Notifications from time to time shall not be used for aquaculture.

1.10 All indigenous cultural species, unless prohibited by the Government can be cultured. Exotic species can be cultured only after obtaining relevant permissions from Competent Authorities

2. Procedure for Registration

2.1 Persons who wish to start aquaculture farms shall apply to the District Level Committee through the District Fisheries Officer (Annexure-I) and pay processing fee of Rs.200/- per acre. The DLC will scrutinize the applications as per the guidelines issued in this order and visit the proposed site if necessary then recommend for registration. District Fisheries Officer will submit the file to the Dist Collector / Chairman DLC to issue the registration

2.2 The District Level Committee visit the ponds at any time after completion of the construction or during culture period. If any violations are observed as per the conditions mentioned in this order, the DLC has the power to recommend for cancellation of the registration.

2.3 The amount collected towards processing fee shall be remitted to the Government account in miscellaneous head of account: 2405- Fisheries, MH –102 License Fees, Fines etc SH.01-License Fees, Fines etc in Registration of Fresh Water Aquaculture in the Telangana.

2.4 The District Collector has the right to take appropriate action including cancellation of the registration, and demolish. If any registered fresh water aquaculture farmer violates the conditions mentioned in this order.

4.2.5 (b) Fish Seed Suppliers

In fish seed suppliers, details of the seed suppliers along with the contact number and address are given. Sample is as follows

Table 19: Fish seed suppliers

Sl.no	Name of farm/ Name of supplier	Address
1.	Sri Dhanalaxmi Fish Seed Farm B.Yuvraj	Nirmal
2.	Jalapushpa Fish Seed Hatching Company, Cheti Sriramulu	Hasnabad Village Jagithyal, Mandal
3.	Matsyagirindra Fisheries Pvt Ltd.,	Karimnagar

4.	Sri Varshini Fish Seed Farm	Kondapaka, Vennavanka Mandal , Karimnagar
5.	M/s Kalpana Fish Traders	Tulasi nagar , Jagithyal
6.	Indur fish farms, V.Gopal	S.N Puram, Nizamabad
7.	Margoni Ganesh Seed Farms	Nalgonda
8.	Raja Fisheries and Orchids	Nachepalli , Khammam
9.	Sri Balaji Fish Seed Farm, T.Avinash	Mancherial
10.	Matsyamithra Enterprises	Indaram, Mancheriyal
11.	Saikrishna fish seed farm Konda Susmitha Patel	Vanchanagiri, , Geesugonda, Warangal rural

4.2.5 (c) Fish Markets in Telangana

Information on village fish markets in each district are given

Table 20: Fish markets in Telangana

Khammam	Kothagudem, Manuguru, Palvancha, Sathupally
Medak	Gajwel, Toopran, Narsapur, Gomaram, Sangareddy
Karimnagar	Kamalapur, Peddapalli, Manthani, Musthabad, Siricilla, Korutla, Malyal,Chandurthi
Adilabad	Manchiryal, Asifabad
Ranga reddy	Edulabad, Alwal

Warangal	Yelambazar, Kumara pally, Doranakal, Bhupalapally
Mahabubnagar	Alampur, Atmakur, Wanaparthy

4.2.6. Results of Content Validity

Content Validity was measured to find out how essential a particular item which was included in the mobile app was. The content validity ratio given by the experts for all the features is given in table 21.

Table 21: Content Validity Ratio of the mobile app features

Sl. no.	Features	Content Validity Ratio
1.	Carp culture	0.87
2.	Composite culture	0.87
3.	Murrel culture	0.84
4.	Tilapia	0.95
5.	GIFT tilapia culture	0.94
6.	Pangassius culture	0.94
7.	Fresh water prawn culture	0.87
8.	Water quality management	0.88
9.	Feed management	0.85
10.	Bacterial diseases	0.84
11.	Viral diseases	0.86
12.	Fungal diseases	0.90
13.	Parasitic diseases	0.83
14.	Environmental diseases	0.85
15.	Handling	0.85
16.	Transportation	0.90
17.	Drying	0.80
18.	Salting	0.80
19.	Smoking	0.75
20.	Canning	0.75
21.	Freezing	0.75
22.	Fish balls	0.90

23.	Fish cutlet	0.85
24.	Fish fingers	0.90
25.	Fish pickle	0.95
26.	Prawn pickle	0.95
27.	Site selection (cage culture)	0.80
28.	Species selection (cage culture)	0.80
29.	Cage maintenance	0.90
30.	Water quality (RAS)	0.85
31.	Feeding (RAS)	0.85
32.	Fish cum agriculture	0.86
33.	Fish cum horticulture	0.79
34.	Fish cum pig	0.83
35.	Fish cum poultry	0.85
36.	Fish cum duck	0.87
37.	Fish cum dairy	0.88
38.	Registration guidelines	0.75
39.	Seed suppliers	0.95
40.	Fish markets	0.95
41.	Schemes	0.90

As the CVR was above 0.75 for all features and sub heads, the content validity was established.

4.3. Developing Mobile App Prototype

The third objective was to develop mobile app prototype**.** As explained in the methodology to achieve this objective a course on Android Application Development was done and based on the skill developed a mobile app prototype was developed. The app was developed with API 17: Android 4.2 (Jelly Bean) so that the app will run on approximately 96.0% of devices. This app is an information retrieval system which provides scientific information to the farmers. This application contains mainly following 6 features as follows:

- Culture practices of carps, murrels, magur, tilapia, prawn in ponds and GIFT tilapia, pangassius in cage
- Management practices such as water quality, feed and health
- Post harvest practices such as handling, transportation, processing and value added products.
- Modern farming techniques such as Cage culture, Recirculatory Aquaculture System and Integrated farming.
- Telangana information which provides details of registration guidelines, fish seed suppliers, schemes and markets.
- Buy or sell which helps the farmer to sell the farm produced fish and an individual/wholesaler to buy the farm produce.

The results of this objective are presented in the form of screenshots from figure 35 to 93. The relevancy score by the farmers and experts and the content validity ratio is presented with each screen shot. The mobile app starts with a home screen of the application.

Home screen of the mobile app

The home screen of the mobile app is presented in figure 35. The home screen of the app consists of 6 tabs ‘Culture practices’, ‘Management practices’, ‘Post harvest practices’, Modern farming practices’, ‘T- fish info’ and ‘Buy and sell’

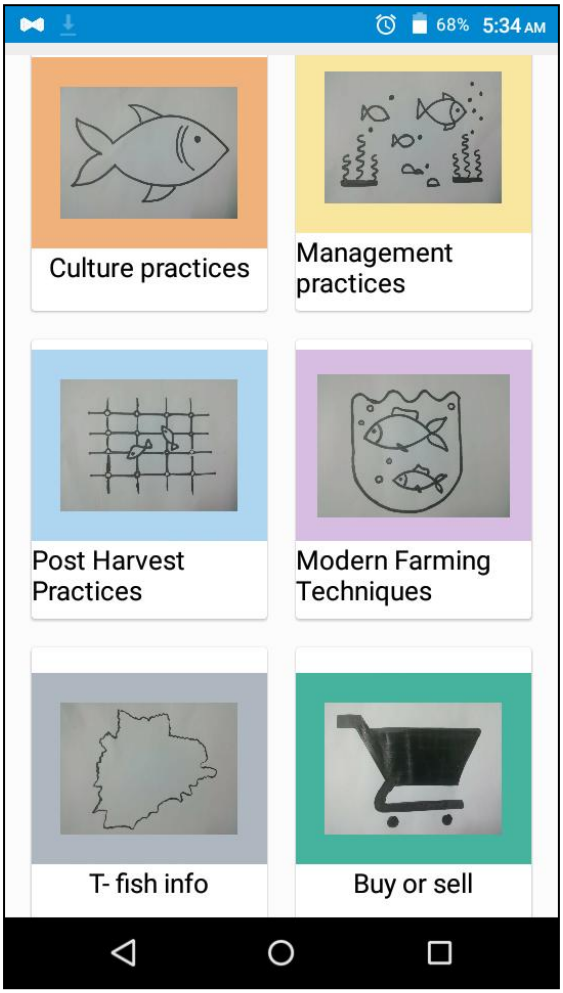


Figure 35: Home Screen of the mobile app

With each click on the specific feature further information can be availed of. When icon culture practices is clicked, a list view opens from which the user can choose the species he/she is interested to get the information about.

Screen Shot of Culture practices:

The screen which provides information on culture practices has been given in the figure 36.

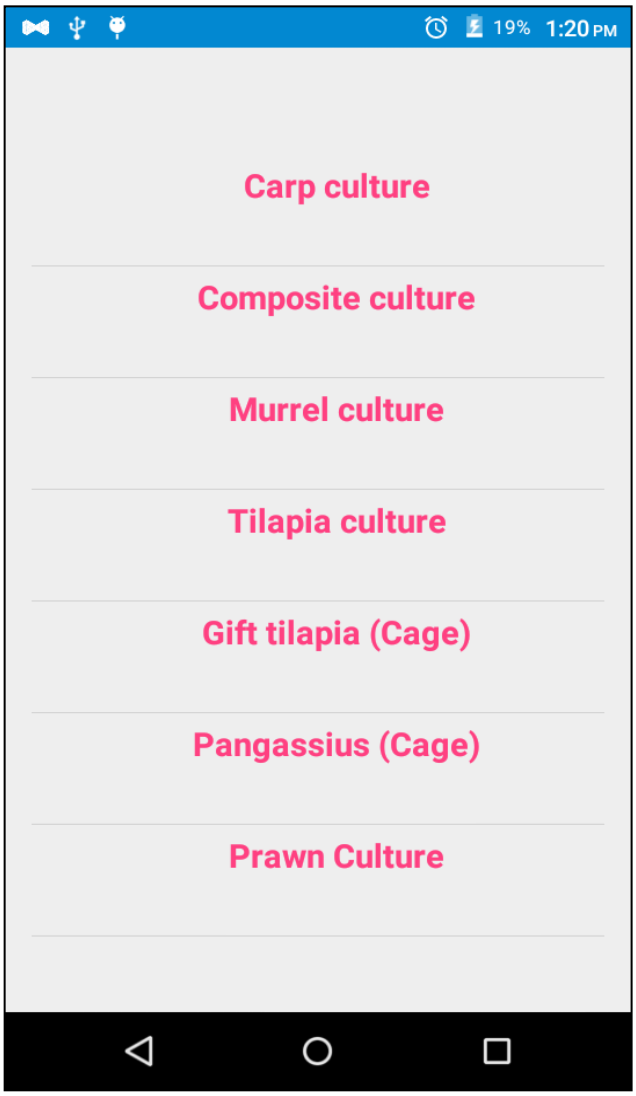


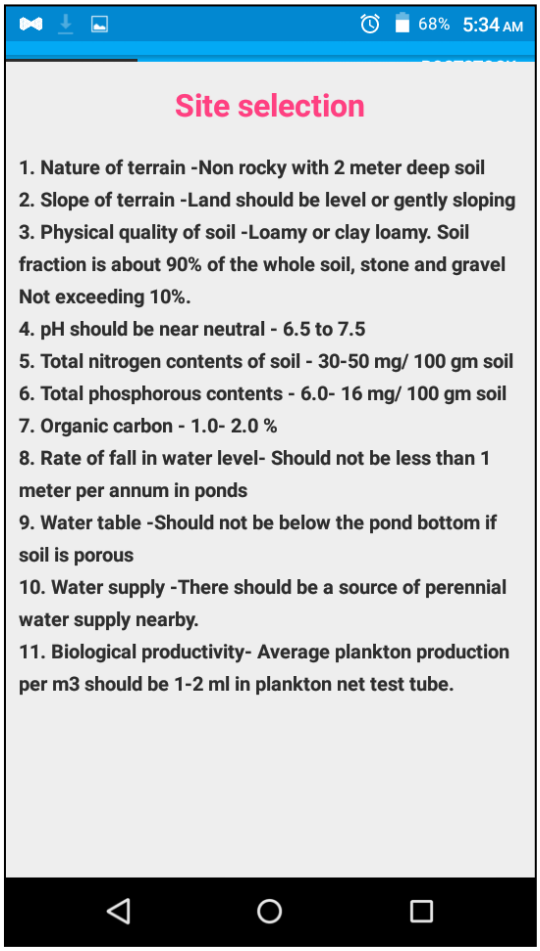
Figure 36: Screen Shot of Culture Practices

This screen has icons for Culture of Carp, Composite, Murrel, Tilapia, GIFT tilapia in cage, Pangassius in cage and Fresh water prawn. In the culture practices when the user clicks on carp culture a screen will be displayed from which he/she can get the information on site selection, prestocking, stocking, poststocking. This is presented from figure 37 to 40.

Screen Shot of Carp culture

The relevancy score of this feature given by both farmers and experts was 4. The content validity ratio given by the experts was 0.85. The user can slide on the screens so that he/she gets the information on sub heads.

Site selection screen of Carp culture



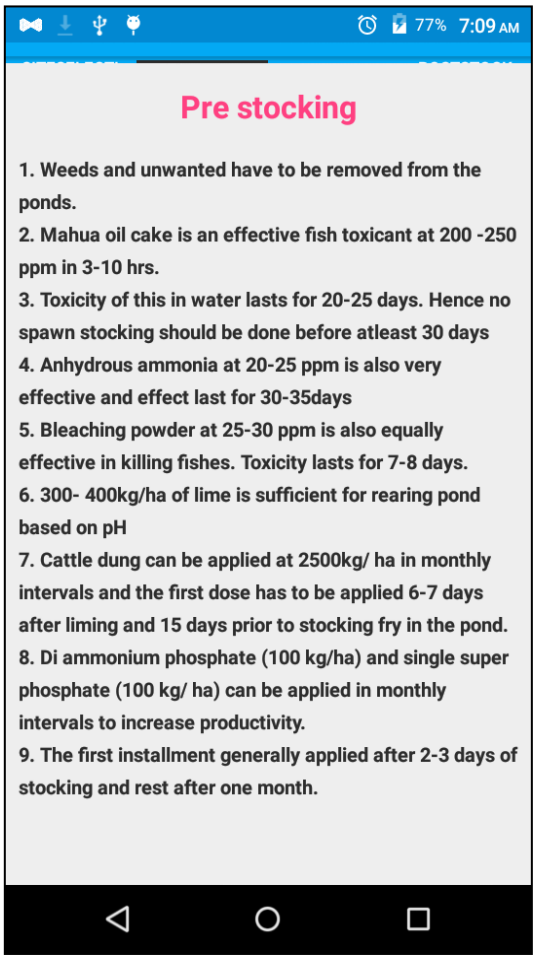
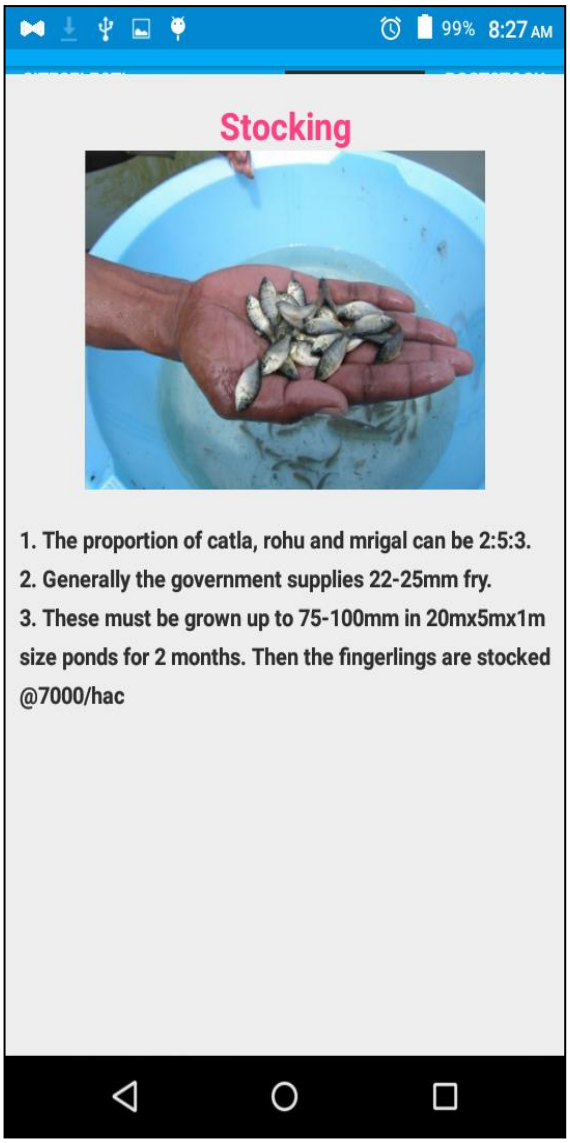


Figure 37 and 38: Screen Shot of Site selection and pre stocking of Carp culture

Screen shot of Stocking and post stocking



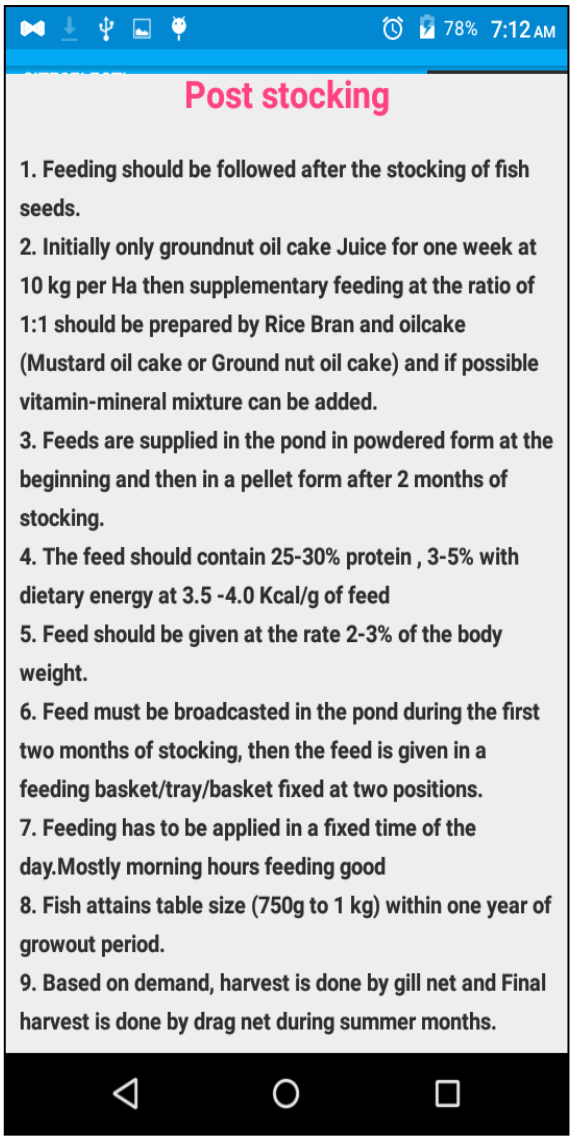


Figure 39 and 40: Screen Shot of Stocking and Post stocking of Carp culture

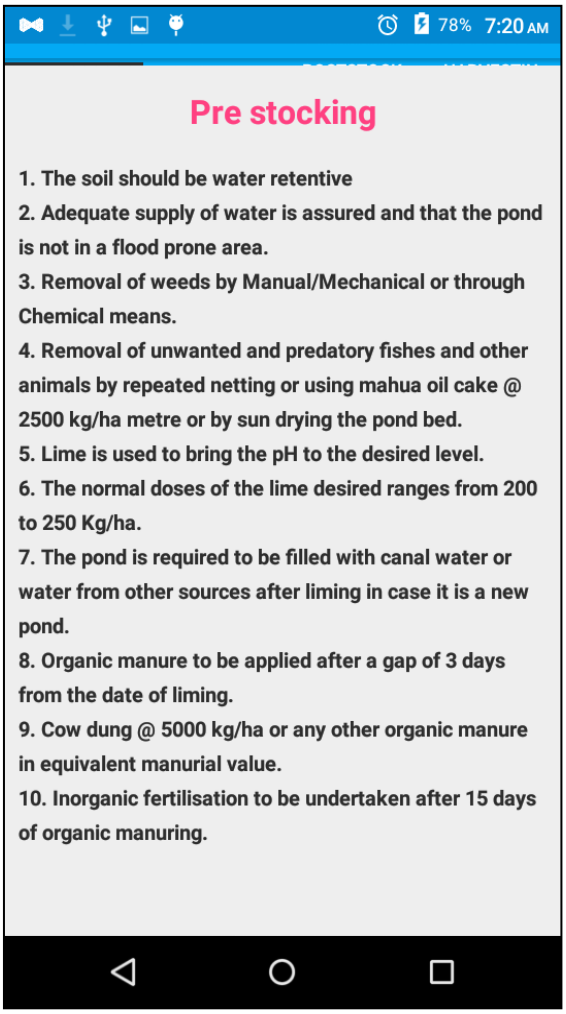
On the icon for culture practices, when the user clicks composite culture, the information will be displayed and this is presented from figure 41 to 44.

Screen Shot of Composite culture

In this screen composite culture information on pre stocking, stocking, post stocking and harvesting is given. The relevancy score given by the farmers and experts for this feature was 4. The content validity ratio given by the experts was 0.85

Screen Shot of Pre stocking and Stocking

In figure 41 information on pre stocking of composite culture has been given. The information on stocking has been given in figure 42. .



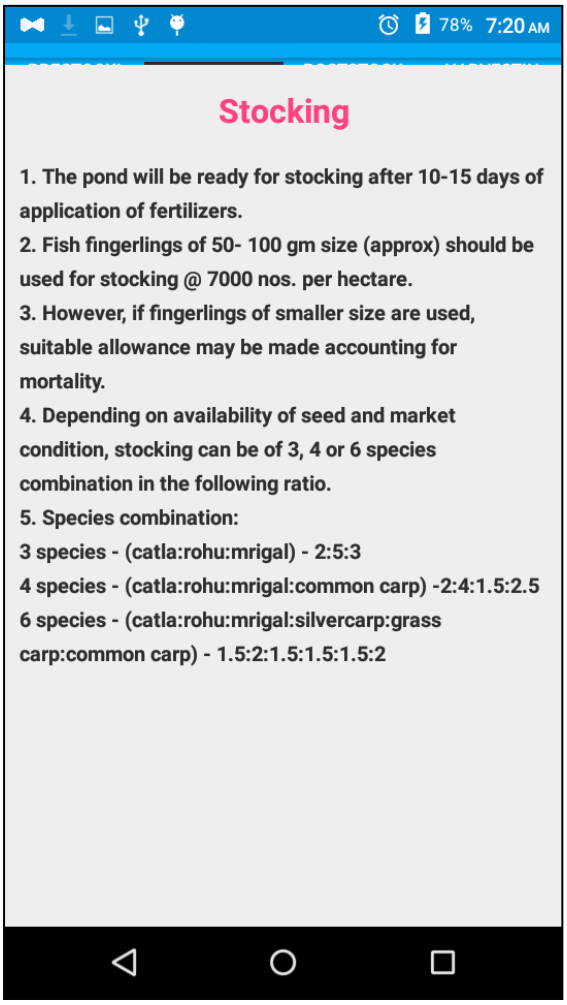


Figure 41 and 42: Screen Shot of Pre stocking and stocking of composite culture

The screen which gives information on post stocking and harvesting is given in figure 43 and 44.

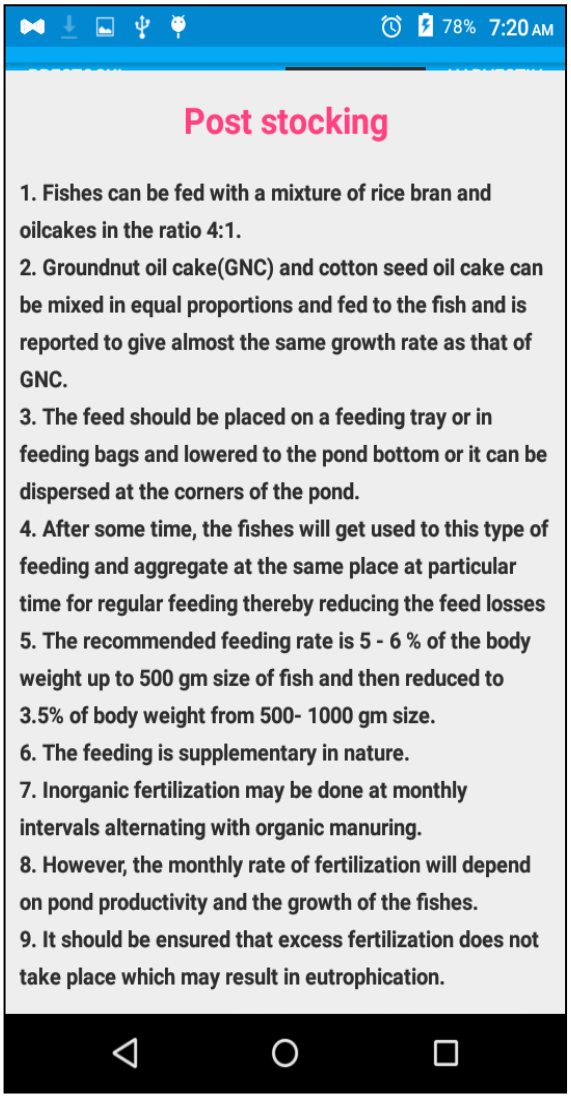


Figure 43 and 44: Screen shot of Post stocking and harvesting of composite culture

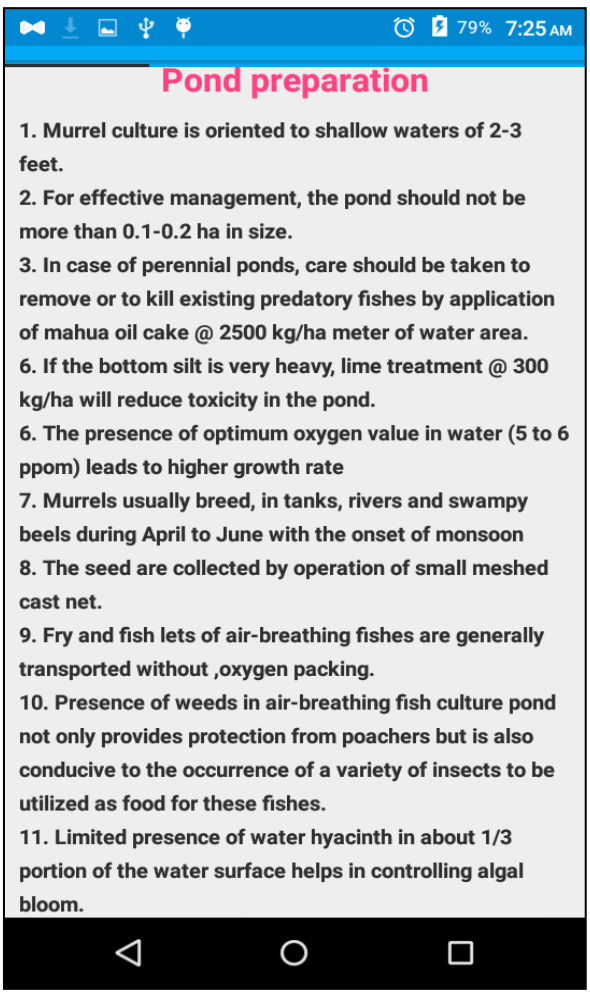
When the user clicks on Murrel culture, the screen will be displayed providing information on culture of Murrels. It is explained in screenshots from figure 45 to 48.

Screen Shot of Murrel culture

In murrel culture the information on pond preparation, nursery, growout culture and feeding of murrel is given. the relevancy score given by the farmers and experts is 3.9 and 4. The content validity ration given by experts is 0.80

Screen Shot of Pond Preparation

In figure 45, the information on preparation of pond for murrel culture is given. Screen Shot of Nursery screen is given in figure 46.



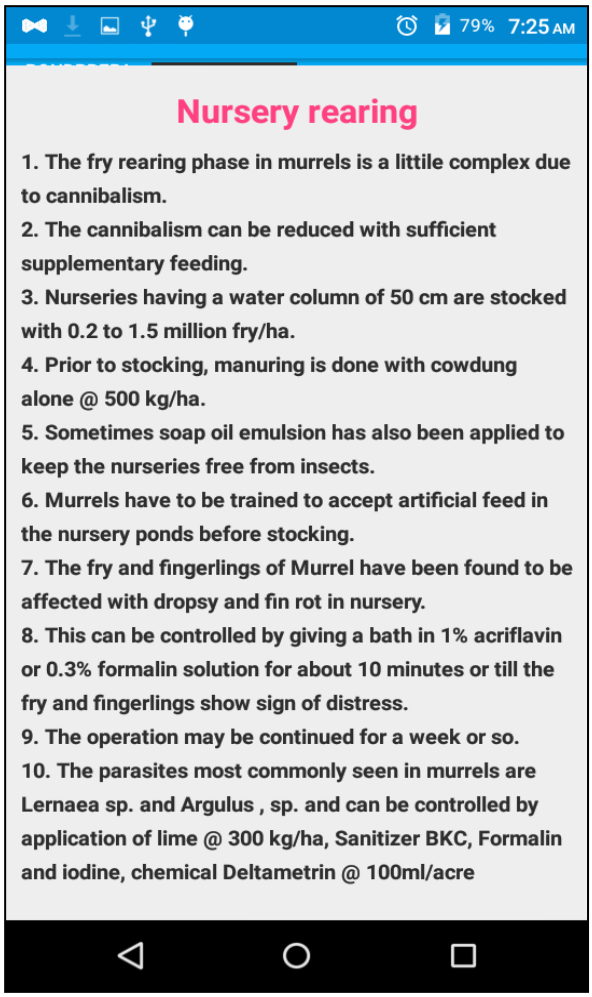


Fig 45 and 46: Screen shot of Pond preparation and nursery rearing of murrel culture

Screen Shot of Growout Murrel culture

In figure 47 the grow out culture of murrels is given

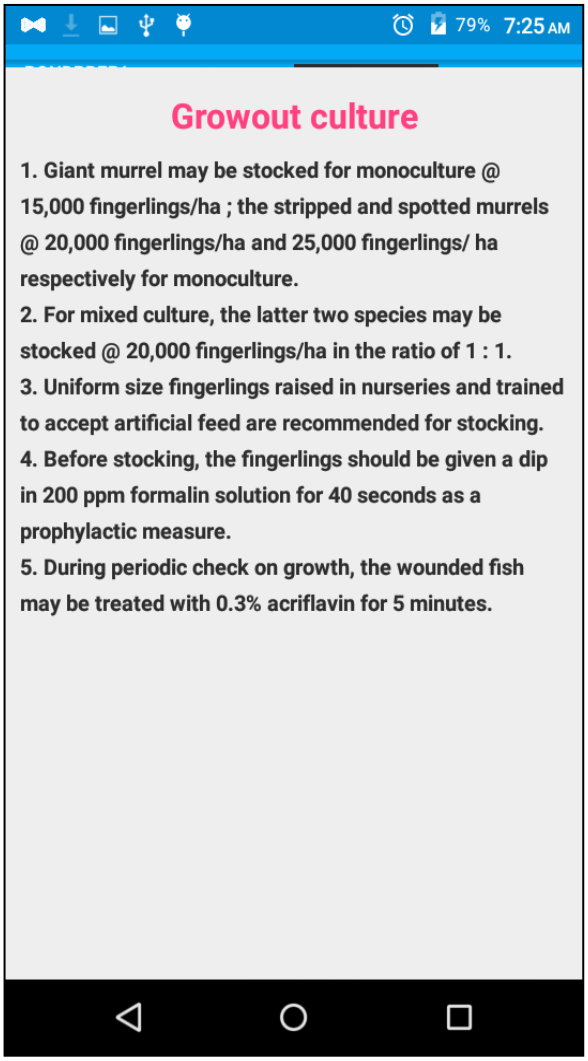


Fig 47 and 48: Screen Shot of Growout culture and Feeding(Murrel)

In the culture practices when the user clicks the Tilapia culture, a screen will be displayed providing information on pond preparation, growout farming and feeding of Tilapia. This is explained from figure 49 to 51.

Screen Shot of Tilapia culture screen

The relevancy score given by farmers and experts is 3.9 and 4 respectively. The content validity ration given by the experts is 0.95.

Pond preparation for Tilapia culture

The steps to be followed in pond preparation for tilapia culture is given in figure 49.

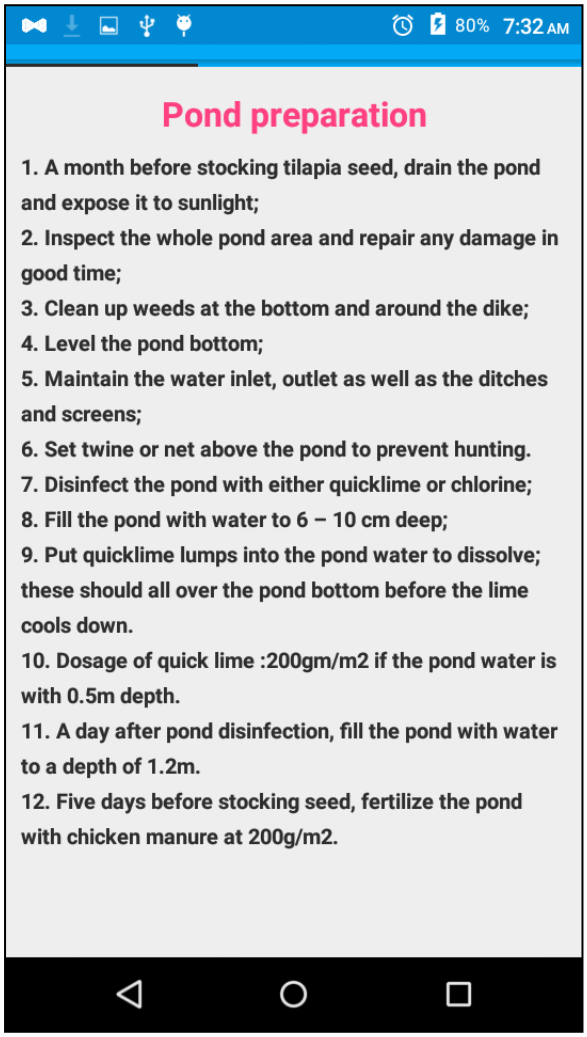
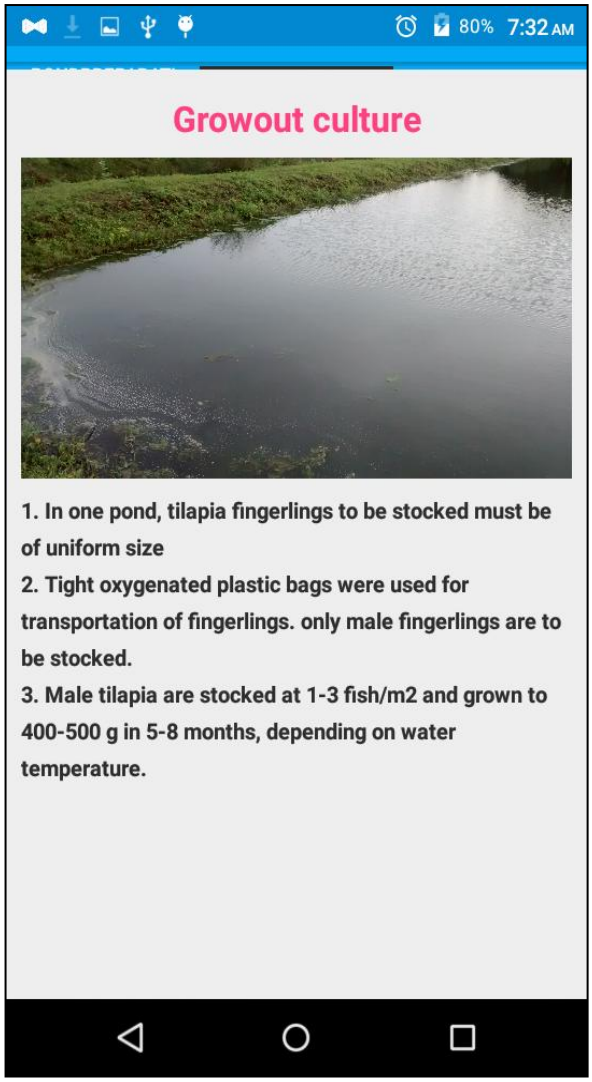


Fig 49: Screen shot Pond preparation (Tilapia)

Screen Shot of Growout culture and Feeding for Tilapia culture

Information on growout farming of tilapia is given in figure 50.

Screen Shot of Tilapia feeding is given in figure 51. In the figure the feeding schedule of tilapia is given as per the size of the fish.



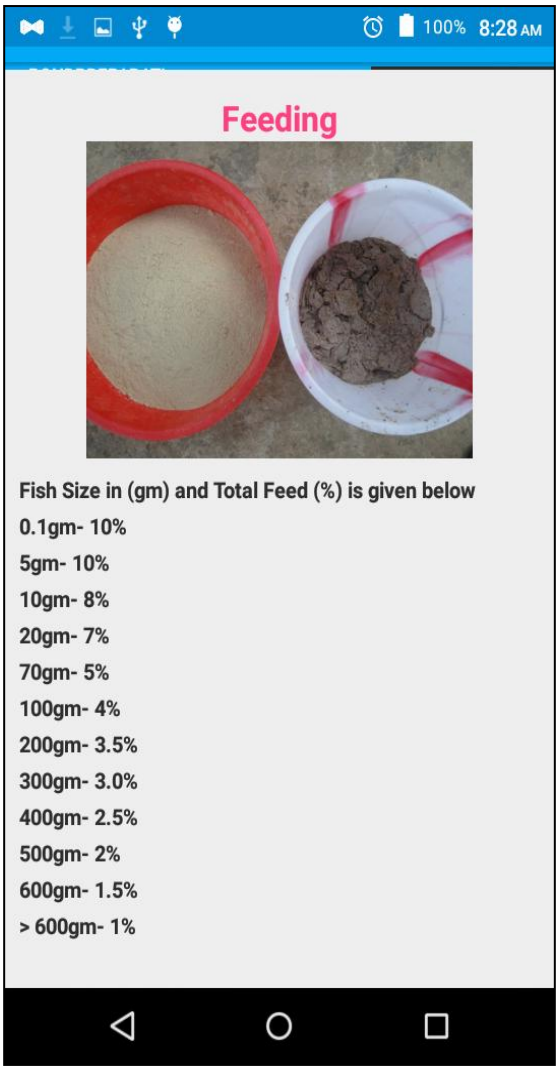


Fig 50 and 51: Screen shot of Growout culture and Feeding(Tilapia)

When the user clicks GIFT tilapia culture, a screen will be displayed providing information on culture of GIFT tilapia in cages. This is explained in the figure 52.

Screen Shot of GIFT Tilapia

The relevancy score given by the farmers and experts is 3.5 and 3.7 respectively. The content validity ratio given by the experts is 0.95.

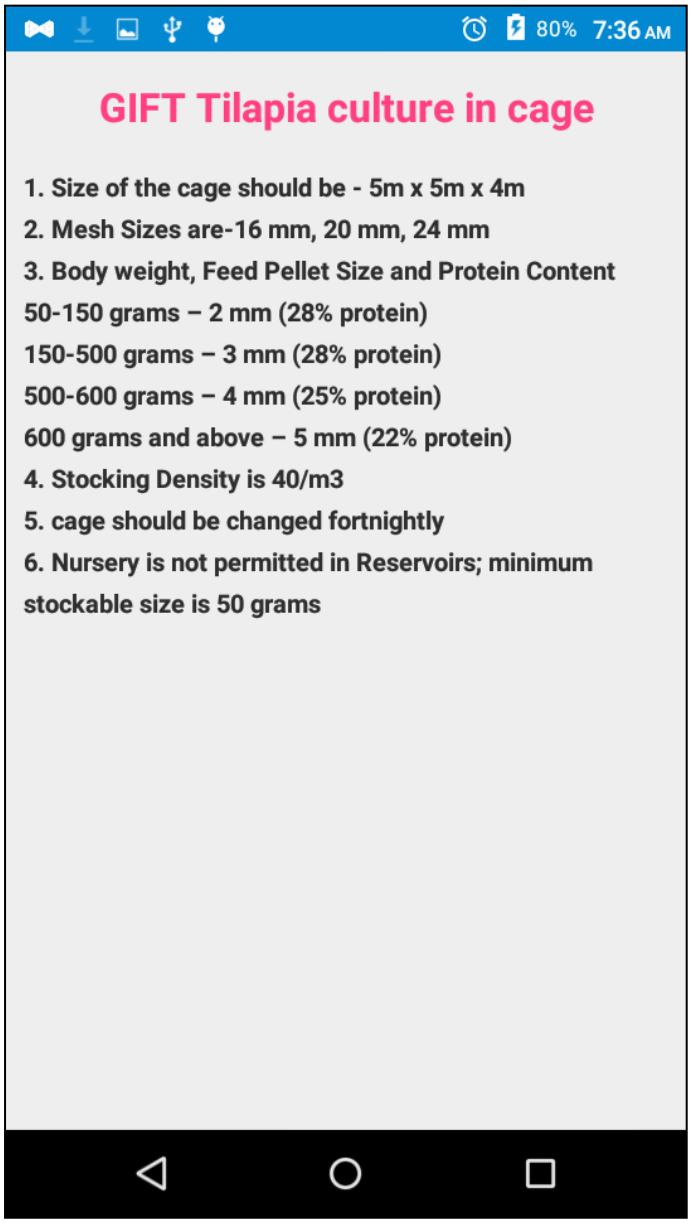


Figure 52: Screen shot of GIFT Tilapia culture in cage

When the user clicks on Pangassius culture, a screen will be displayed providing information on culture of pangassius in cage. It is explained in figure 53.

Screen Shot of Pangassius culture in cages

The relevancy score given by the farmers and experts is 3.5 and 3.7. the content validity ratio given by experts is 0.9

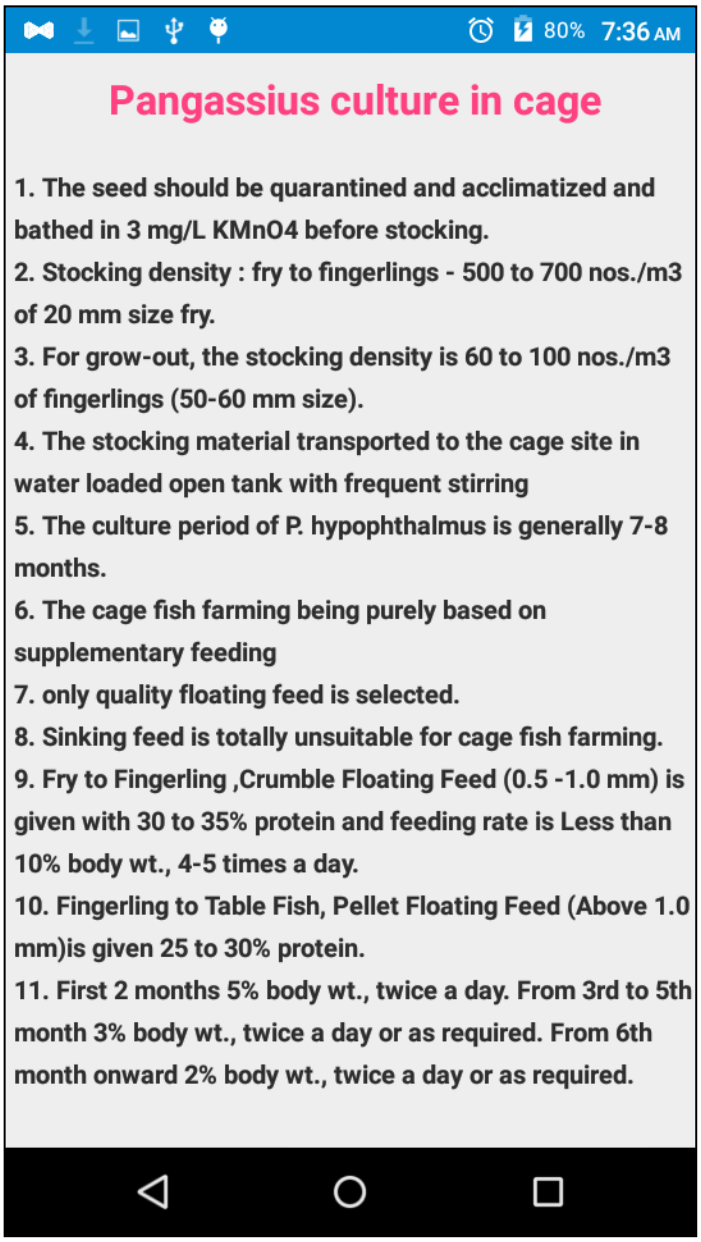


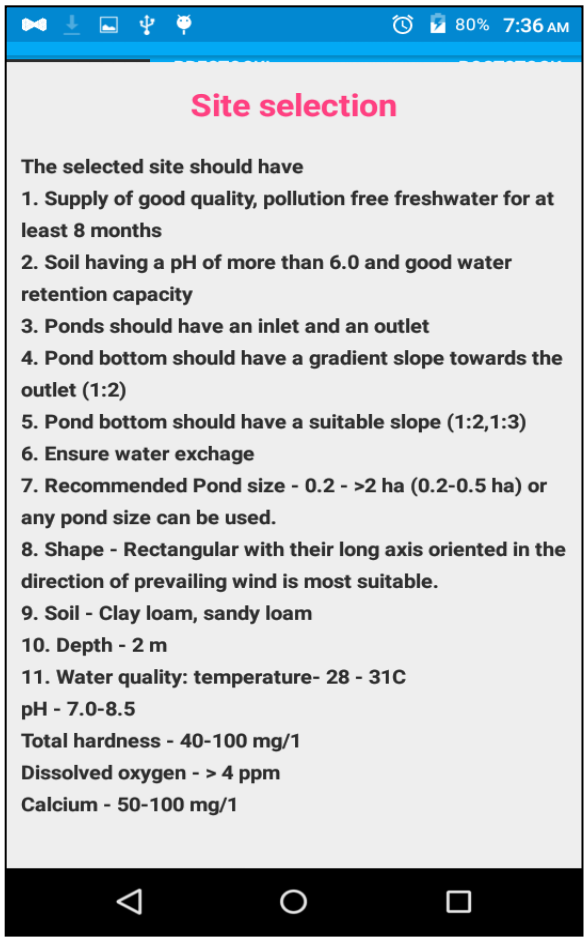
Figure 53: Screen shot of Pangassius culture in cage

In the culture practices when the user clicks Prawn culture, a screen will be displayed providing information on site selection, pre stocking, stocking and post stocking. The user can slide the screens to get the information on various components. It is explained from figure 54 to 57.

Screen Shot of Prawn culture

The relevancy score given by the farmers and experts is 3.8 and 4. The content validity ratio given by experts is 0.85.

Screen Shot of Site selection



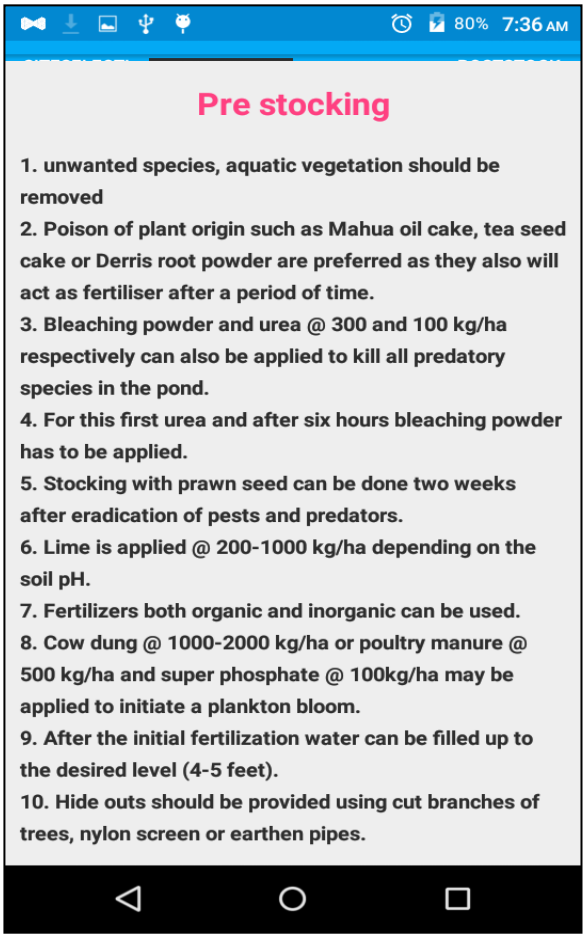


Figure 54 and 55: Screen shots of Site selection and Pre stocking of Prawn culture

From the figure 54 it is clear that the criteria for selecting the site for prawn culture is given. In figure 55, the information on measures to be followed prior to stocking is given.

Screen Shot of Stocking and Post stocking of Prawn culture

In figure 56. the information on stocking density and measures to be followed during stocking is given.In figure 57, the information on the measures to be taken after stocking is given.

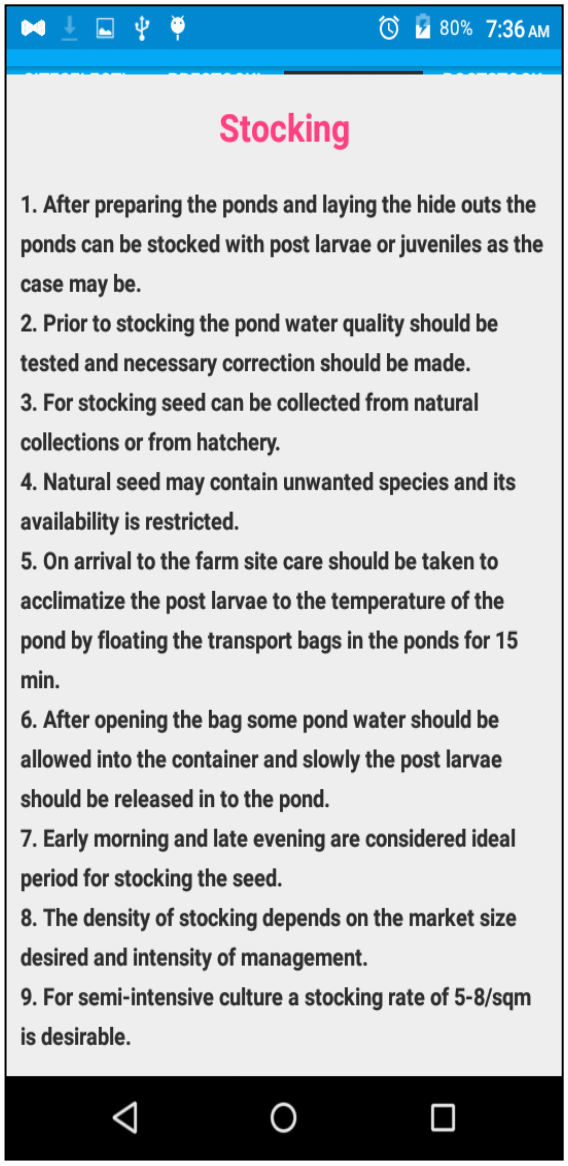


Figure 56: Stocking screenshot of Prawn

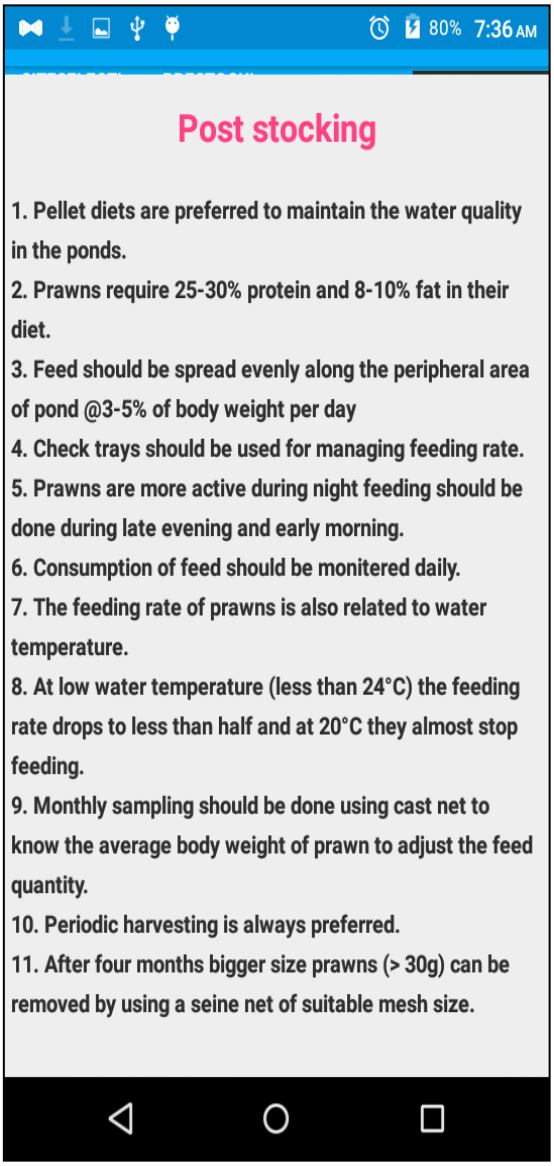


Figure 57: Post stocking of Prawn

When the user clicks the management practices in the screen with a view will be displayed consisting of Water quality management, feed management and health management. This is explained in the figure 58.

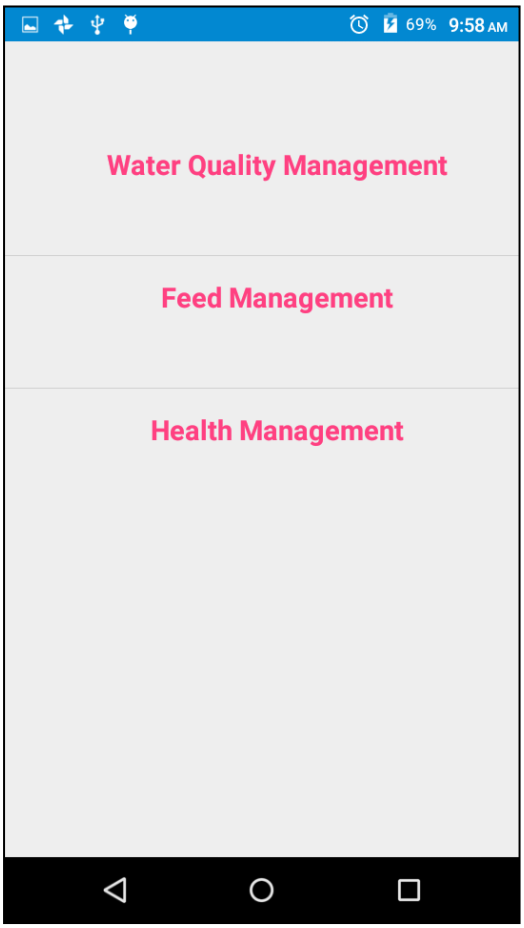


Figure 58: Screen Shot of Management practices

When the user clicks water quality management, a screen will be displayed providing information on the water quality parameters- acceptable range, desirable range, stress range and measures to be followed to maintain the desirable range. The screenshots of water quality management are given from figure 59a to 59f.

Screen Shot of Water quality management

The relevancy score given by the farmers and experts was 4. The content validity ratio given by experts was 0.

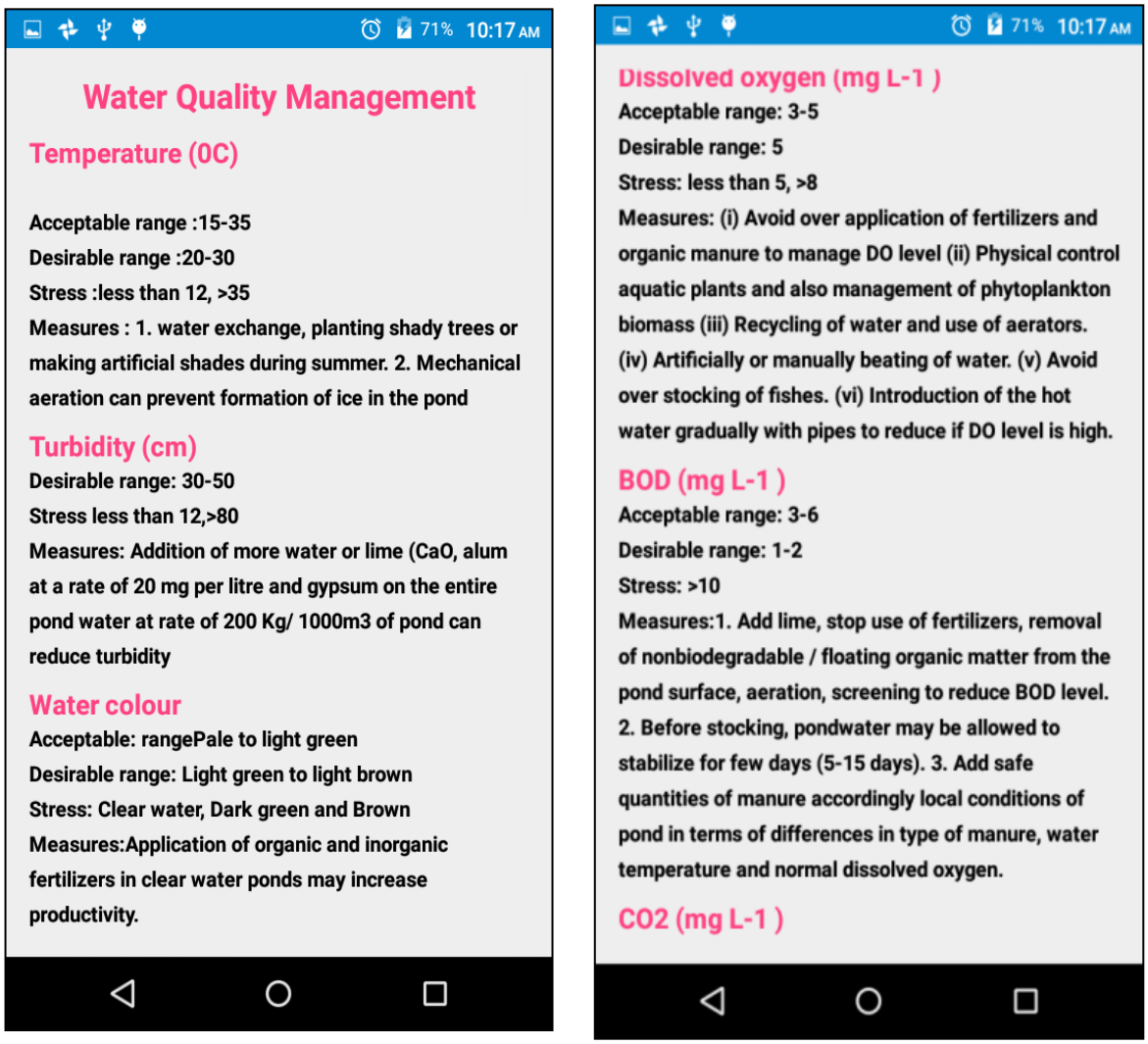
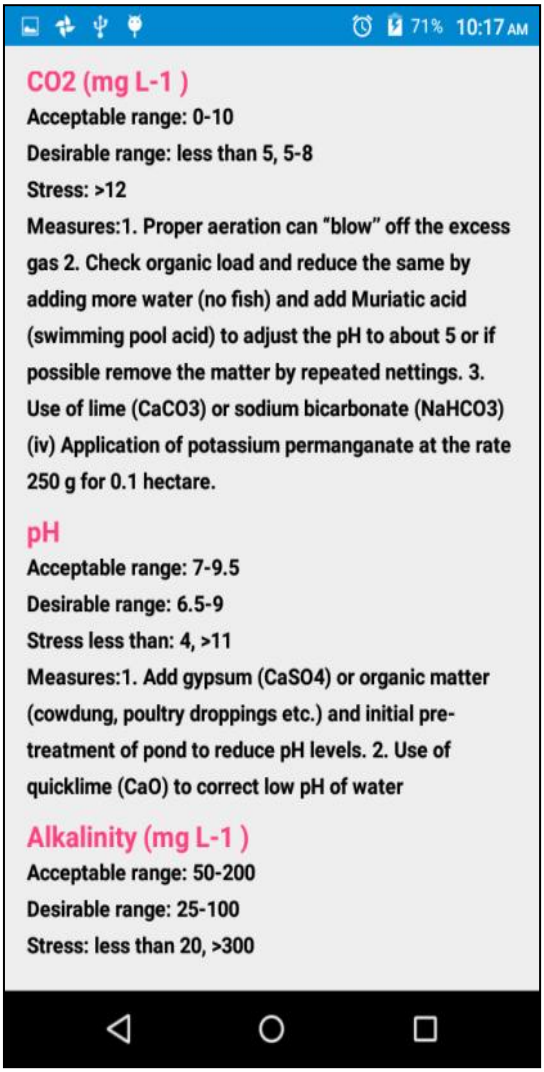


Figure 59a and b: 1st and 2nd Screenshot of water quality

From the above it is clear that in figure 59a. The information on desirable, acceptable, stress range and measures to maintain temperature, turbidity and water color are given.

In figure 59b the ranges and measures to be taken for maintaining Dissolved oxygen and Biological oxygen demand is given.



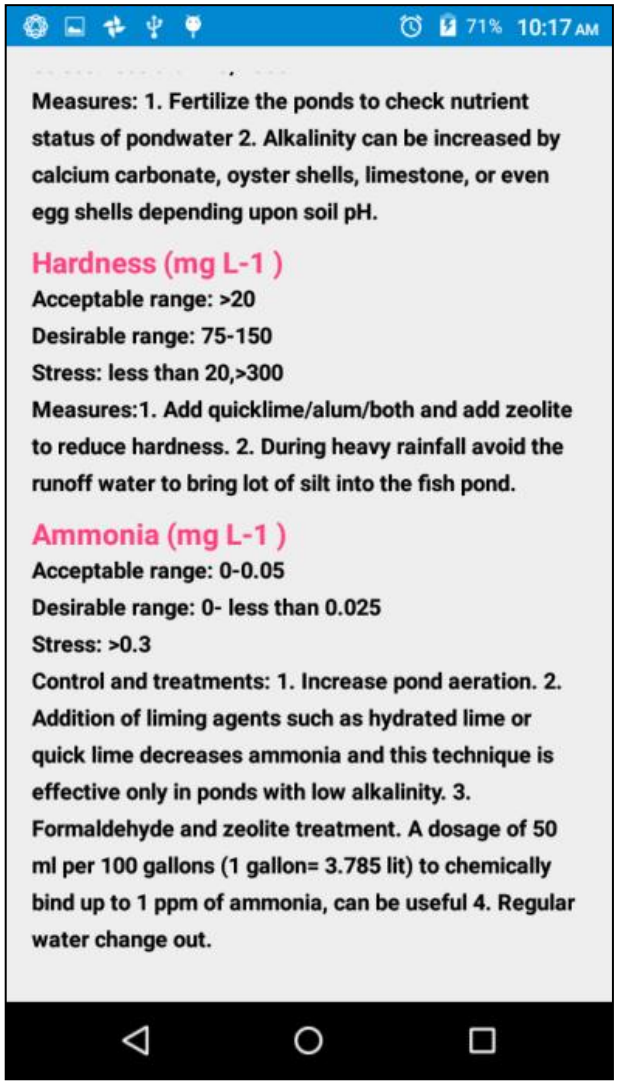
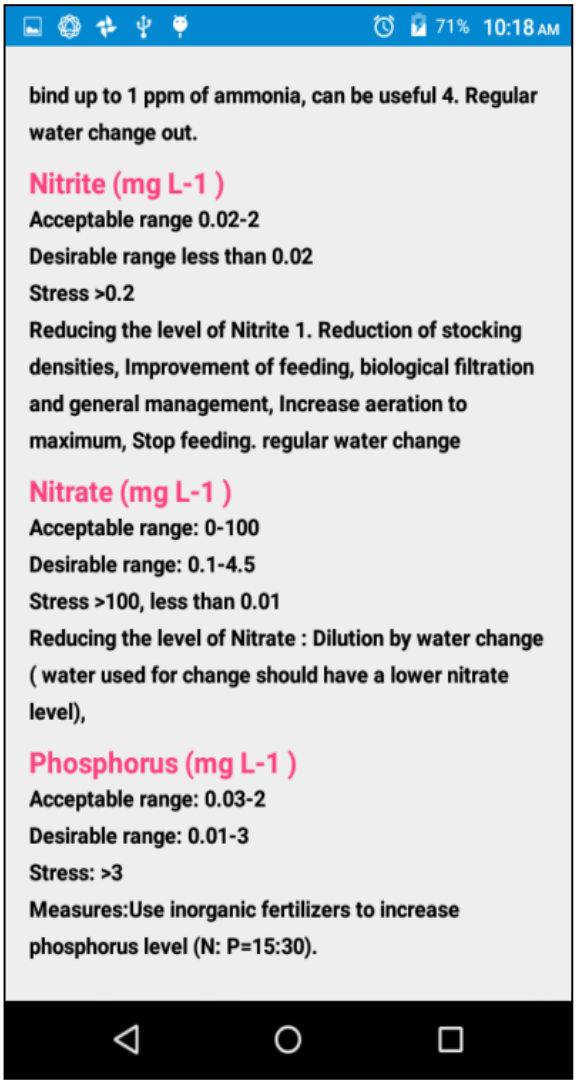


Figure 59c and d: 3rd and 4rth Screenshot of water quality

In the figure 59c, information on ranges and measures to be taken to maintain carbondioxide, pH and alkalinity is given

In the figure 59d, information on ranges and measures to be taken to maintain hardness and ammonia are given



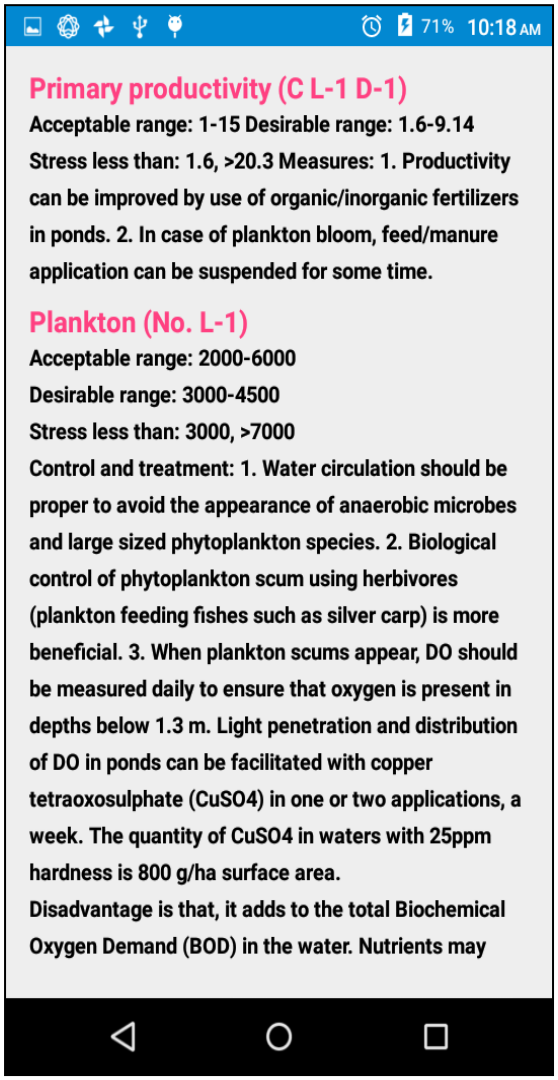


Figure 59e and f: 5th and. 6th Screenshot of water quality

In figure 59e, information on ranges and measures to be taken to maintain nitrite, nitrate and phosphorous are given. In figure 59f information on primary productivity and plankton are given.

On the screen of management practices when the user clicks feed management a screen will be displayed providing information it. The relevancy score both for farmers and experts was 4. The content validity ratio given by experts is 0.85. The screenshot has been presented in figure 60.

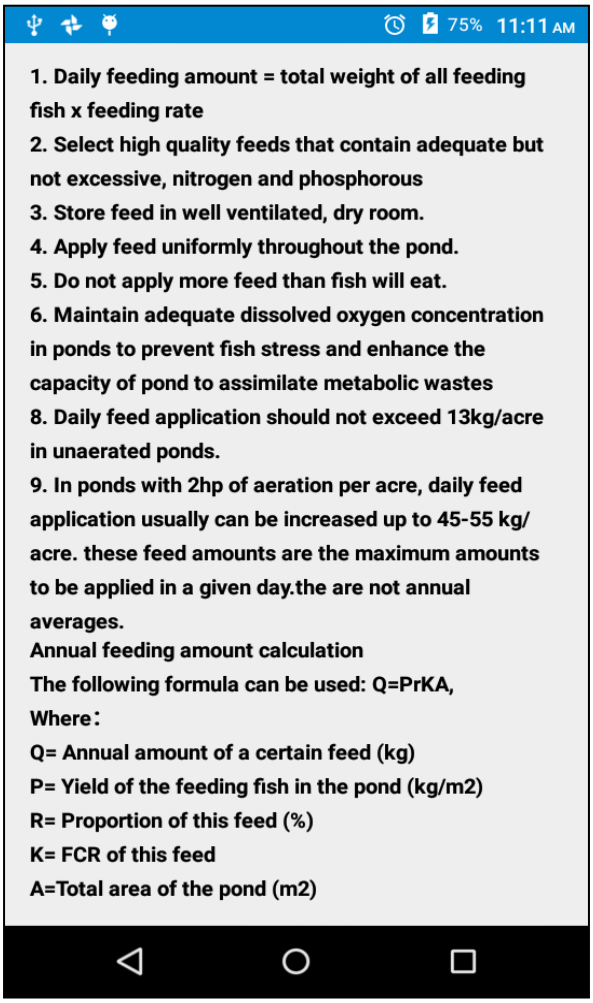


Figure 60: Screen shot of Feed management

In figure 60 information on calculation of feed amount, selection of feeds and application of feeds is given

In the screen of management practices, when user clicks on health management a screen is displayed on bacterial diseases with images and text on disease causing agent, symptoms and measures to be followed. The user when slides the screen the information on parasitic, fungal, viral and environmental diseases in the same format is displayed. Some of the images are taken from the

internet and the credit for the information sources are given at the end of each screen.

Screen Shot of Health Management

The relevancy score given by both farmers and experts was 4. The content validity ratio given by the experts is 0.80. This is presented in screenshots from figure 61a to 66g.

Screen Shot of Bacterial Diseases

In bacterial diseases the causative agent, symptoms and measures to treat eye disease, ulcer, columnaris, dropsy, and epizootic ulcerative syndrome are given. This is given from figure 61a to 67e

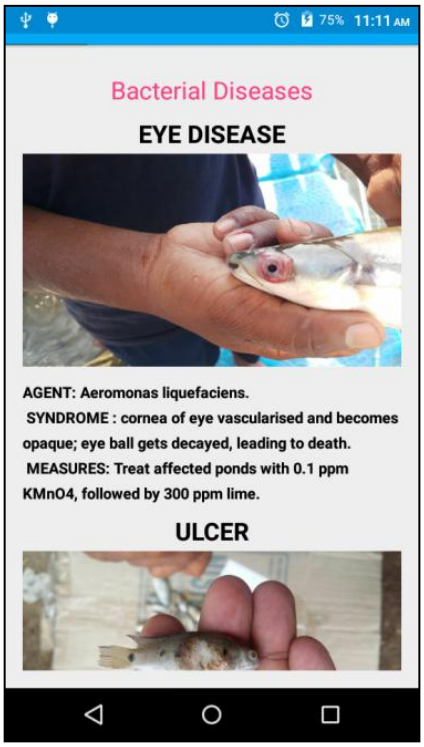


Figure 61a: First screenshot of bacterial diseases

In the figure 61b, information on causative agent, symptoms, and measures to treat ulcer disease are given.

In the figure 61c, information on causative agent, symptoms, and measures to treat columnaris disease are given.

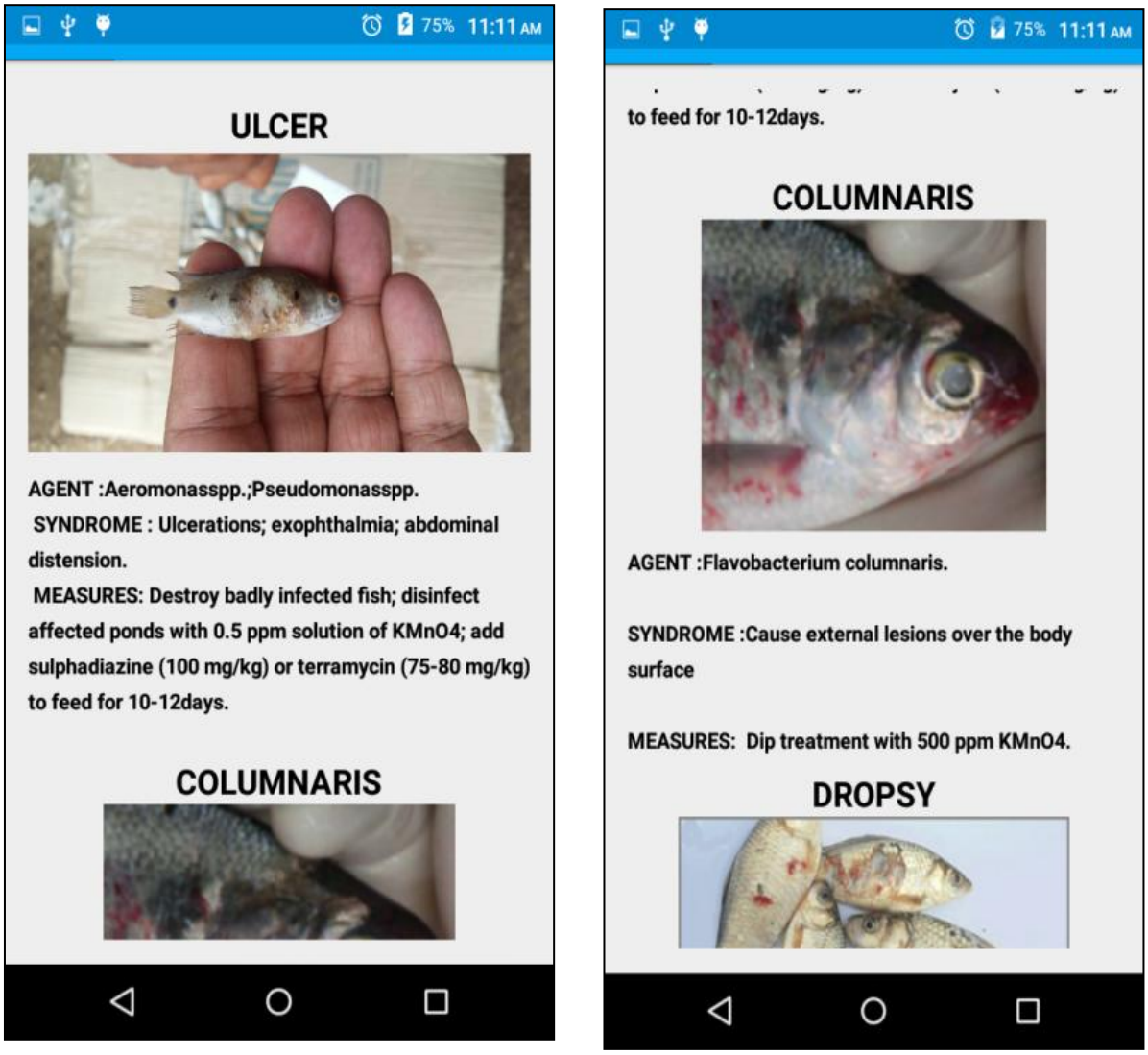
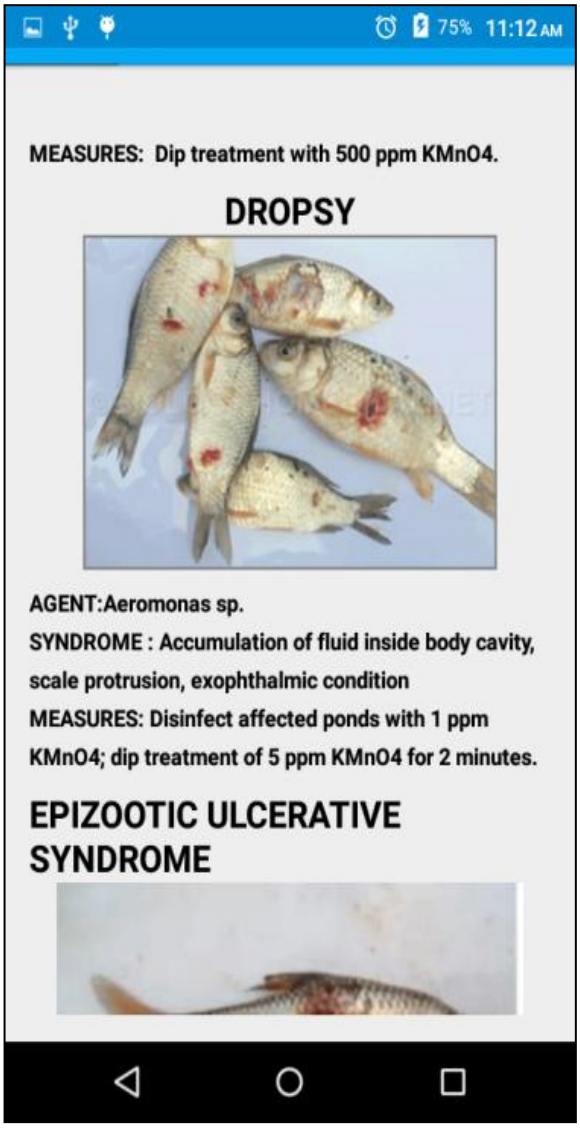


Figure 61b and c : 2nd and 3rd screenshot of bacterial diseases

In figure 61d information on causative agent, symptoms, and measures of dropsy disease are given.

In figure 61e information on causative agent, symptoms, and measures of EUS disease are given. The credits for image sources of Columnaris, Dropsy and EUS are given at the end of the screen.



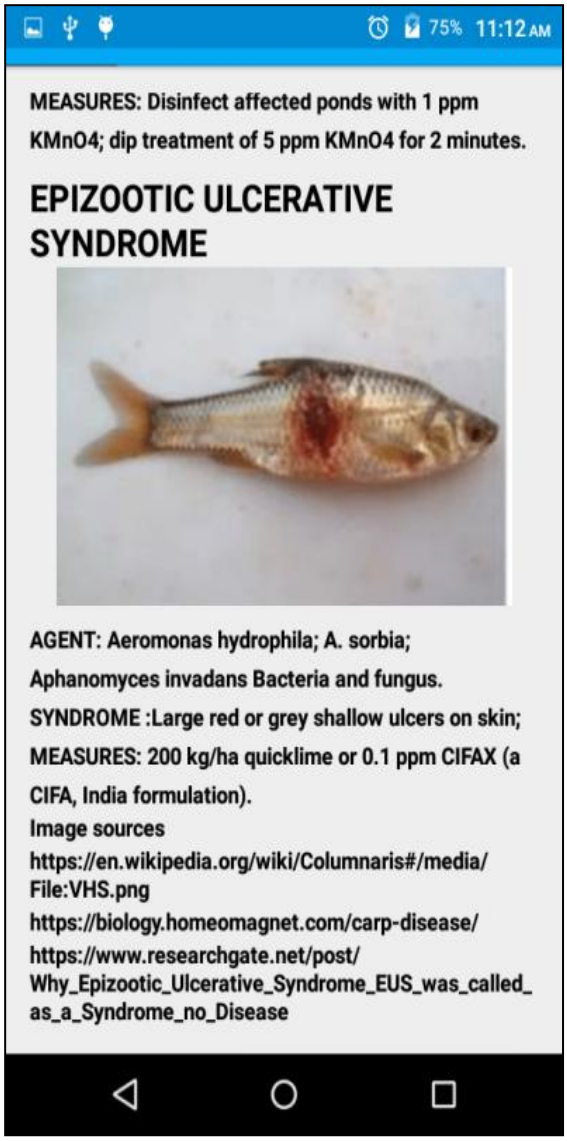
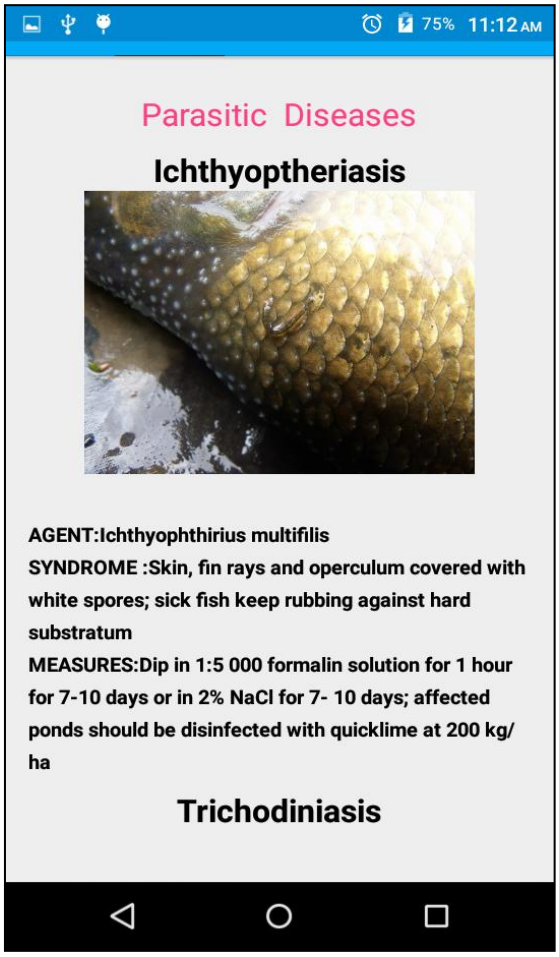


Fig 61d and e: 4rth and 5th screenshot of bacterial diseases

Screen shot of parasitic diseases

In the parasitic diseases screen information on causative agent, symptoms and measures to be taken to treat Ichthyoptheriasis, Trichodiniasis, Gyrodactylus and dactylogyrus, blackspot disease and argulosis with images are given from figure 62a to 62e.



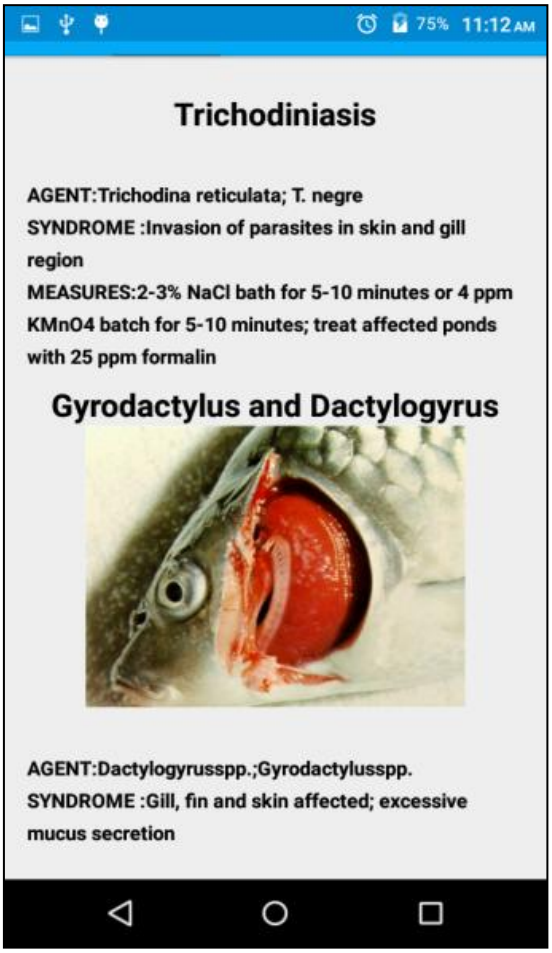


Fig 62a and b: 1st and 2nd screen shot of parasitic diseases

Figure 62a, provides information on causative agent, symptoms and measures to treat Ichthyoptheriasis.

Figure 62b provides information on causative agent, symptoms and measures to treat Trichodiniasis.

Figure 62c provides information on causative agent, symptoms and measures to treat Gyrodactylus and Dactylogyrus.

Figure 62d, provides information on causative agent, symptoms and measures to treat black spot disease.

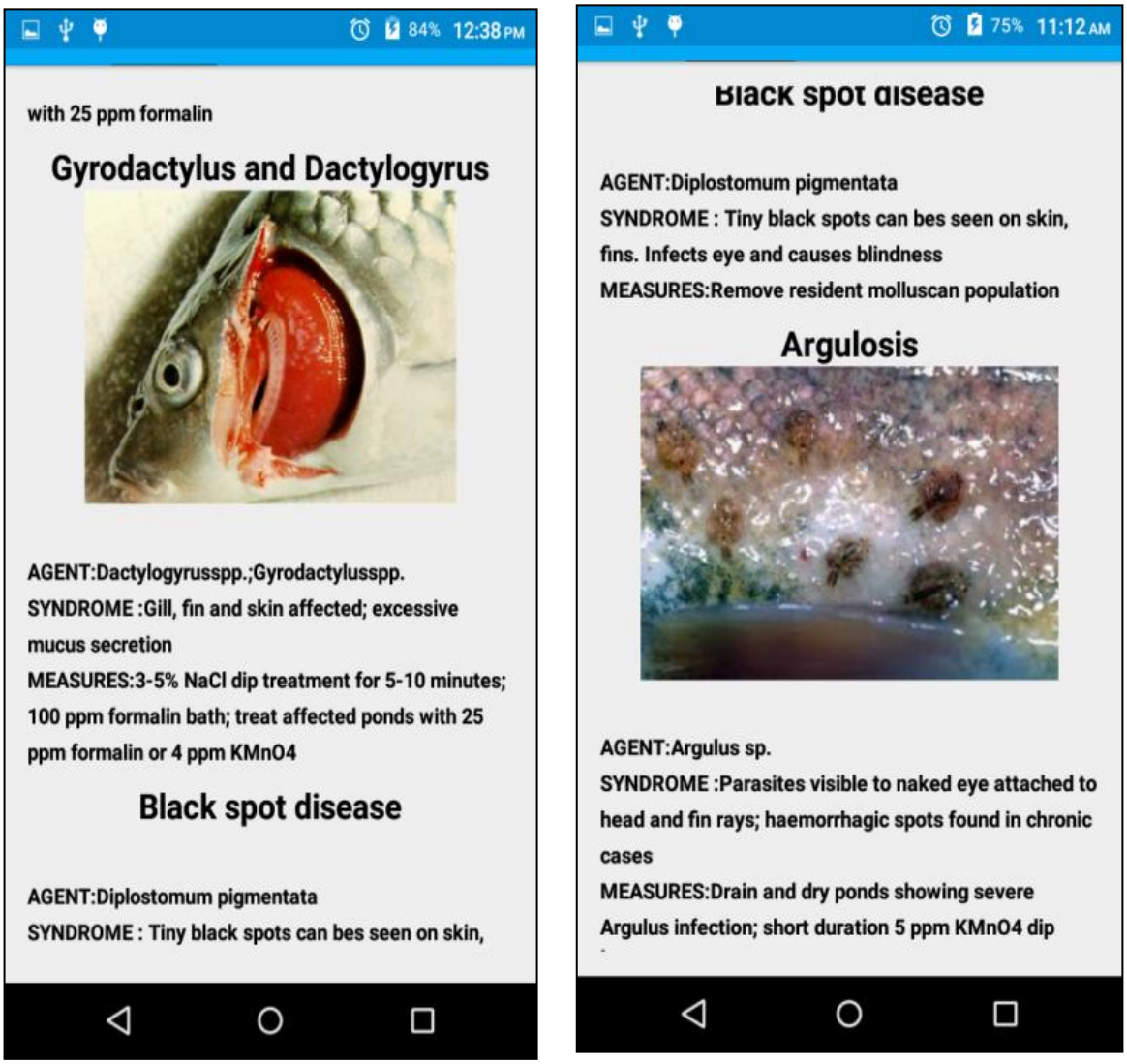


Figure 62c and d: 3rd and 4rth screenshot of parasitic diseases

Figure 62e, provides information on causative agent, symptoms and measures to treat argulosis. The credits for the image sources of the diseases are also given at the end of the screen.

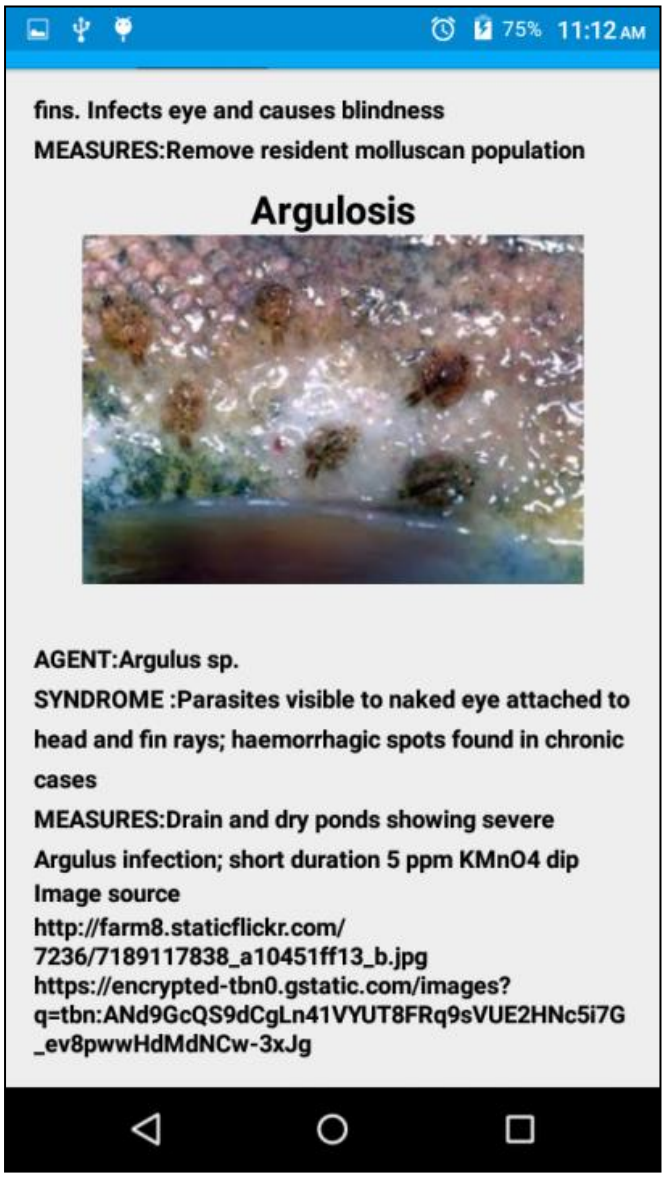
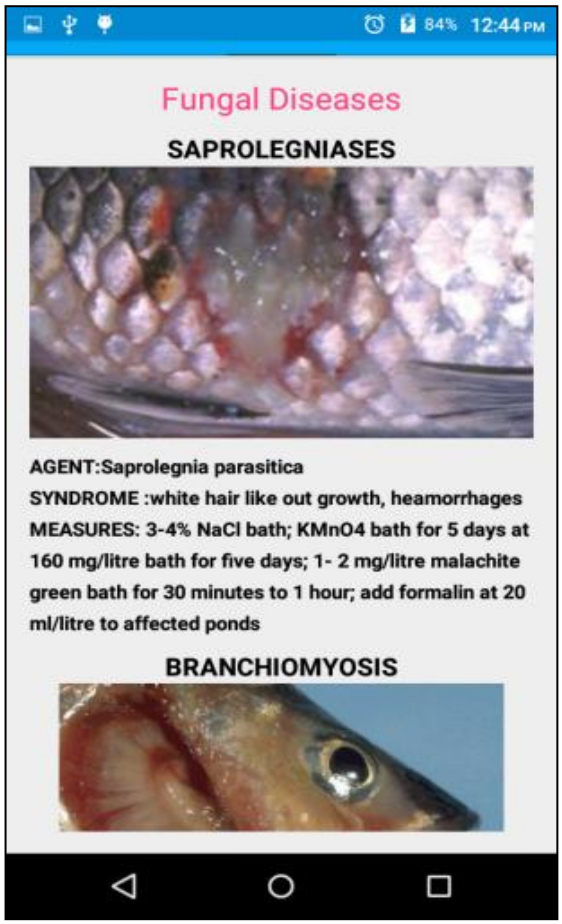


Figure 62e: 5th screenshot of parasitic diseases

When the user slides the screen, information on fungal diseases can be displayed.

Screen Shot of fungal diseases

In the fungal diseases information on causative agent, symptoms and measures to treat saprolegniasis and branchiomysis are given. The screenshots for fungal diseases are given in figure 63a and 63b.



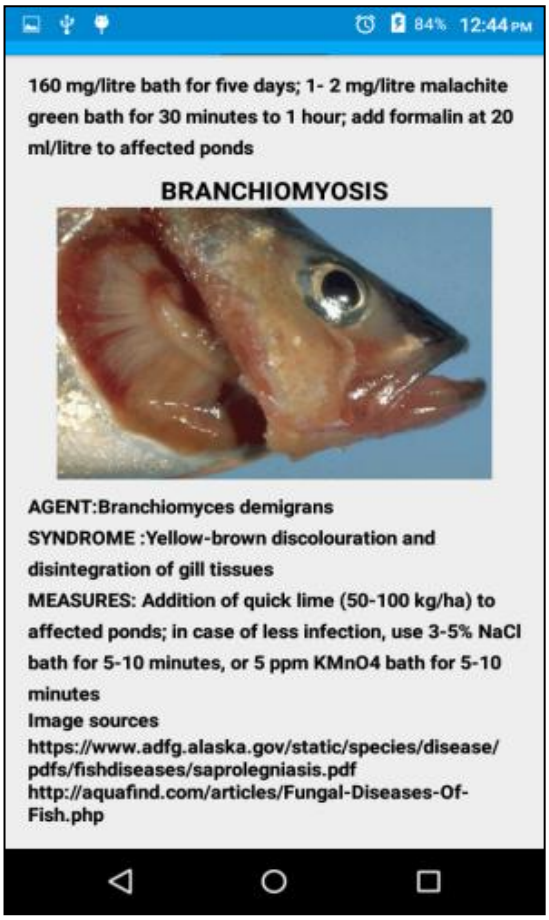


Figure 63a and b: 1st and 2nd screenshot of fungal diseases

In figure 63a, information on causative agent, symptoms and measures to treat saprolegniasis are given.

In figure 63b, information on causative agent, symptoms and measures to treat saprolegniasis are given. Credits are given to the image sources at the end of screen.

Screen Shot of Viral Diseases

In the viral diseases screen information on causative agent, symptoms and measures to treat Viral Heamorrhagic septicemia (VHS) and Carp pox are given. The screen shots for viral diseases are given in figure 64a and 64b.

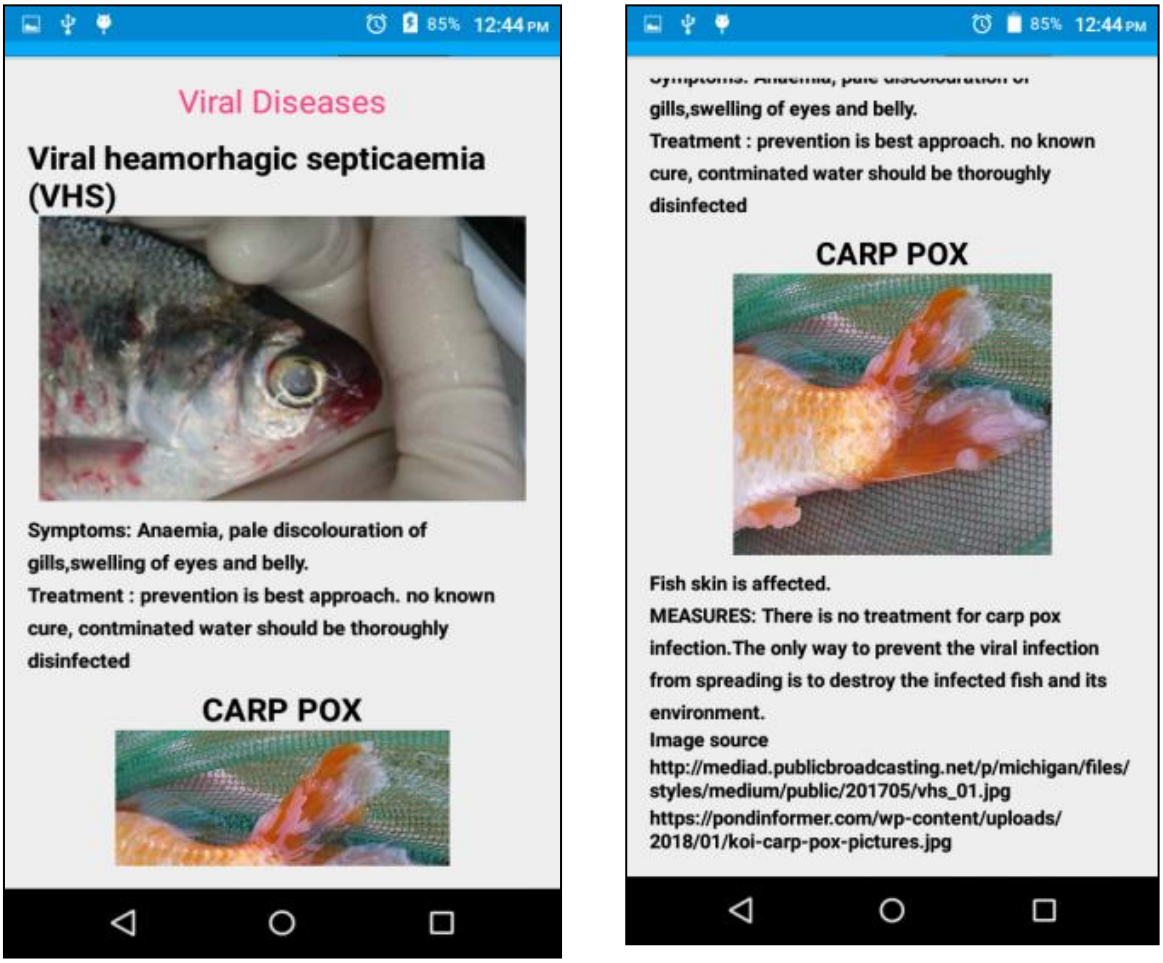


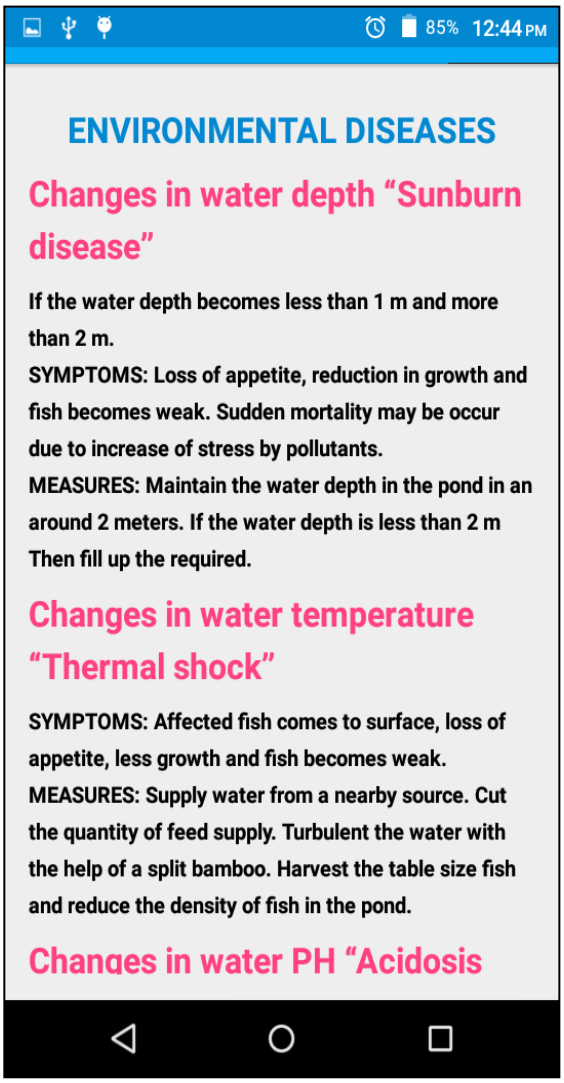
Fig. 64a and 64b: 1st and 2nd screenshot of viral diseases

In figure 64a, information on causative agent, symptoms and measures to treat Viral Heamorrhagic Septicimia are given.

In figure 64b, information on causative agent, symptoms and measures to treat Carp pox are given. Credits are given to the image sources at the end of screen.

Screen Shot of Environmental diseases

In the Screen Shot of environmental diseases information on changes in different environmental parameters, the symptoms and measures to be taken are given. The screenshots for environmental diseases are given from figure 65a to 65g.



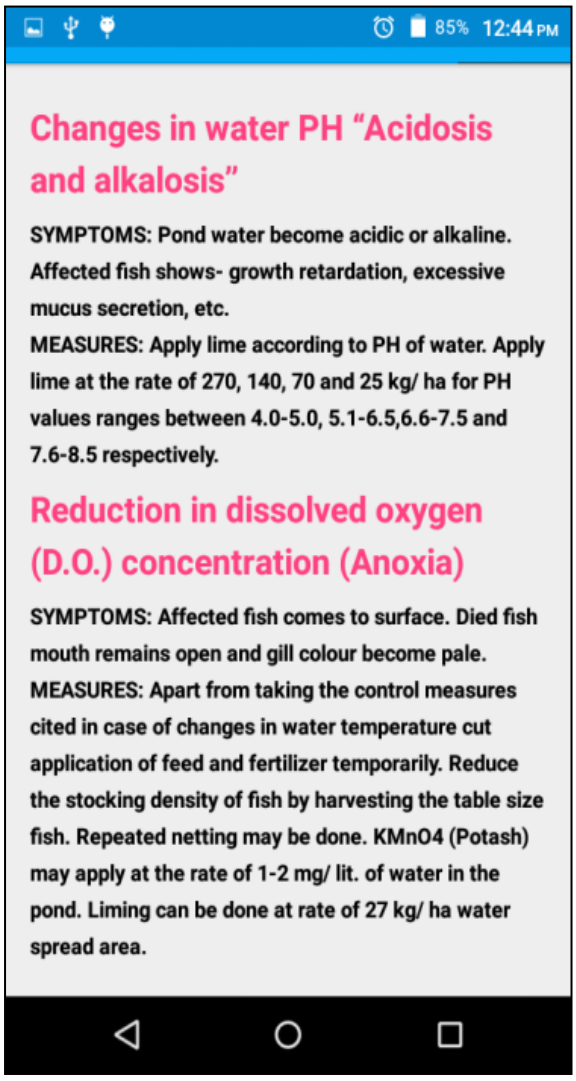
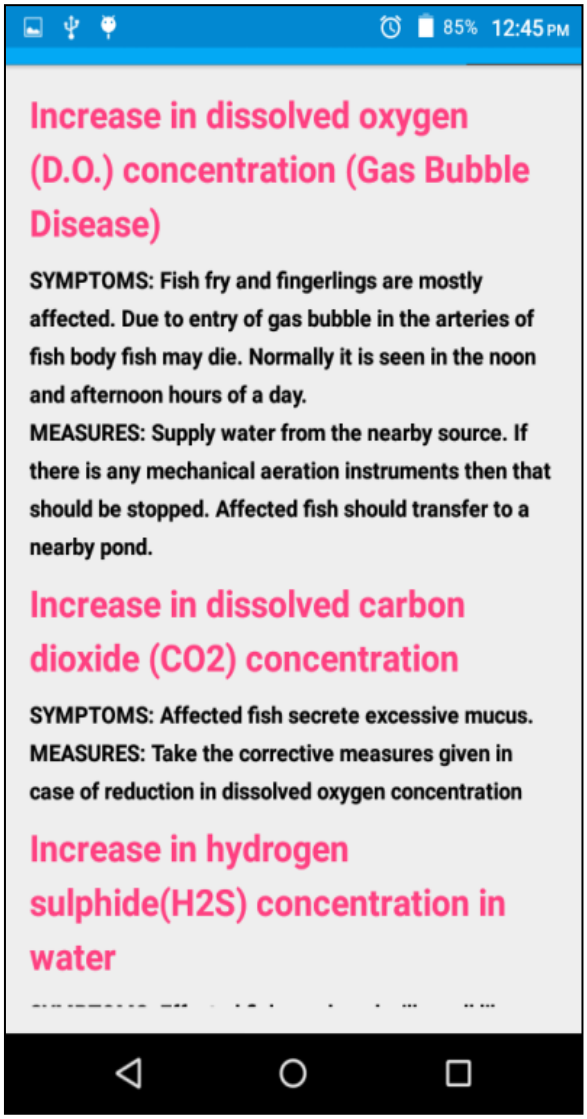


Figure 65a and b: 1st and 2nd screenshot of environmental diseases

Figure 65a presents the symptoms and measures to treat sun burn, thermal shock. Figure 65b, presents the symptoms and measures to treat acidosis and alkslosis, anoxia.



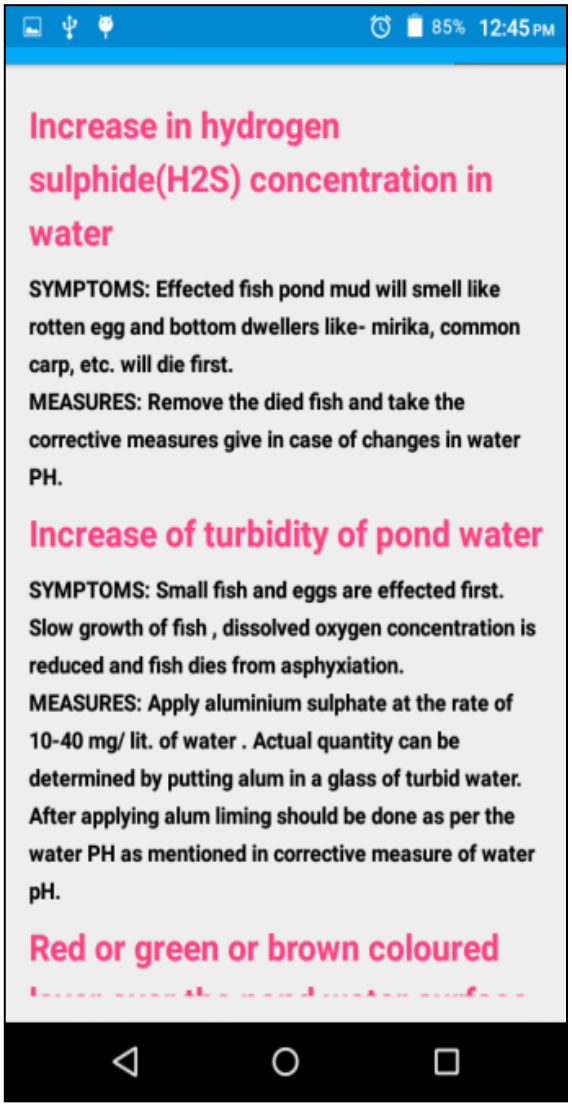


Fig 65c and d: 3rd and 4rth screenshot of environmental diseases

In figure 65c information on symptoms and measures to treat gas bubble disease and increased carbon di oxide concentration.

Figure 65d provides information on symptoms and measures to be taken when there is increased hydrogen sulphide concentration and turbidity in pond water.

Figure 65e, has information on symptoms and measures to be taken for algal toxicosis diseases and increased unionized ammonia.

Figure 65f, provides information on symptoms and measure to be taken for Traumatic injuries and acute anaphylaxis.

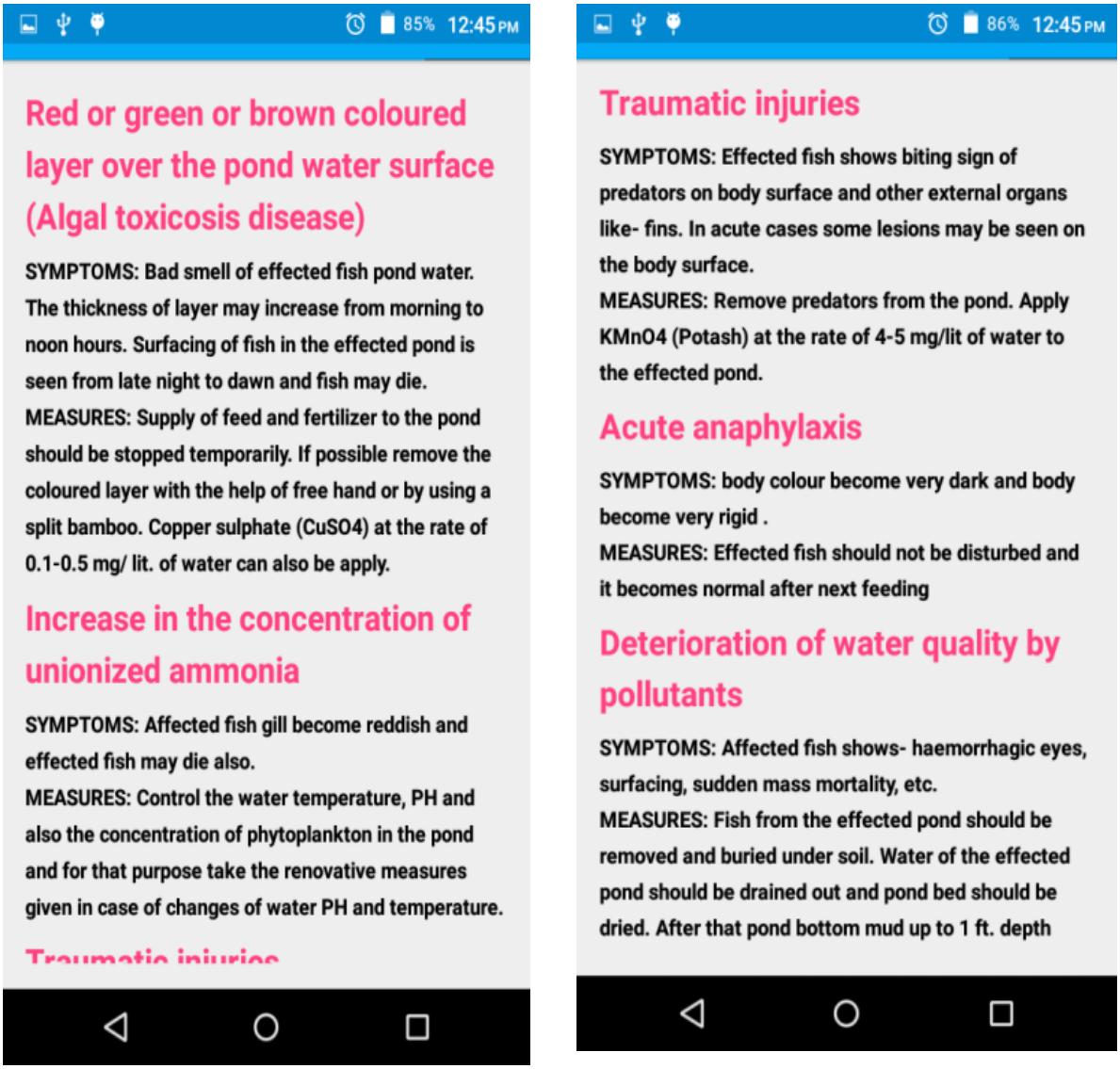


Fig 65e and f: 5th and 6th Screenshot of environmental diseases

Figure 65g, provides information on symptoms and measures to be followed when water quality is deteriorated by pollutants.

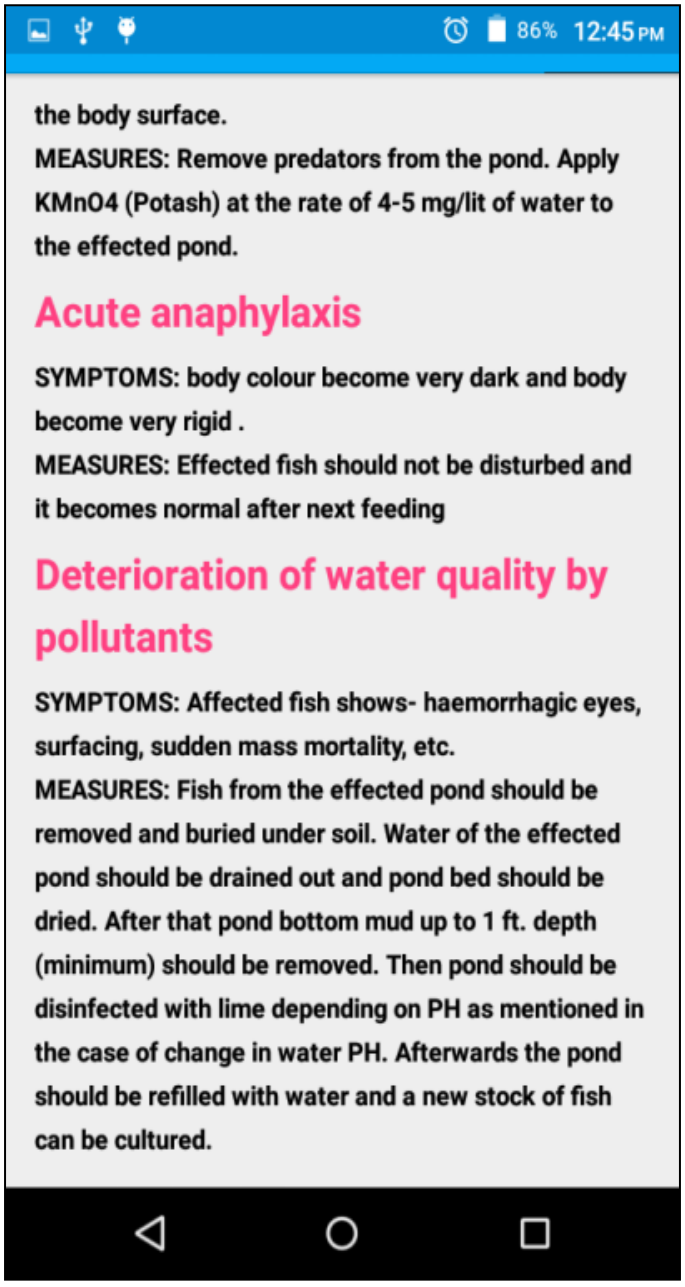


Figure 65g: 7th screenshot of environmental diseases

When the user clicks on Post harvest practices a screen will appear with sub features of handling, transportation, processing and products. The screenshots for post harvest practices are given from figure 66 onwards.

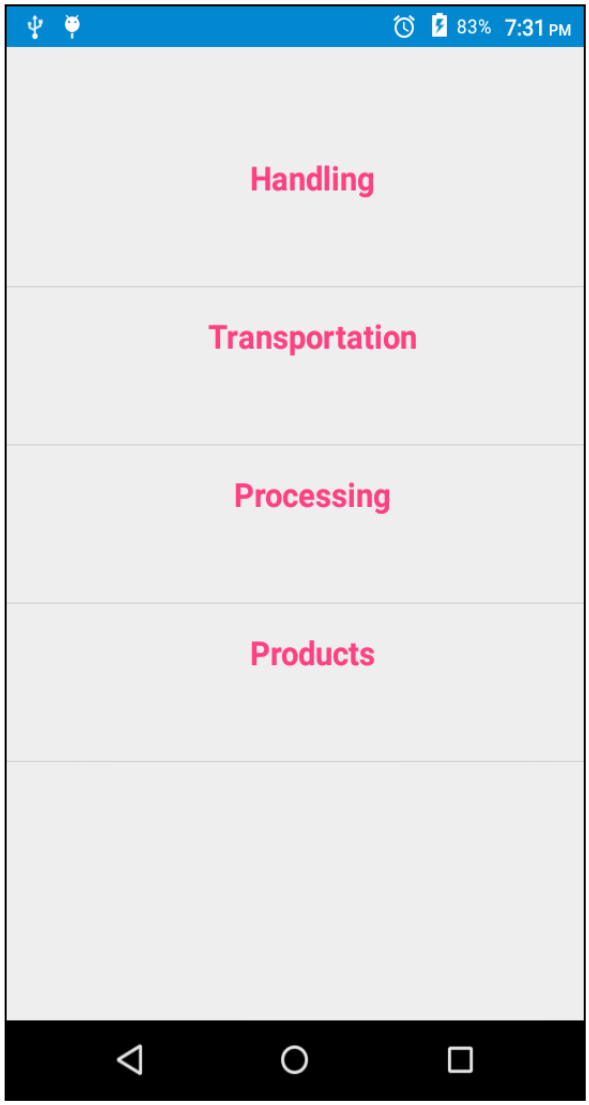


Figure 66: Post harvest practices screen

In the screen of post harvest practices, when the user clicks on handling a screen will be displayed providing information on the measures to be followed for handling of the fish after harvesting.

Screen shot of Handling and Transportation

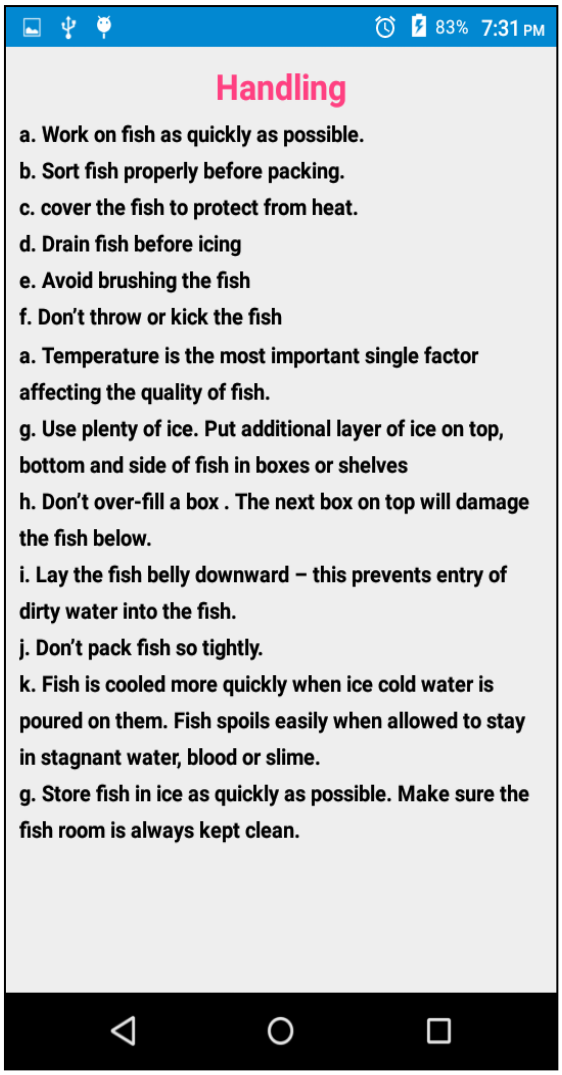


Figure 67: Screen shot of handling

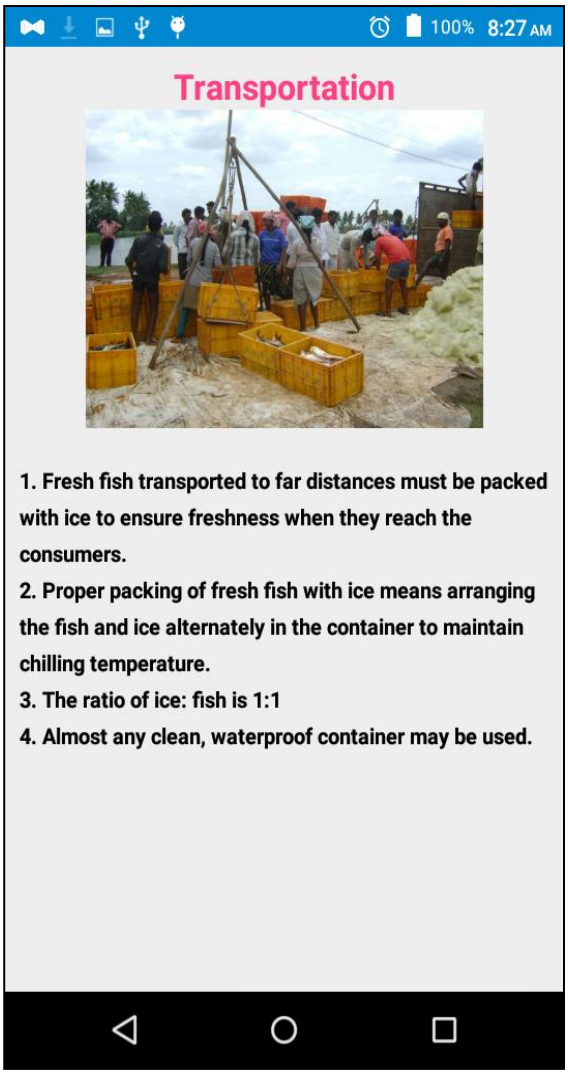


Figure 68: Screen shot of transportation

For handling feature the relevancy score given by farmers and experts was 3.5 and 3.8 respectively. The content validity ratio given by experts is 0.85. The screenshot of handling is given in figure 67.

When the user clicks on transportation in the post harvest practices, a screen will be displayed providing information on transportation of fish after harvest. The relevancy score for this feature given by the farmers and experts was 3.8 and 4. The content validity ratio given by the experts is 0.90. The screenshot of transportation is given in figure 68.

When the user clicks on processing in post harvest practices a screen will be displayed providing information on drying. The user can slide the screen to get information on salting, freezing, smoking and canning of fish. The average relevancy score for this feature given by the farmers and experts was 3.5 and 3.9. Content validity ratio given by experts was 0.85 Screenshots of processing are given from figure 65a to 65e. The screenshots for drying and salting are given in figure 69a and 69b.

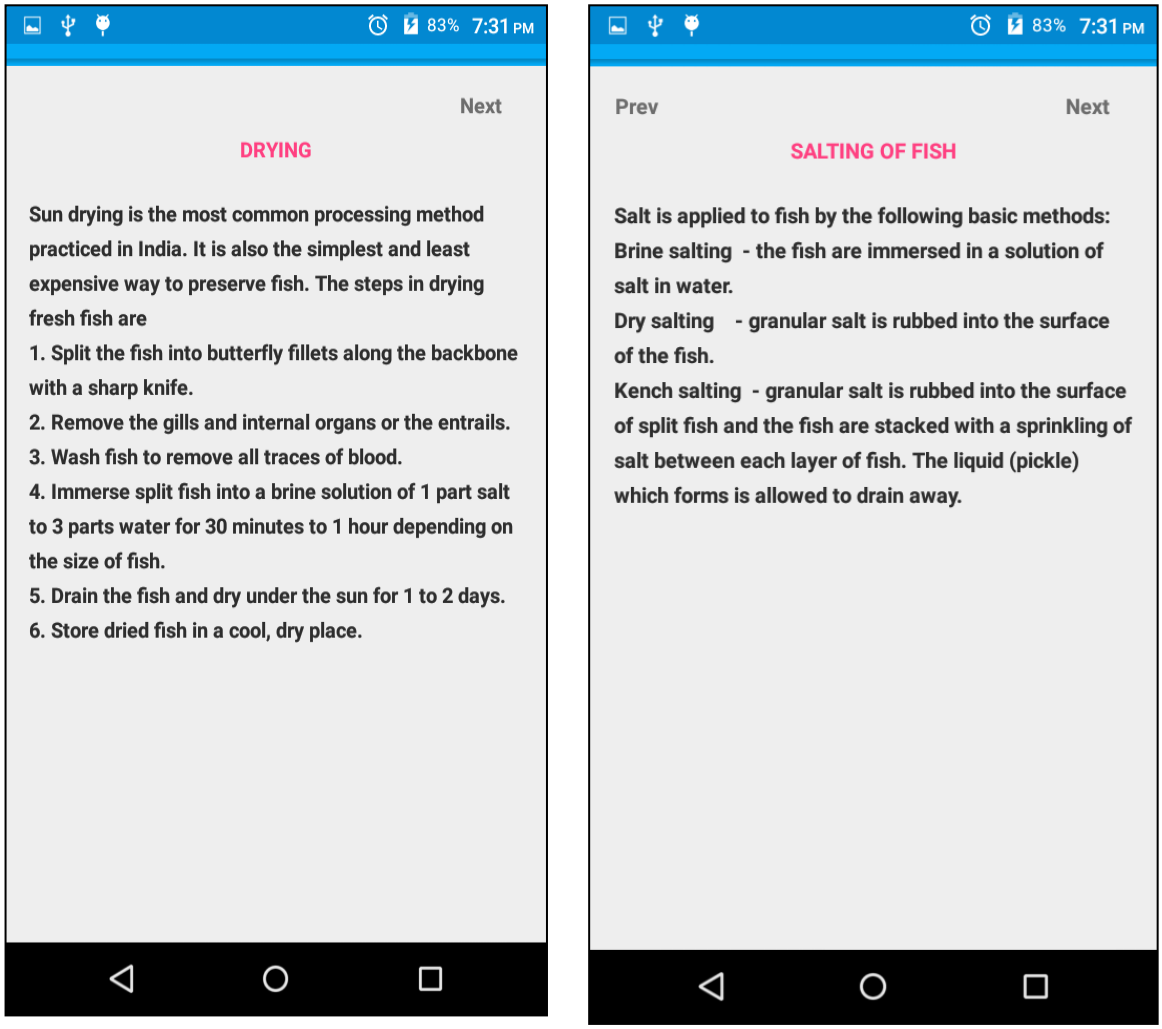
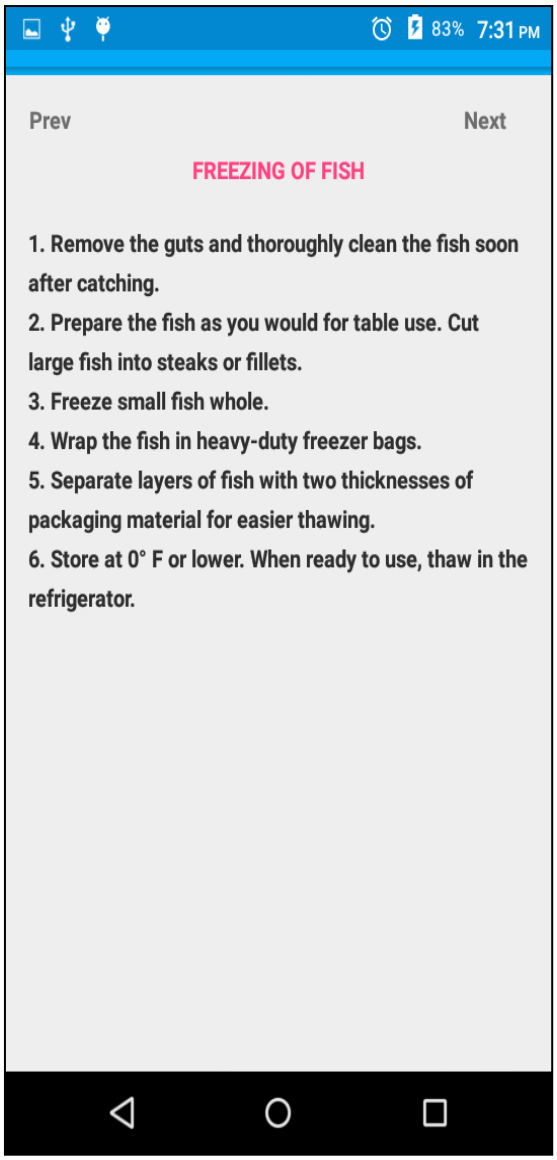


Figure 69a and b: Screen Shots of Drying and Salting

The screenshots for freezing and smoking of fish are given in figure 69c and 69d



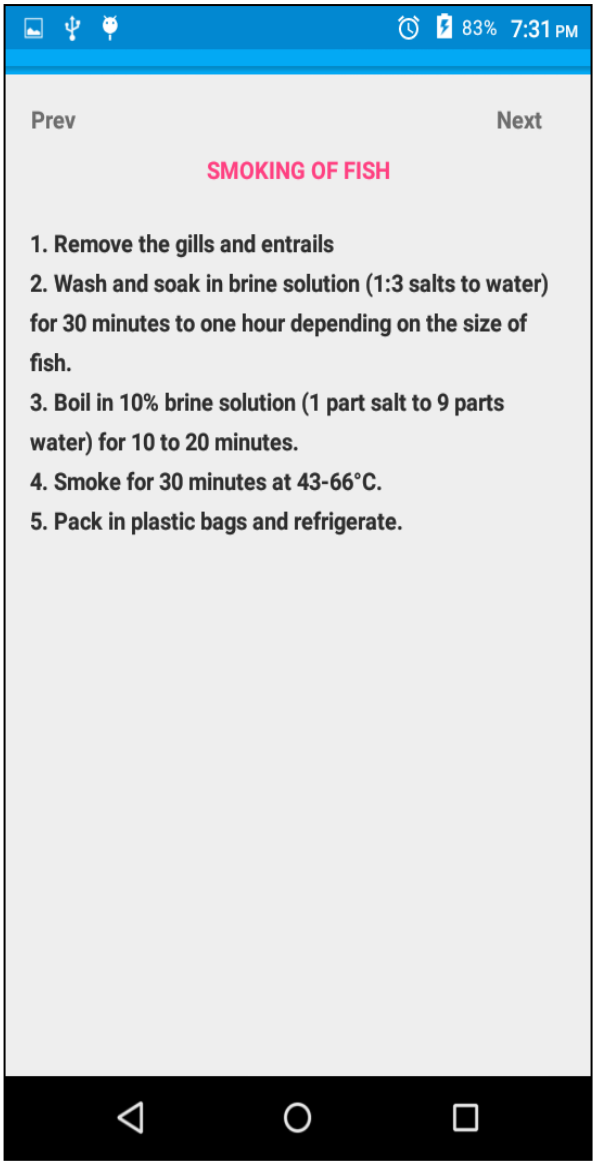


Figure 69c and d: Screen Shot of Freezing and Smoking

The screenshot for canning of fish is given in figure 69e.

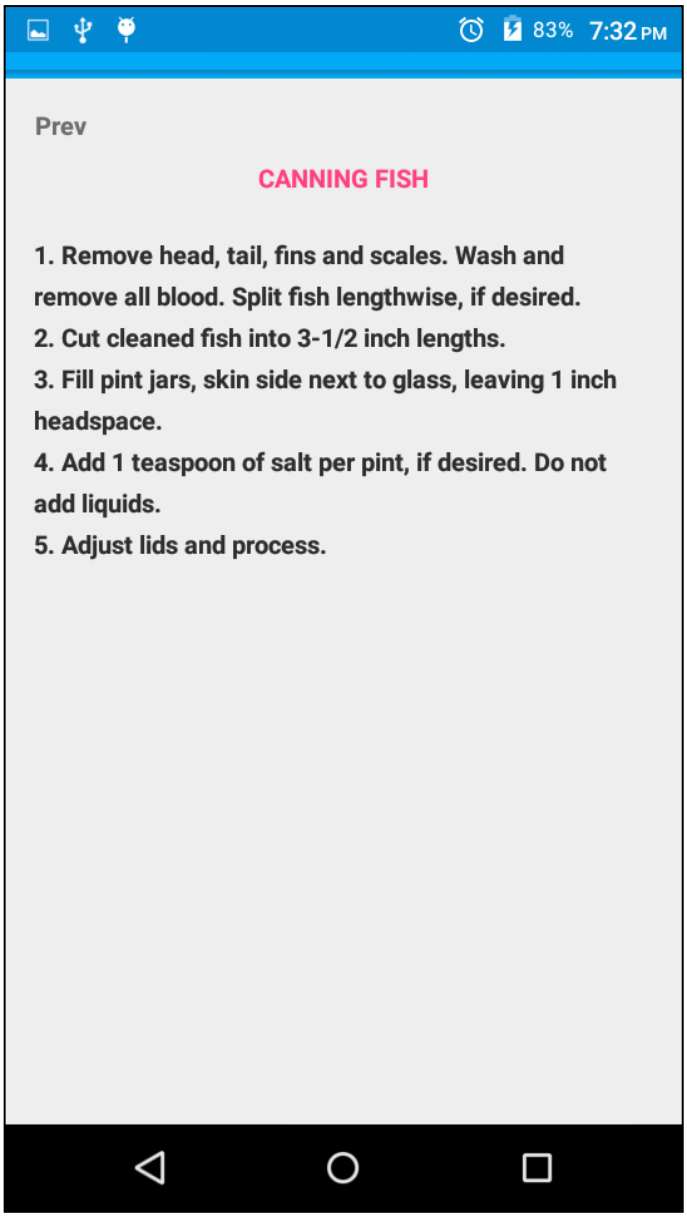


Fig 69e: Screen Shot for Fish Canning

When the user clicks on products in post harvest practices a screen will be displayed showing information on preparation of fish balls. The user can slide the screen to get the information on preparation of different products like fish cutlet, fish fingers, fish pickle and prawn pickle. The relevancy score given by the farmers and experts are 3.6 and 4. The content validity ratio given by the experts is 0.85. The screenshots for products are given from figure 70a to 74c.

Screen Shot for Preparation of Fish balls

The fish balls screen is given in figure 70a and 70b.

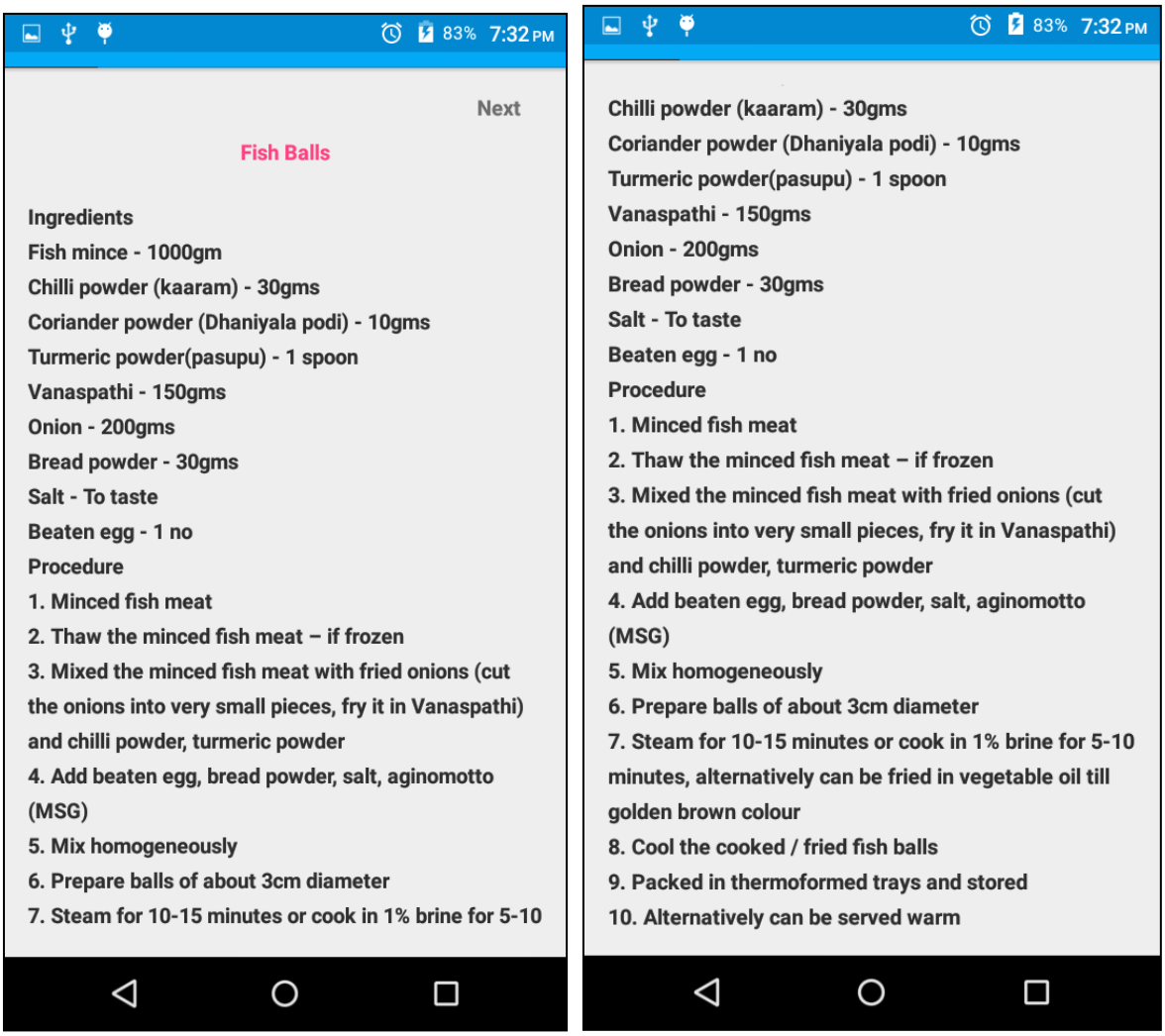


Figure 70a and b: 1st and 2nd Screenshot for Preparation of fish balls

Screen Shot for Preparation of Fish cutlet

The screen shot of fish cutlet is given in figure 71a and 71b.

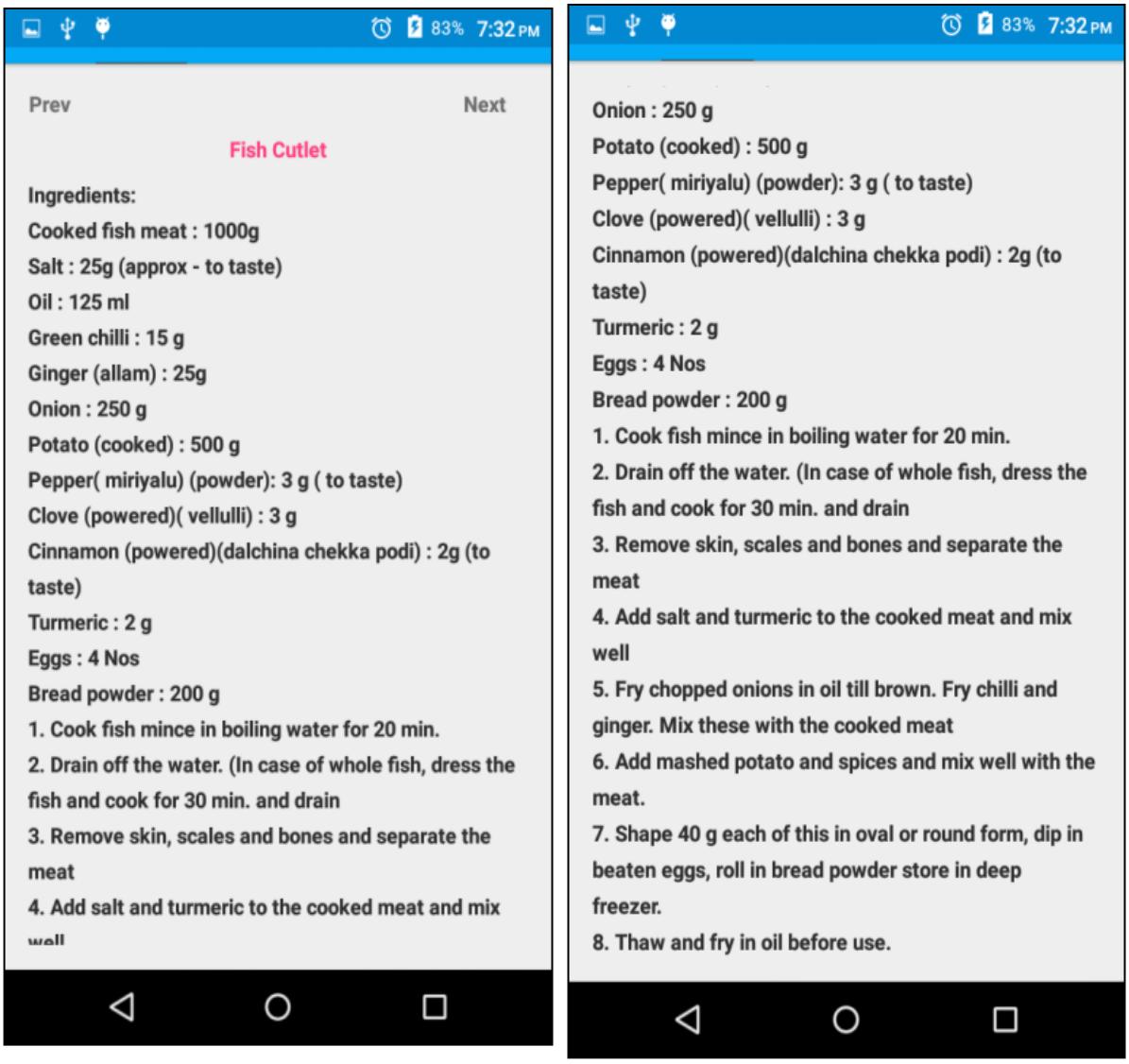


Figure 71a and b: 1st and 2nd Screen shot for preparation of fish cutlet

Screen Shot for Preparation of Fish fingers

The screenshot for preparation of fish fingers is given in figure 72

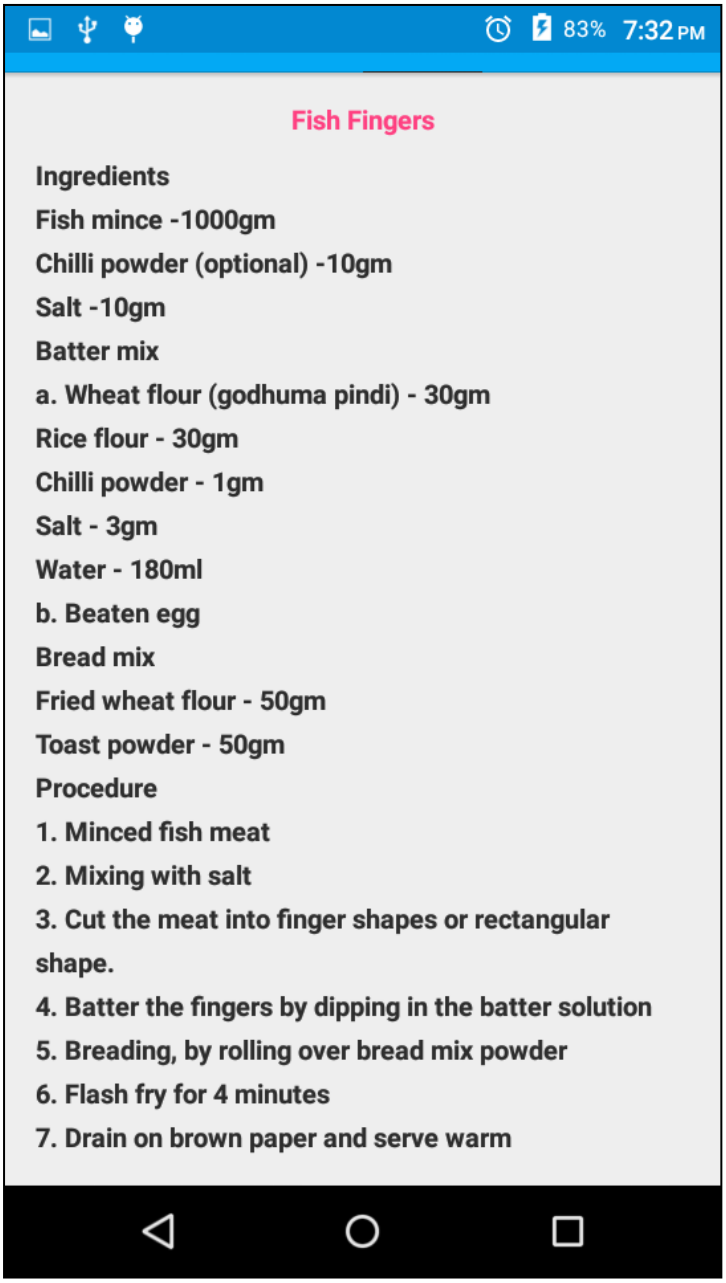


Figure 72: Screen shot for preparation of Fish fingers

Screen Shot for Preparation of Fish pickle

The screenshot of fish pickle is given from figure 73a to 73c.

Figure 73a: 1st Screen Shot for Preparation of Fish Pickle

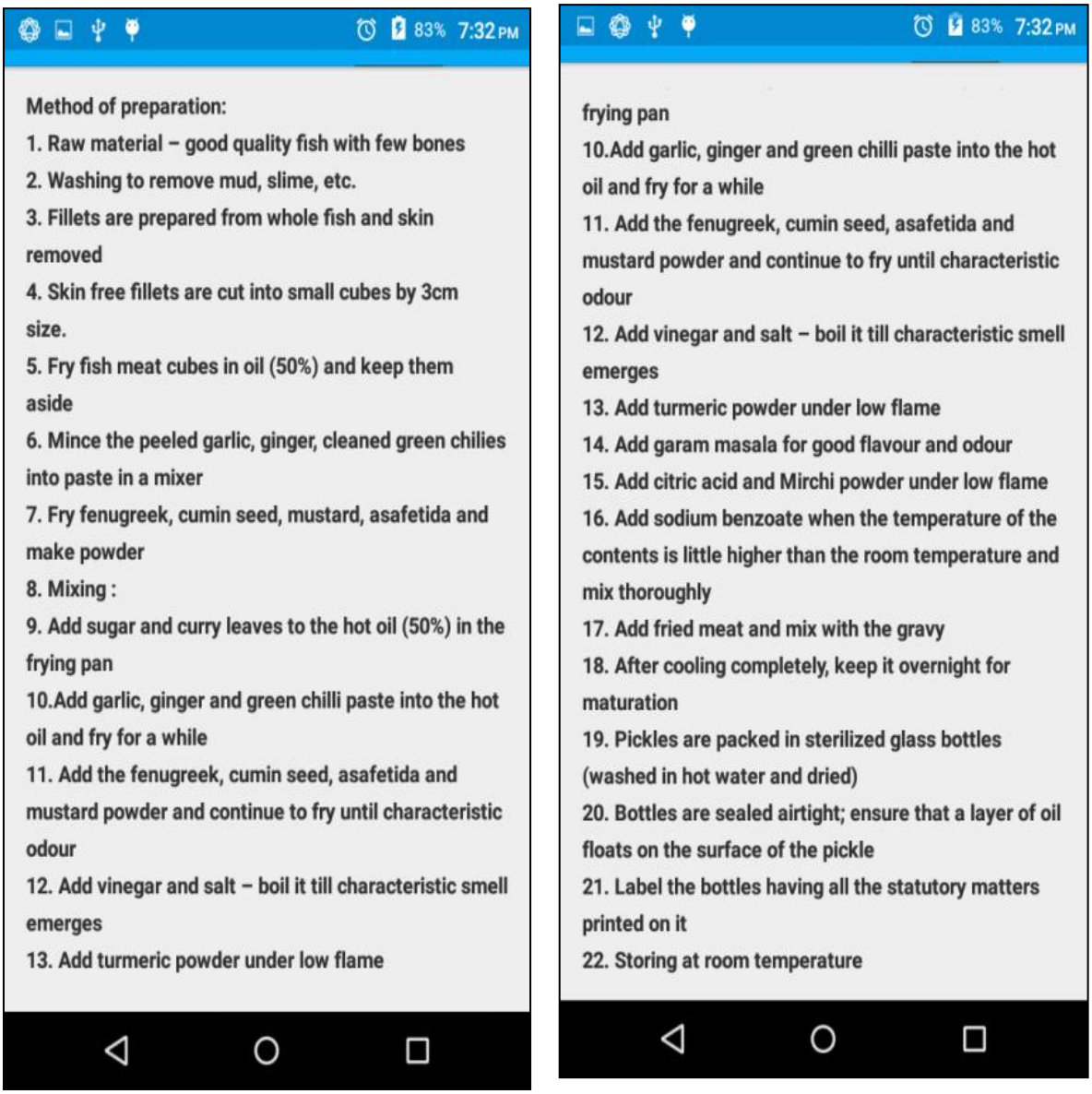


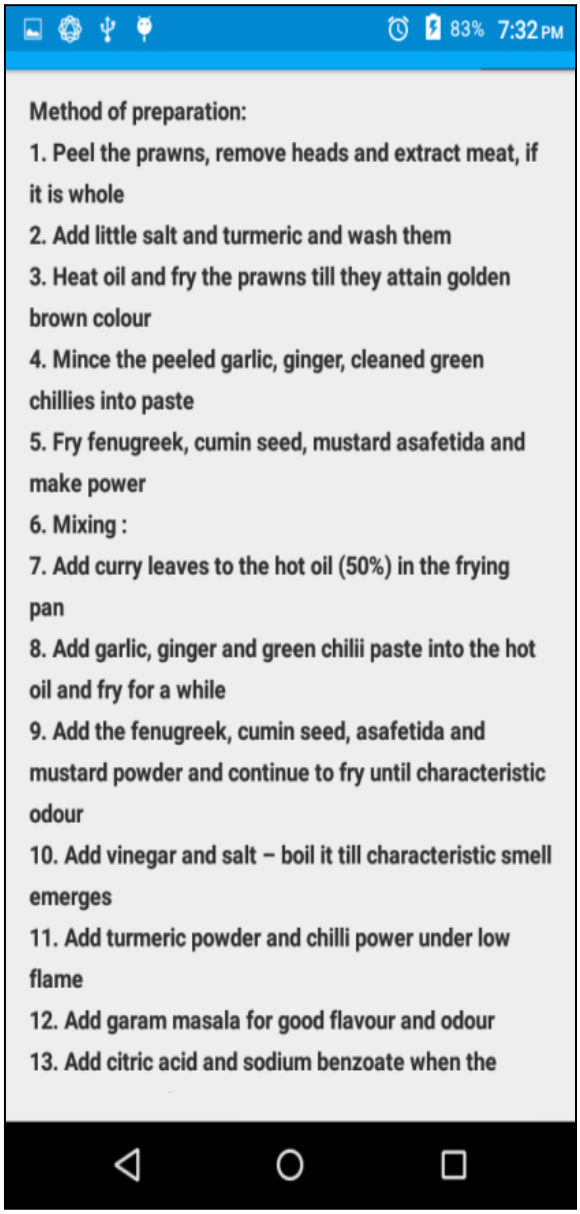
Figure 73b and c: 2nd and 3rd Screen Shot for Preparation of Fish Pickle

It is clear from the above figures that the method of preparation of fish pickle are given

Screen Shot for Preparation of Prawn Pickle

The screenshot of prawn pickle is given from figure 74a to 74c

Figure 74a: 1st Screen Shot for Preparation of Prawn Pickle



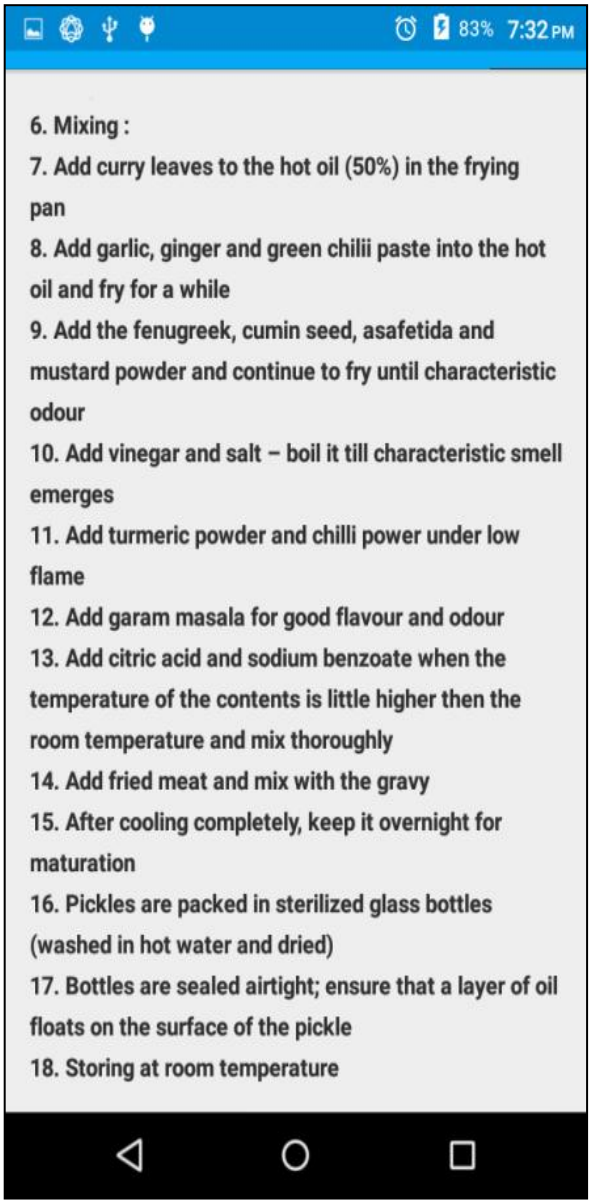


Fig 74b and c: 2nd and 3rd Screen shot for preparation of prawn pickle

When the user clicks the Modern Farming practices in the home screen a list view consisting the options Cage culture, Recirculatory aquaculture system and Integrated Fish Farming will be displayed. Modern farming practices screenshots is explained from figure 75 to 82b.

Screen Shot of Modern Farming Practices

The screen shot of modern farming practices is given in figure 75

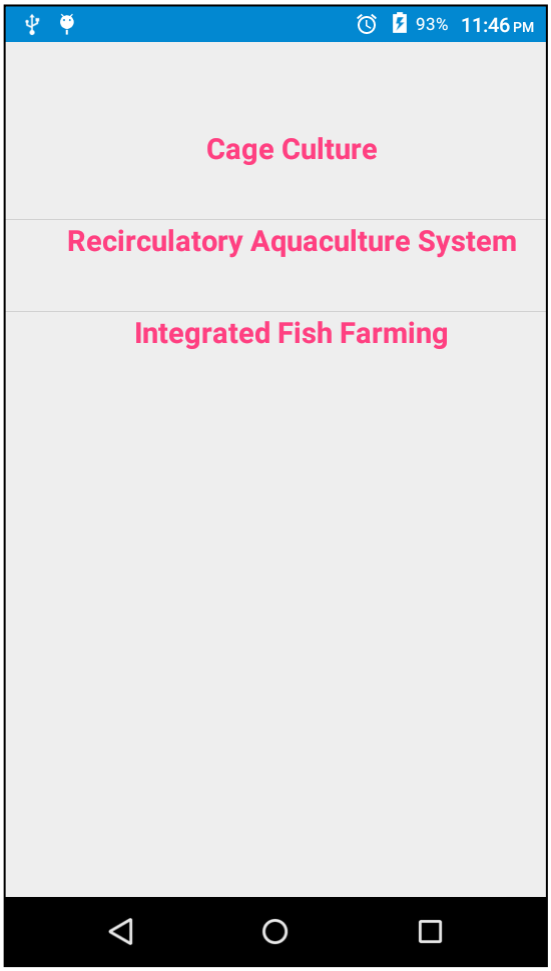


Figure 75: Screen shot of Modern farming practices

In the modern farming practices when the user clicks Cage culture the information with illustrations will be displayed. Information on cage culture are given in screenshots from figure 75a to 77.

Screen Shot of Cage culture

The relevancy score for this feature given by the farmers and experts were 3.4 and 3.7 respectively. The content validity ratio given by the experts was 0.90. In cage culture the information suitable site for cage culture, species suitable in cage culture and maintenance of cages are given.

Screen Shot of Site Selection

In the site selection screen the user gets the information on the criteria required to select a site for installing the cage. The screen shot is given in the figure 75a

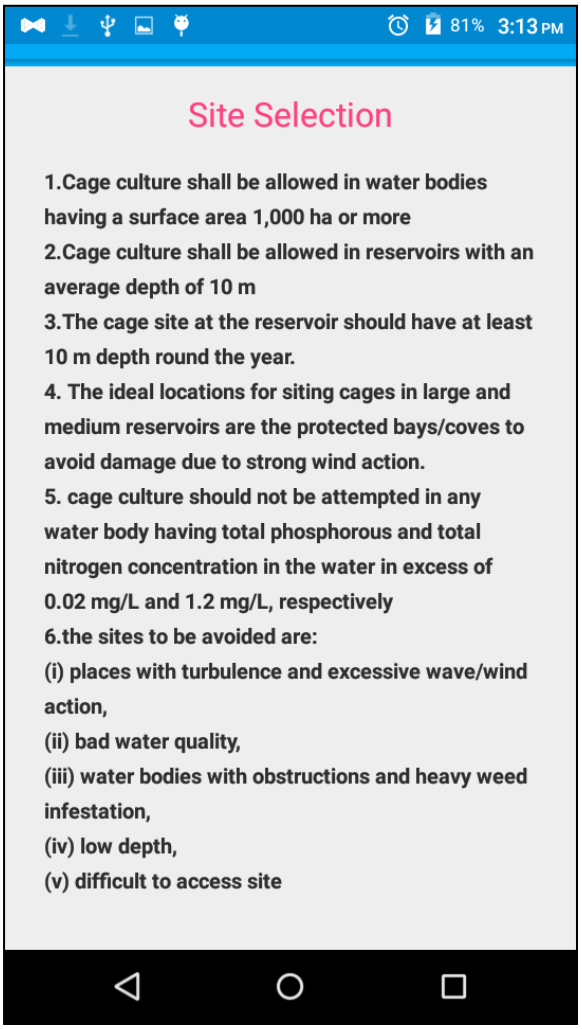


Fig 75a: Screen Shot of Site selection

Screen Shot of Species selection and Maintanance

In the screen of species selection, the suitable species that can be cultured in cage in inland water bodies are given. The screen shot is given in the figure 75b.

In the screen shot of maintenance, information on the precautionary measures to be taken for cage maintenance is given. The screen shot is given in figure 75c.

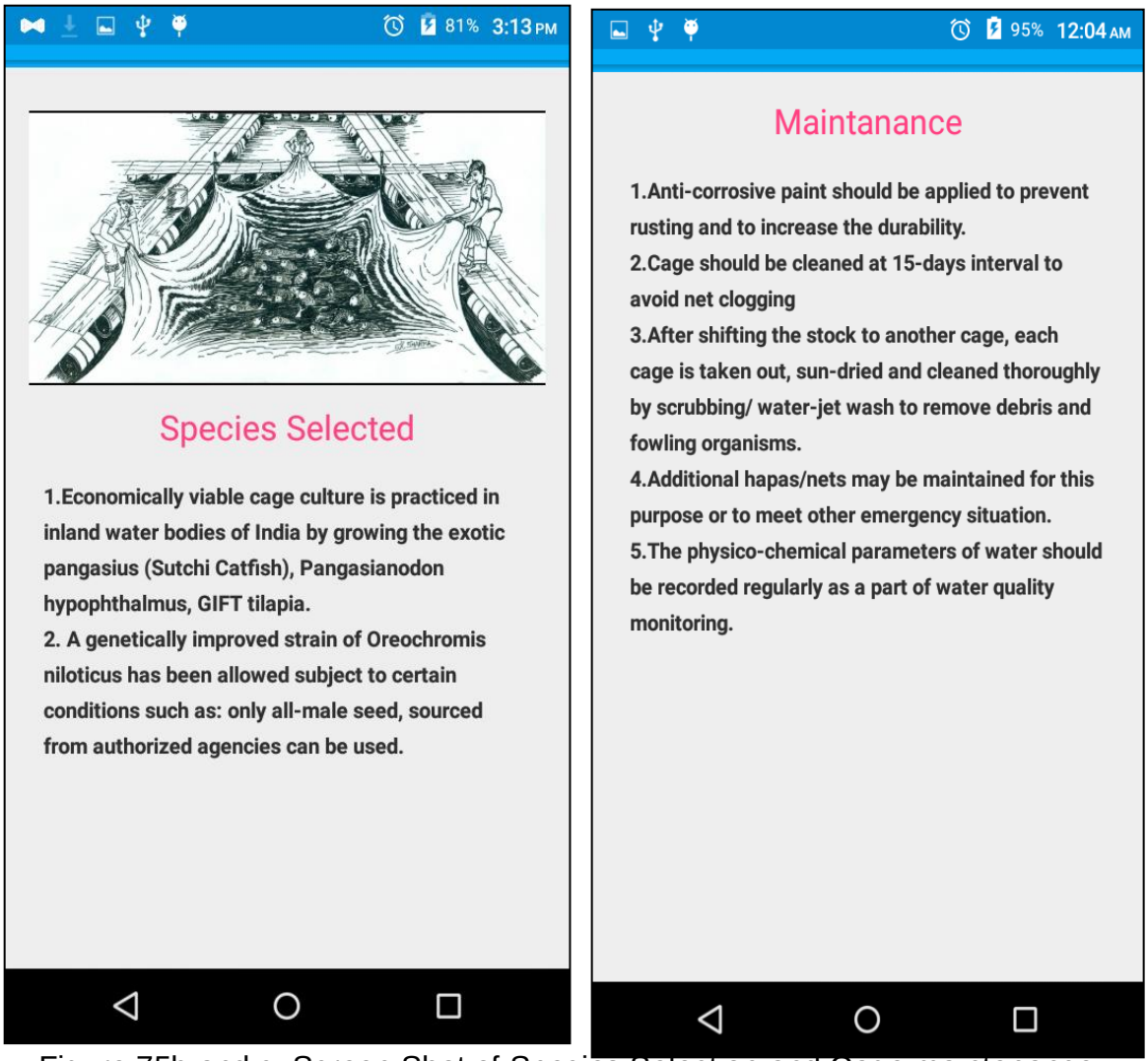


Figure 75b and c: Screen Shot of Species Selection and Cage maintenance

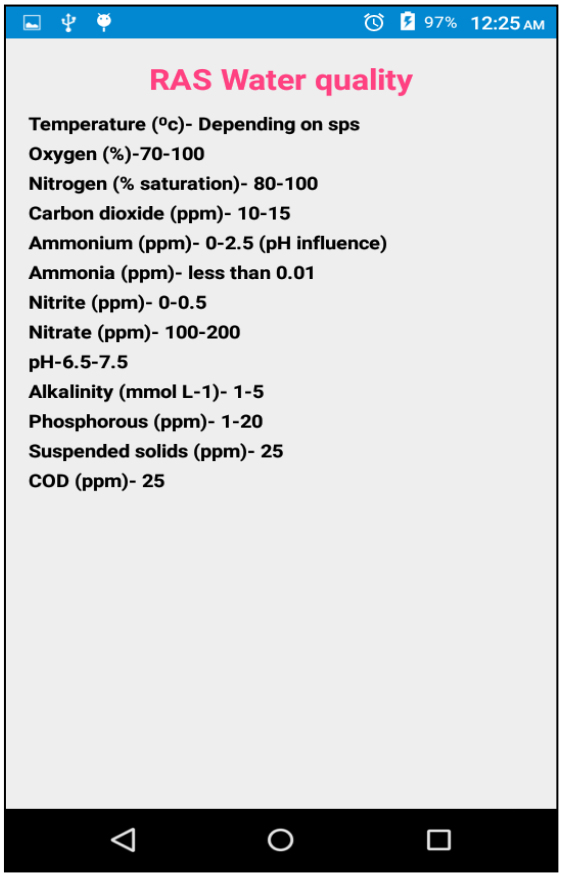
In the screen of modern farming practices, when the user clicks on Recirculatory Aquaculture system a screen will be displayed showing water quality parameters required in RAS culture. The user can slide the screen to get the information on feeding in RAS culture. The screen shots of RAS are given in figure 76a and 76b.

Recirculatory Aquaculture System

The relevancy score for this feature given by farmers and experts were 3.5 and 3.7 respectivley. The content validity ratio given by experts was 0.85

Screen shot of Water quality and Feeding in RAS

Information on water quality parameters that are to be maintained in RAS are given. The screenshot is given in the figure 76a.In the Screen of RAS Feeding the information on feeding amount, type of feeds used and feed management are given. The screenshot is given in the figure 76b.



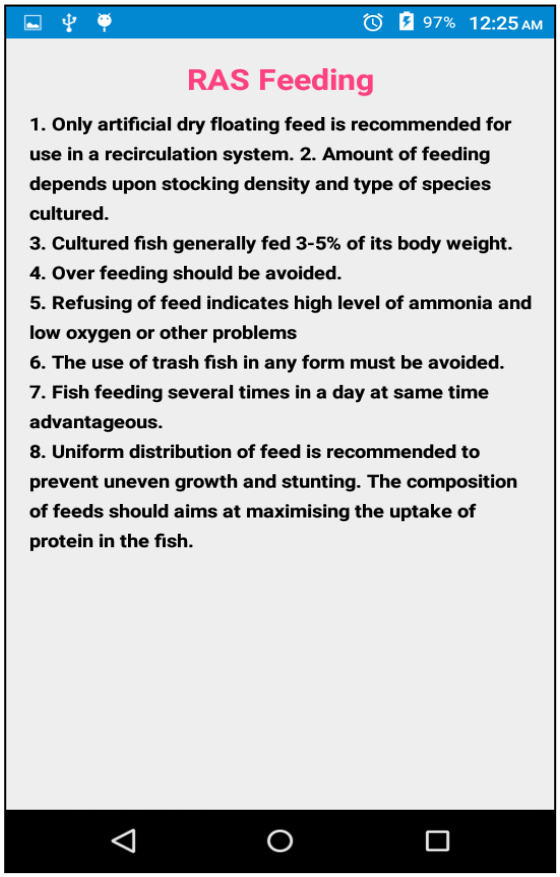


Figure 76a and b: Screen Shot of RAS Water Quality and feeding

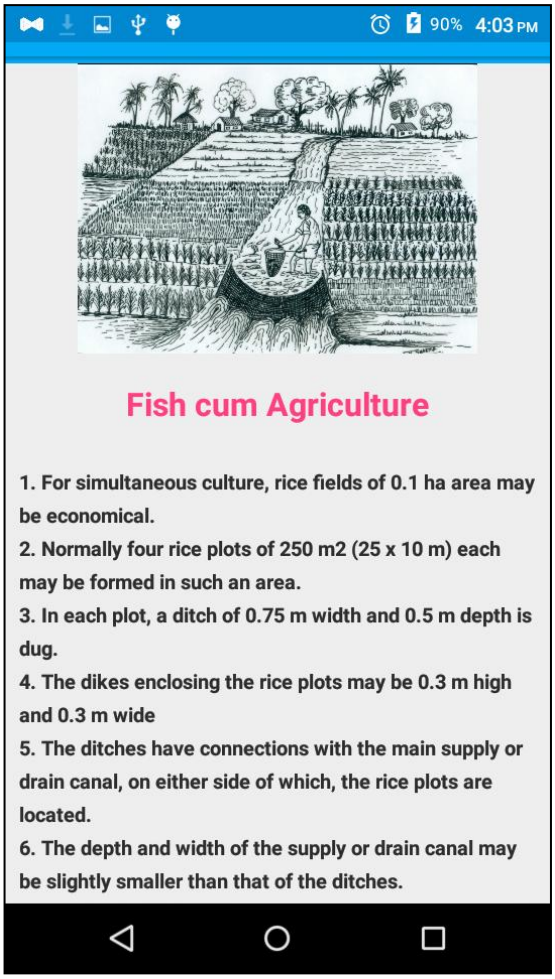
In the screen of modern farming practices when the user clicks on Integrated fish farming a screen will be displayed giving information on fish cum agriculture. The user when slides the screen the information on fish cum horticulture, fish cum duck, fish cum dairy , fish cum poultry and fish cum pig are given.

Integrated fish farming

The relevancy score given by farmers and experts was 3.7 and 4 for this feature. The content validity ratio given by experts for integrated farming was 0.80. The screen shots for Integrated fish farming are given from figure 77a to 82b.

Screen Shot of Fish cum Agriculture

The screenshots of fish cum agriculture screen are presented in figure 77a and 77b.



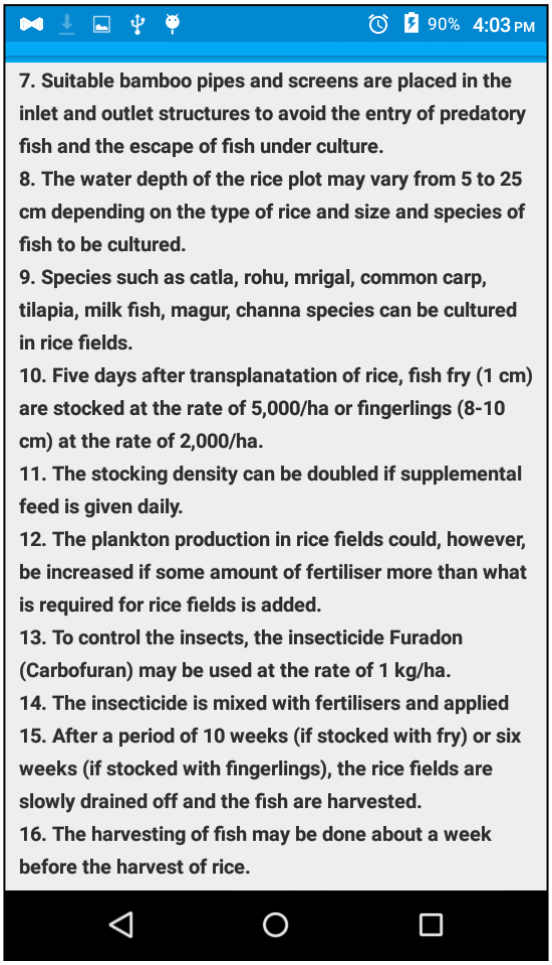


Figure 77a and b: 1st and 2nd screenshot of fish cum agriculture

Screen Shot of Fish cum Horticulture

The information on fish cum horticulture has been provided in screenshots in figure 78a and 78 b.

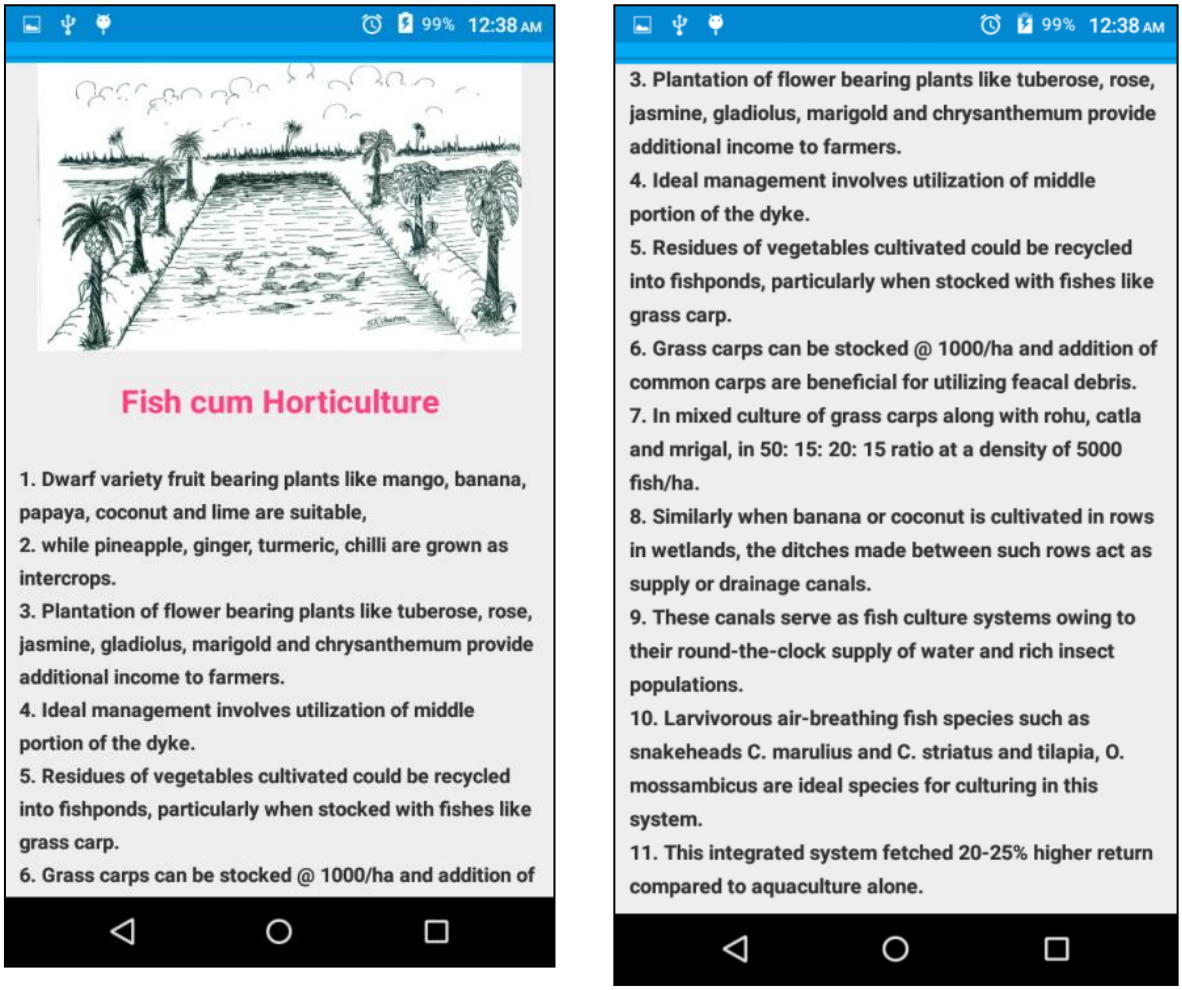
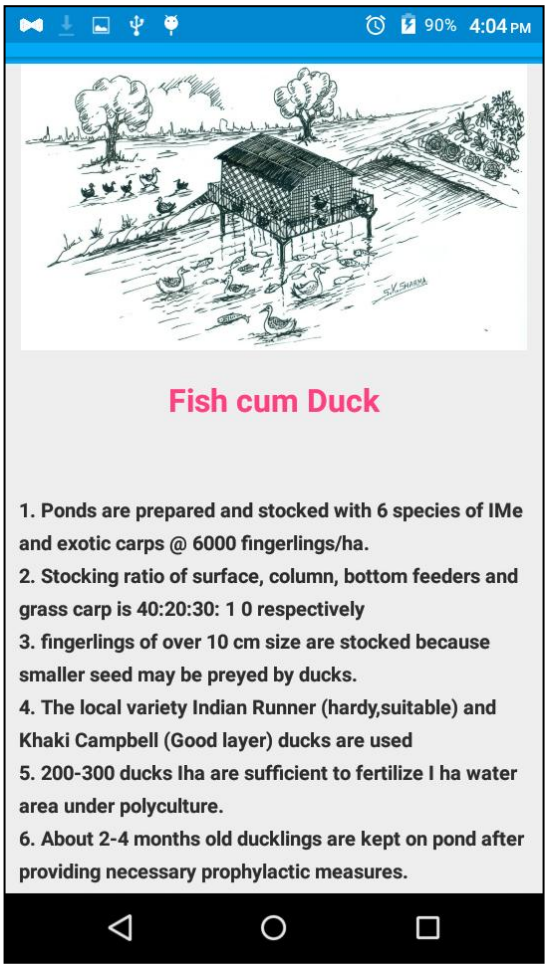


Figure 78a and b: 1st and 2nd screen of fish cum horticulture

Screen Shot of Fish cum Duck Culture

The information on fish cum duck culture is provided in the figure 79a and 79b.



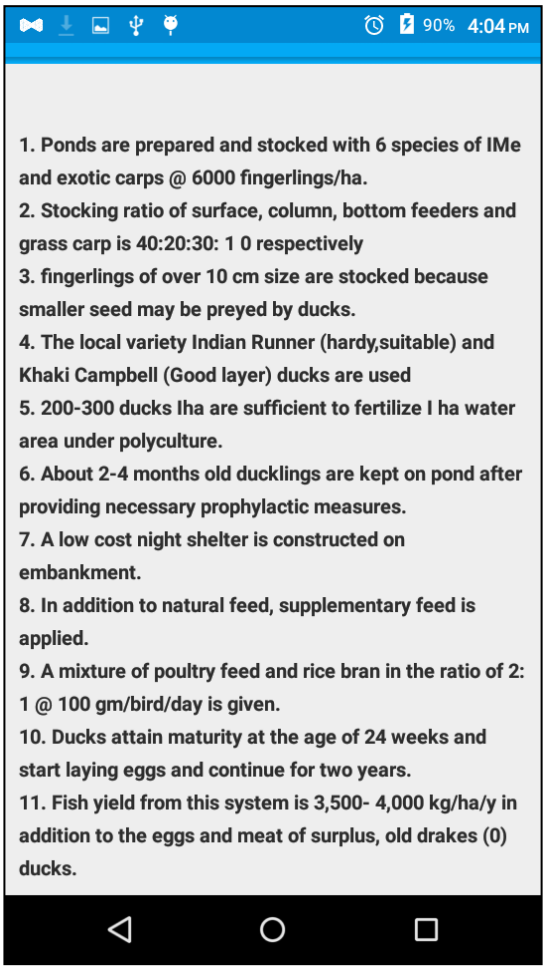
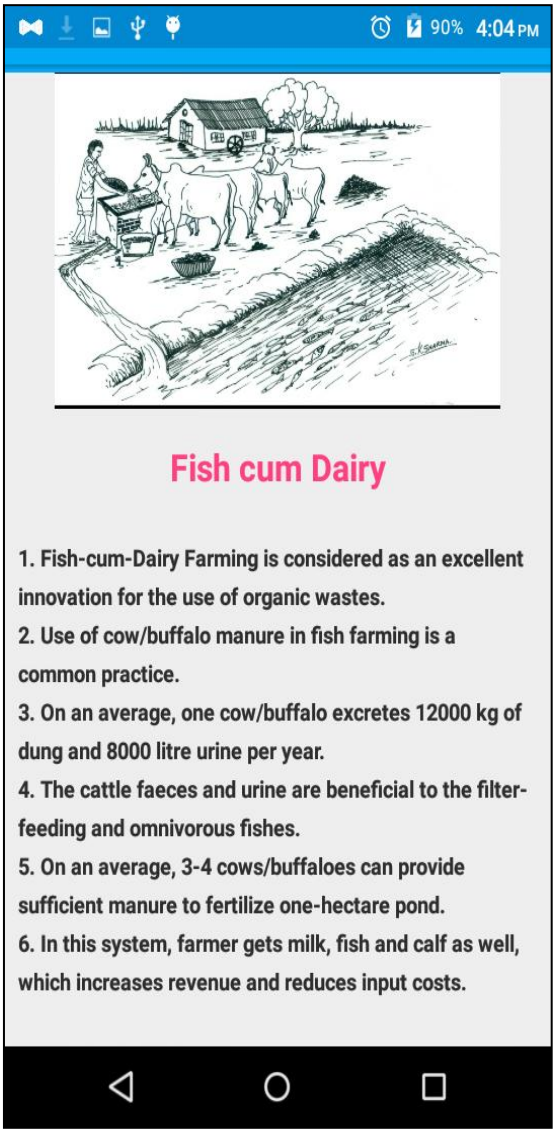


Figure 79a and b: 1st and 2nd screenshot of fish cum duck

From the above figures it is clear that the information on fish culture utilizing the duck manure is given.



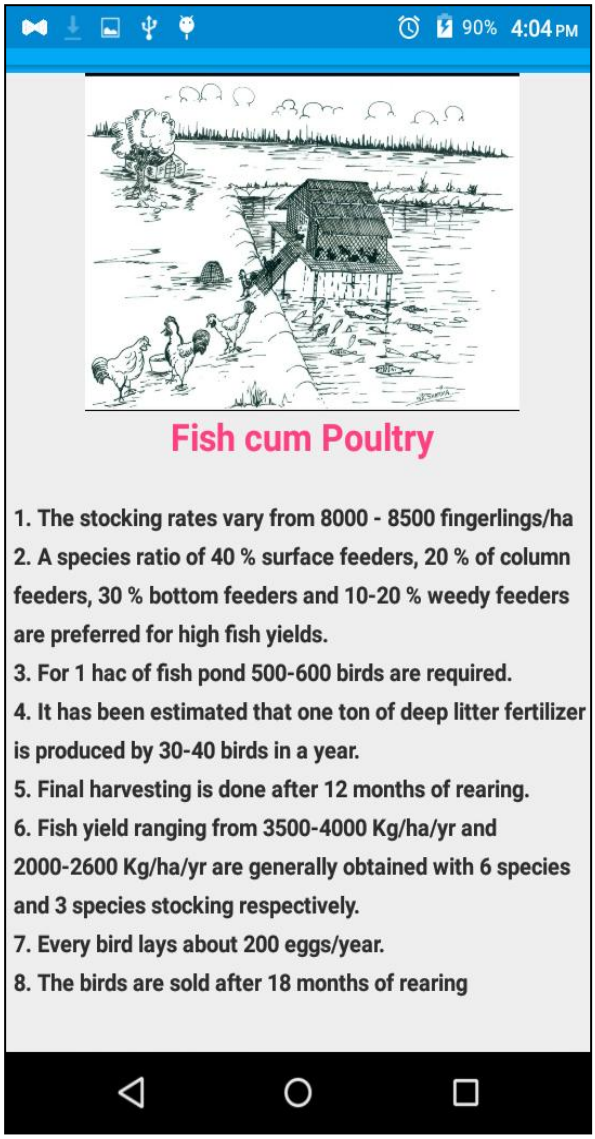


Figure 80 and 81: Screen shot of Fish cum dairy and Fish cum poultry

In the figure 80 information on fish cumdairy has been provided.

In the figure 81 information on fish cum poultry has been provided

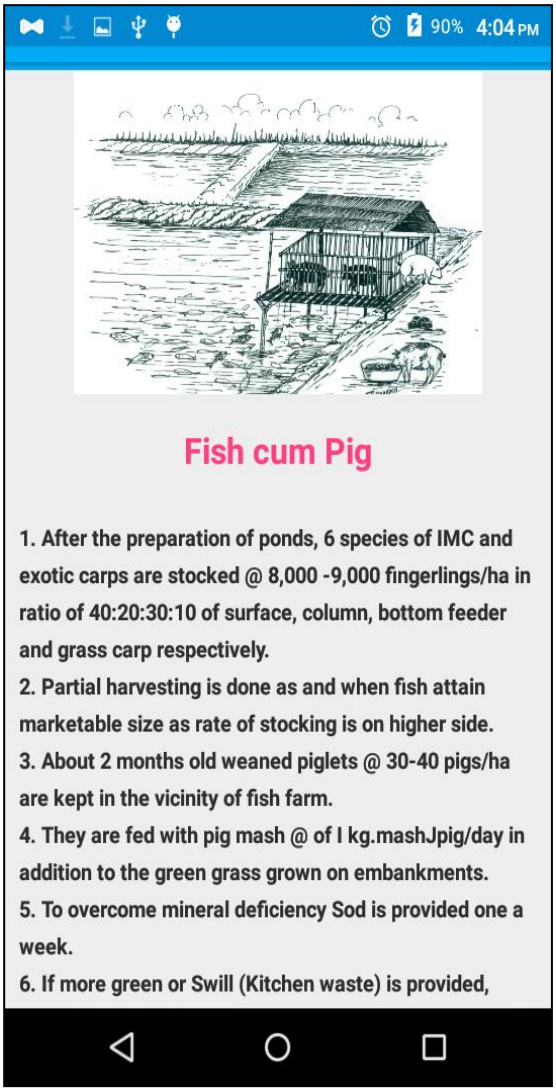


Figure 82a and 82b: 1st and 2nd screen of fish cum pig culture

When the user clicks T- fish info, a screen is displayed with list view consisting Registration guidelines for aquaculture, seed suppliers in Telangana, schemes, fish markets in telangana. The screenshots of Telangana information are given from 83 to 86b

T- fish info

The screenshot of T-fish info is given in figure 83.

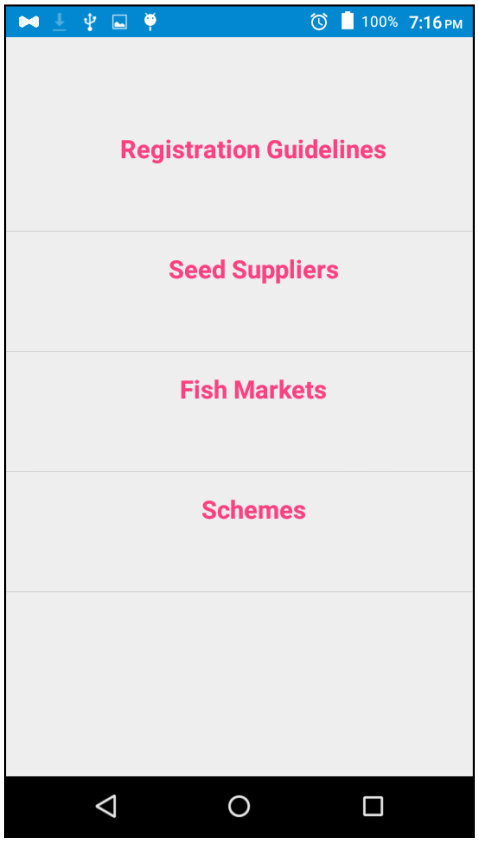
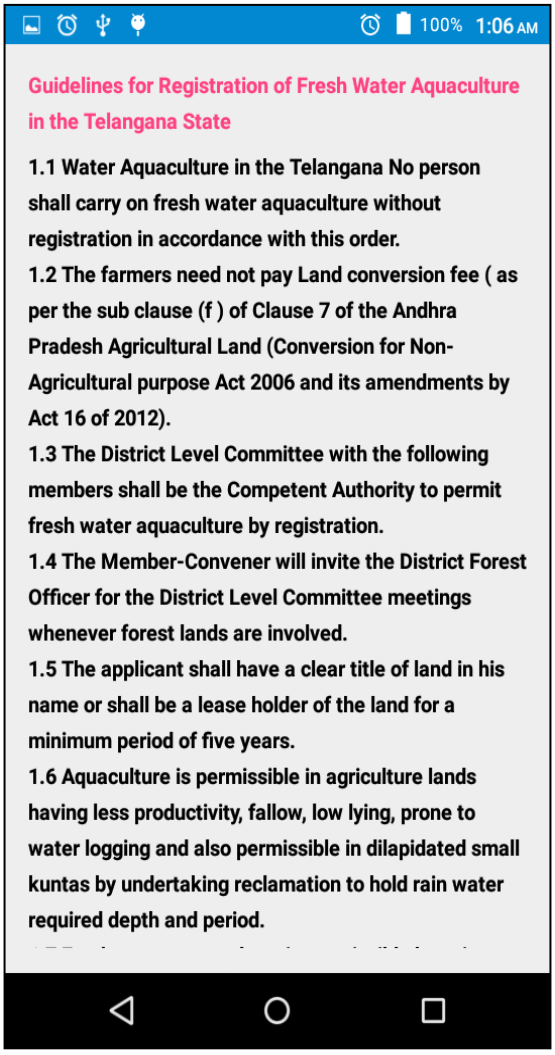


Figure 83 : Screenshot of T-fish info

Screen Shot of Registration Guidelines

The relevancy score for this feature given by the farmers and experts was 3.5 and 4. The content validity ratio was 0.75. In the screen for registration guidelines the information on the guidelines and procedure for registration of freshwater aquaculture farm are given. The screenshots are given from figure 84a to 84c.



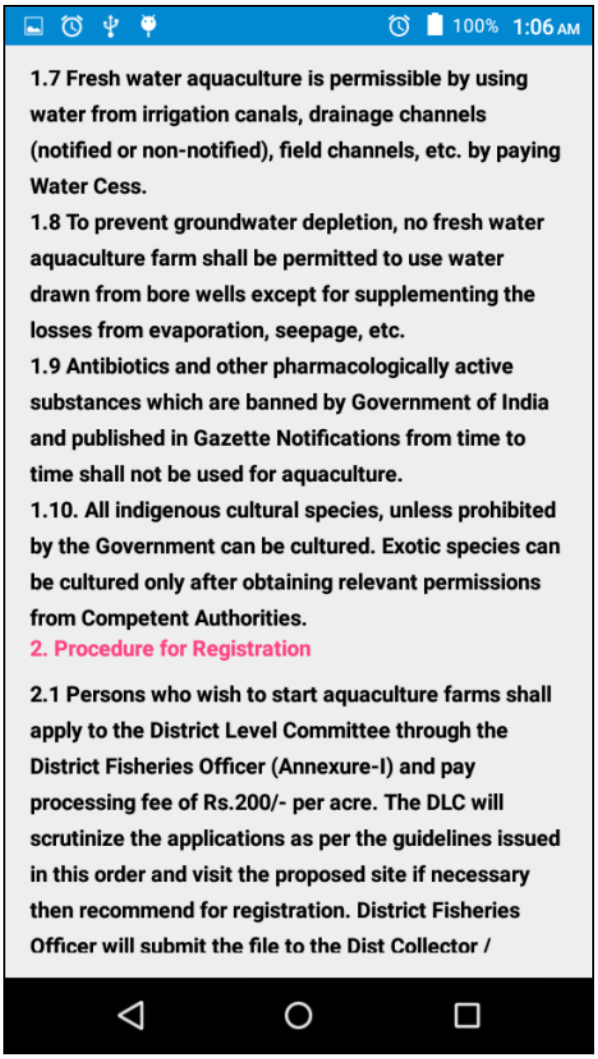


Figure 84a and b : 1st and 2nd Screenshot of registration guidelines

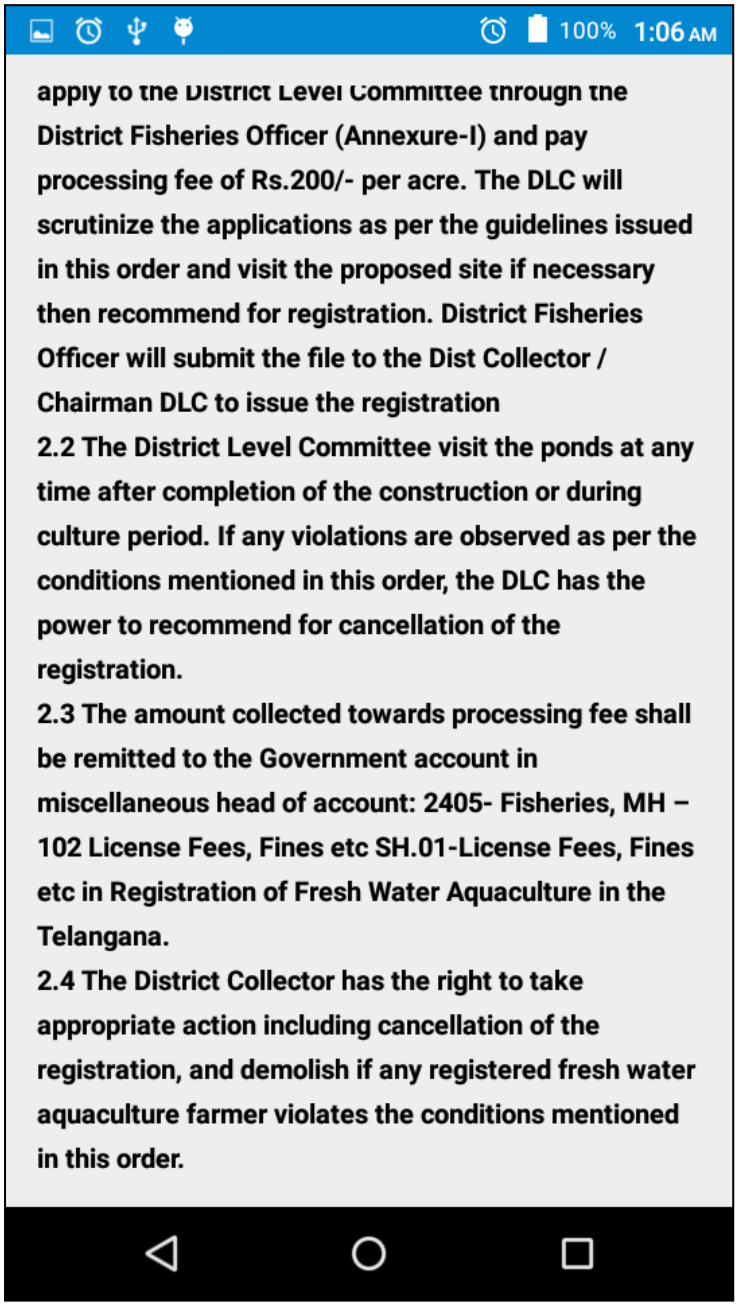


Figure 84c: 3rd Screenshot of registration guidelines

In the figures 84a, 84b, 84c the information on registration guidelines for fresh water aquaculture and procedure for registration are given.

Screen Shot of Fish Seed Suppliers

In this screen information about seed suppliers present in Telangana along with their address. The relevancy score given by both farmers and experts was 4. The content validity ratio was 0.95. The screenshots are given from figure 85a to 85c

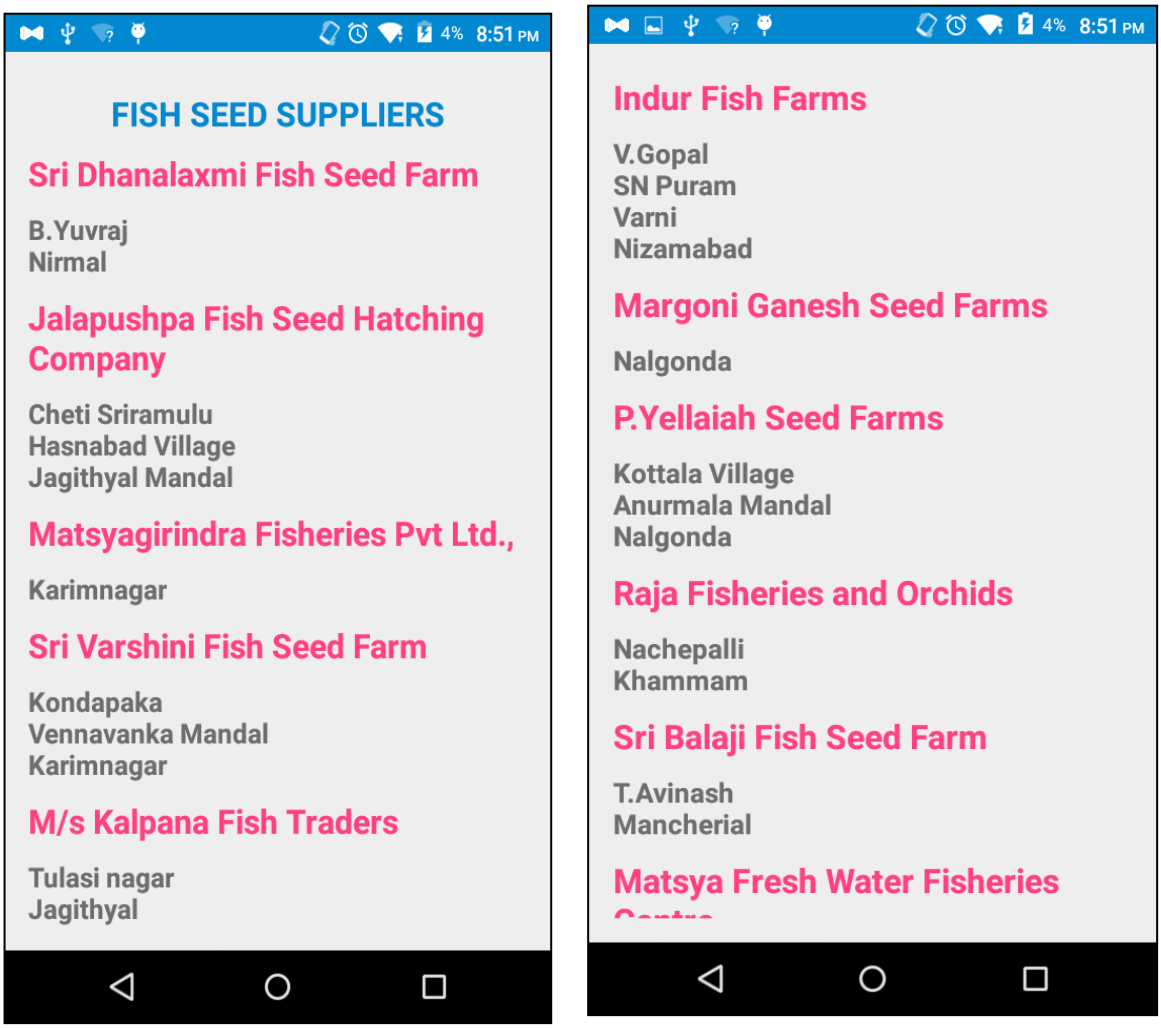


Figure 85a and b: 1st and 2nd Screenshots of fish seed suppliers

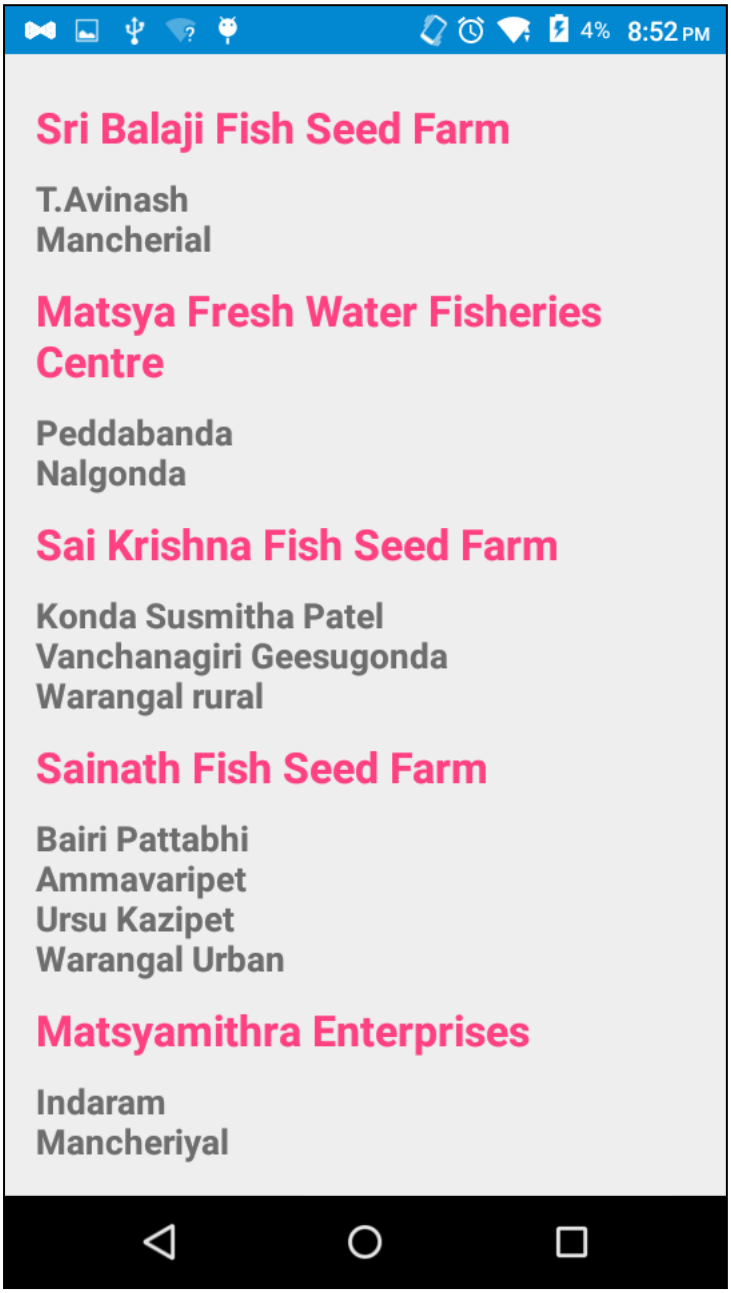


Figure 85c: 3rd Screenshot of fish seed suppliers

Fish markets screen

In the fish markets screen information on village markets in each district were given. The relevancy score given by farmers and experts was 4. The screenshots were given figure 86a and 86b.

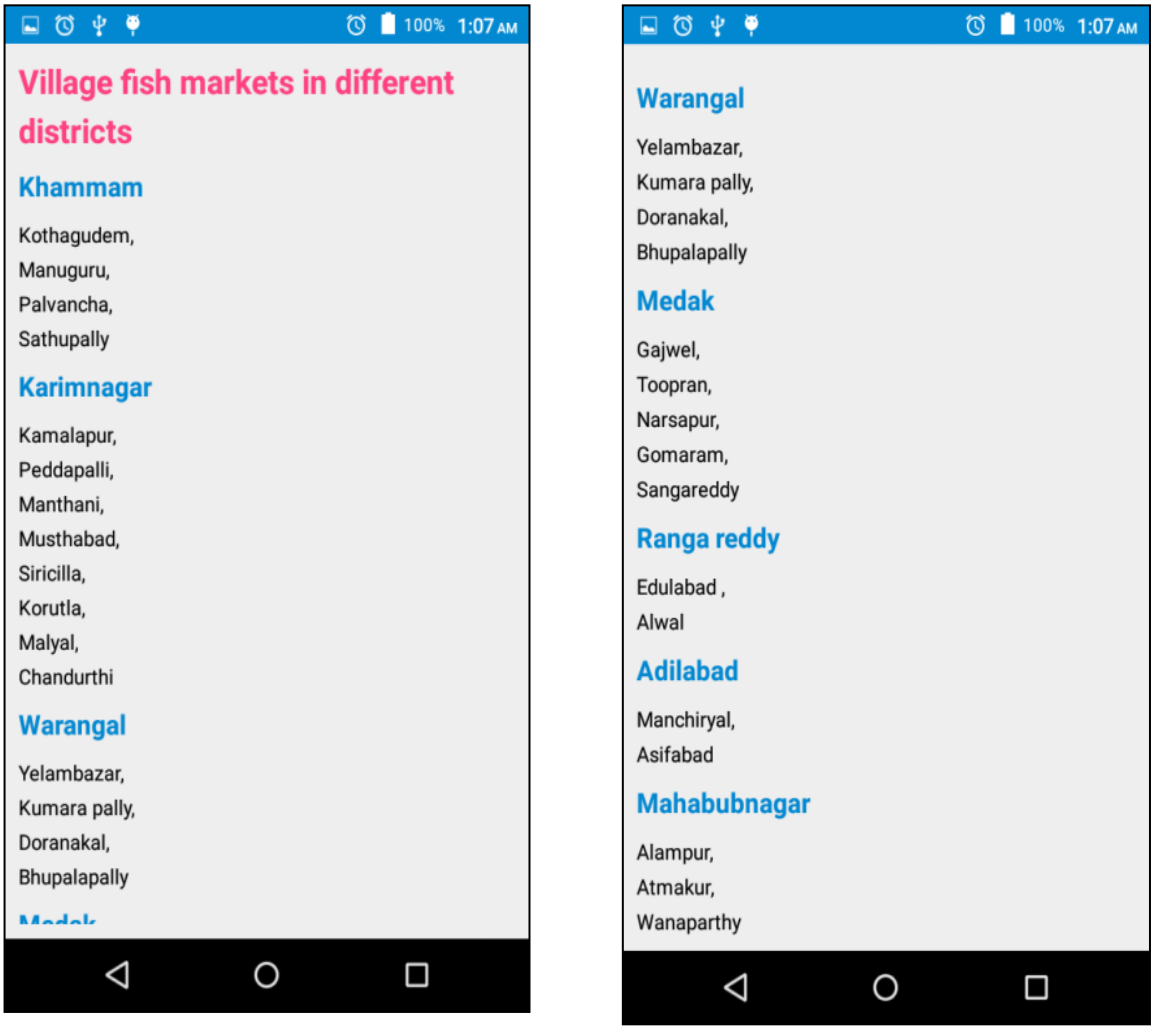


Figure 86a and b: 1st and 2nd screenshot of fish markets

The schemes of the Governement in T-fish info is linked with the State Fisheries Department website. If a user clicks on schemes the fisheries department website opens and displays the information on state sponsered schemes. The relevancy score given by the farmers and experts was 3.2 and 3.5 resepctively. The content validity ratio given by experts was found to be 0.85. This screen screen is given in figure 87.

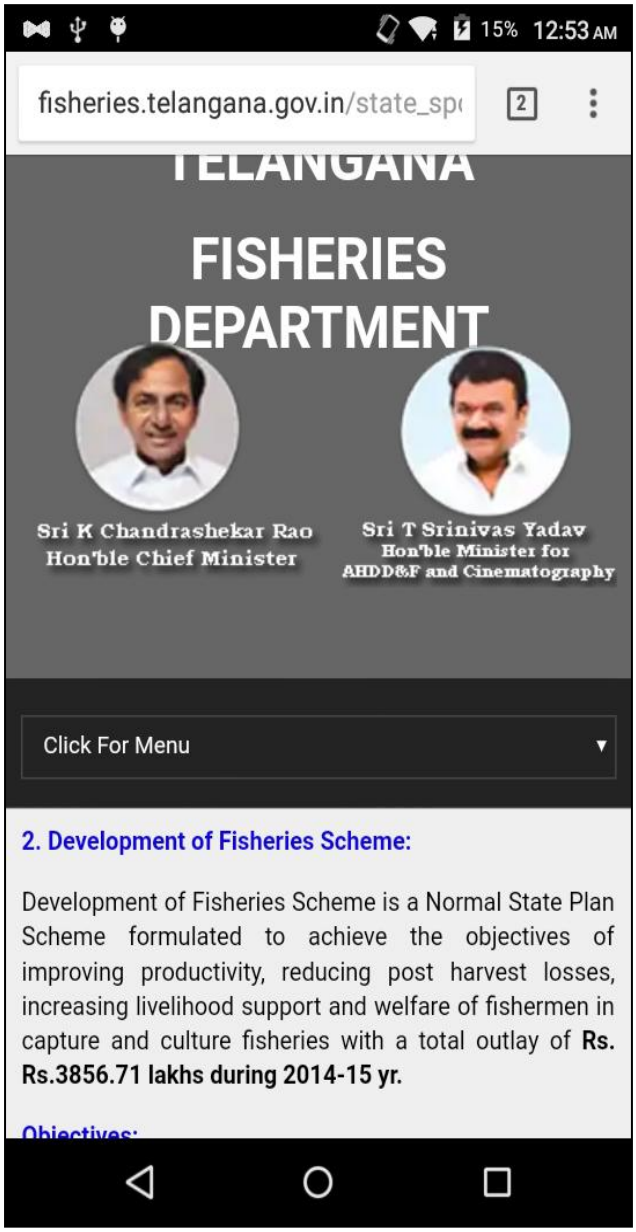


Figure 87: Screen Shot of DoF Schemes

In the home screen when the user clicks on Buy or sell a screen will be displayed showing list view with options seller posts, buyer posts and add post. The screenshots were given from figure 88 to 93.

Screen Shot for Buy or Sell a produce

The relevancy score for this feature given by both farmers and experts was 4. The screen shot is given in figure 88.

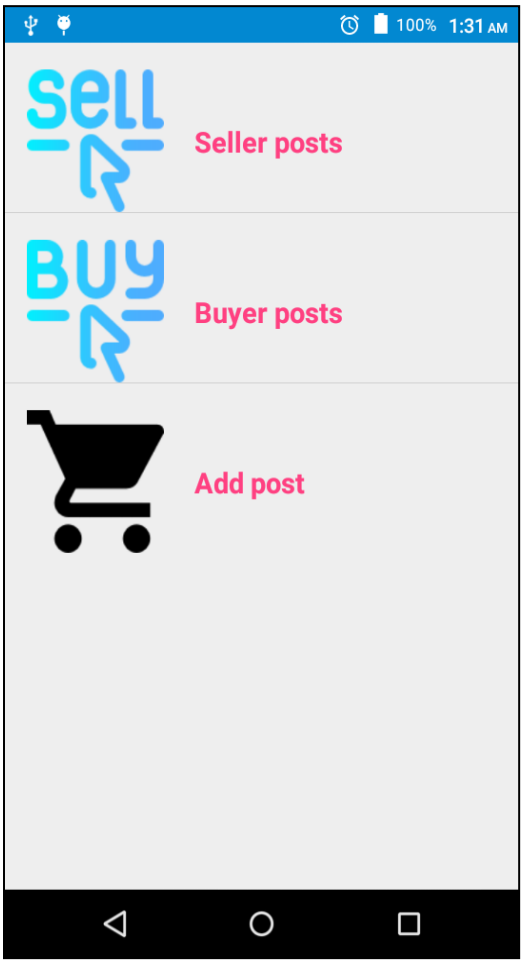


Figure 88: Screen Shot for Buy or sell post

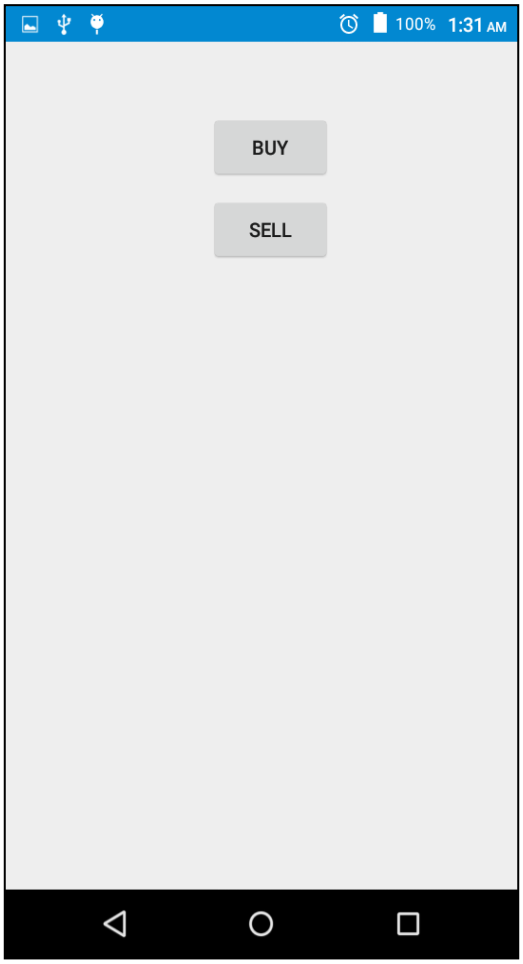


Figure 89: Screen Shot for Add

Screen Shot for Add Post

When the user clicks add post in buy or sell screen another screen will be displayed with two buttons buy and sell. This is presented in figure 89.

If the user wants to buy the fish, he/she can click on buy and a form will be displayed collecting information on type, variety, quantity of fish to buy, details of buyer, and the dates on which fish is required. The buyer has to enter the details and click on submit button. The form for buyer is presented in figure 90.

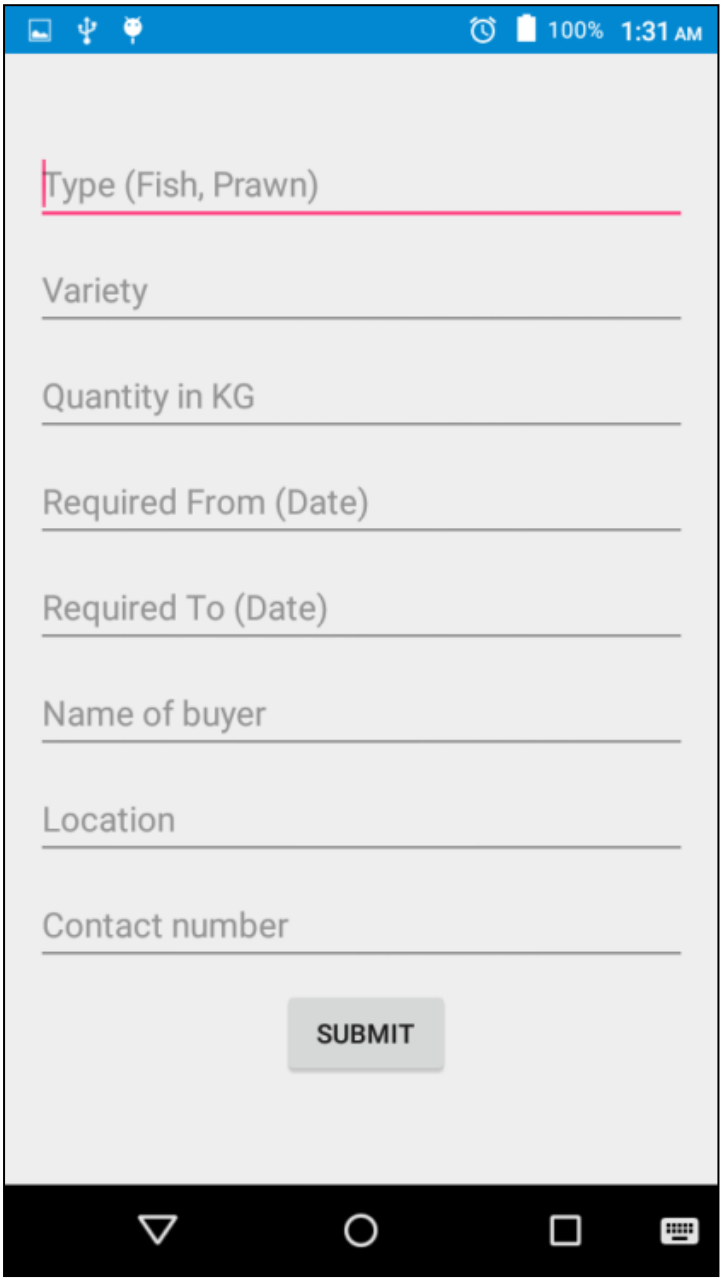


Figure 90: Screen Shot of Buying

If the user want to sell the fish, he/she clicks on sell button and fill a form which gives the details about the seller, type, variety, quantity, price of fish and the fish availability dates and click on submit. The form for sellers is presented in figure below.

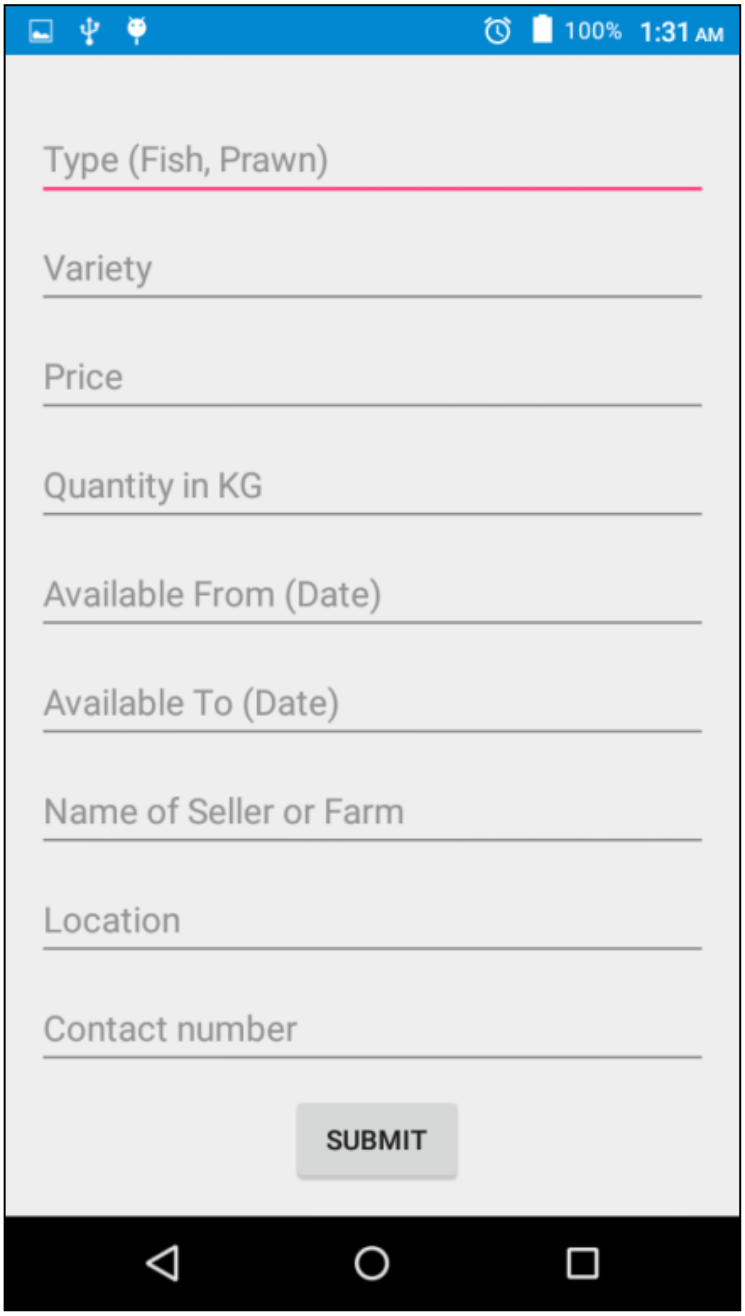


Figure 91: Screen Shot of Selling

Screen Shot of Selling the produce

In the screen shot of seller the form filled and submitted by the seller will be displayed with the details of seller, variety and quantity of fish for sale and the available dates of fish. The screen shot is given in figure 92. Hypothetical names were taken for testing the prototype.

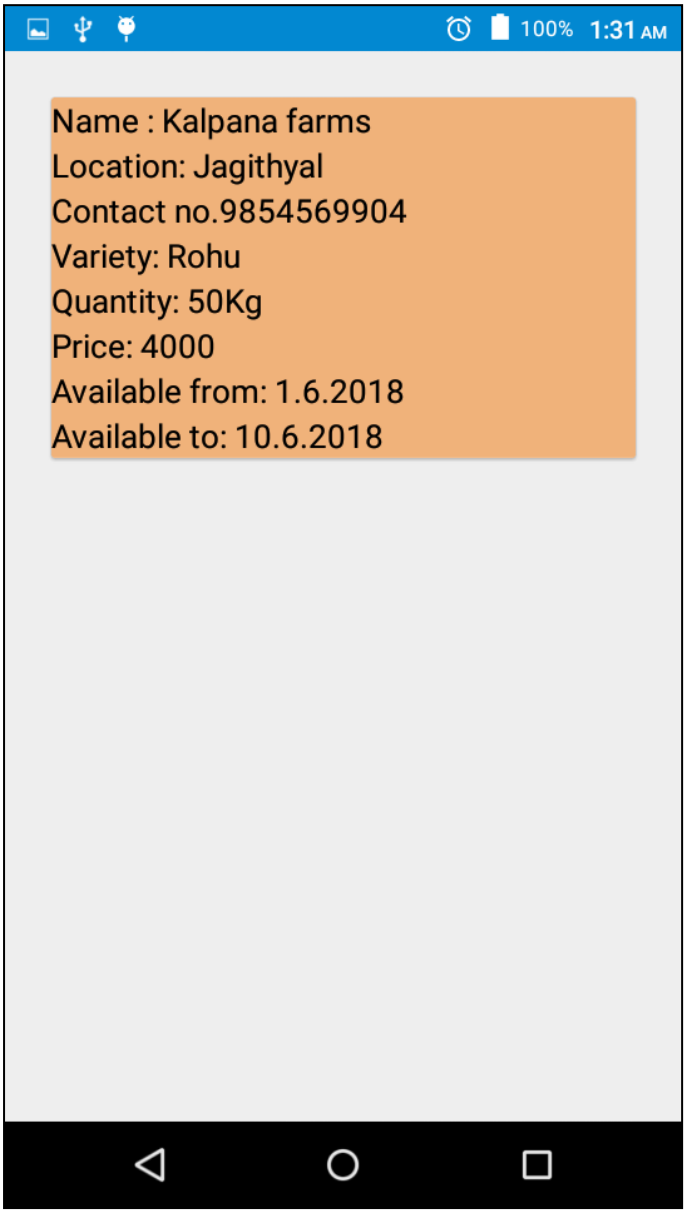


Figure 92: Screen Shot of Seller

Screen Shot of Buyer

In the buyer posts screen, the form filled and submitted by the buyer will be displayed with the details of the buyer variety, quantity required and the dates in which the fish is required. The screen shot is given in the figure 93. Hypothetical names were taken for testing the prototype.

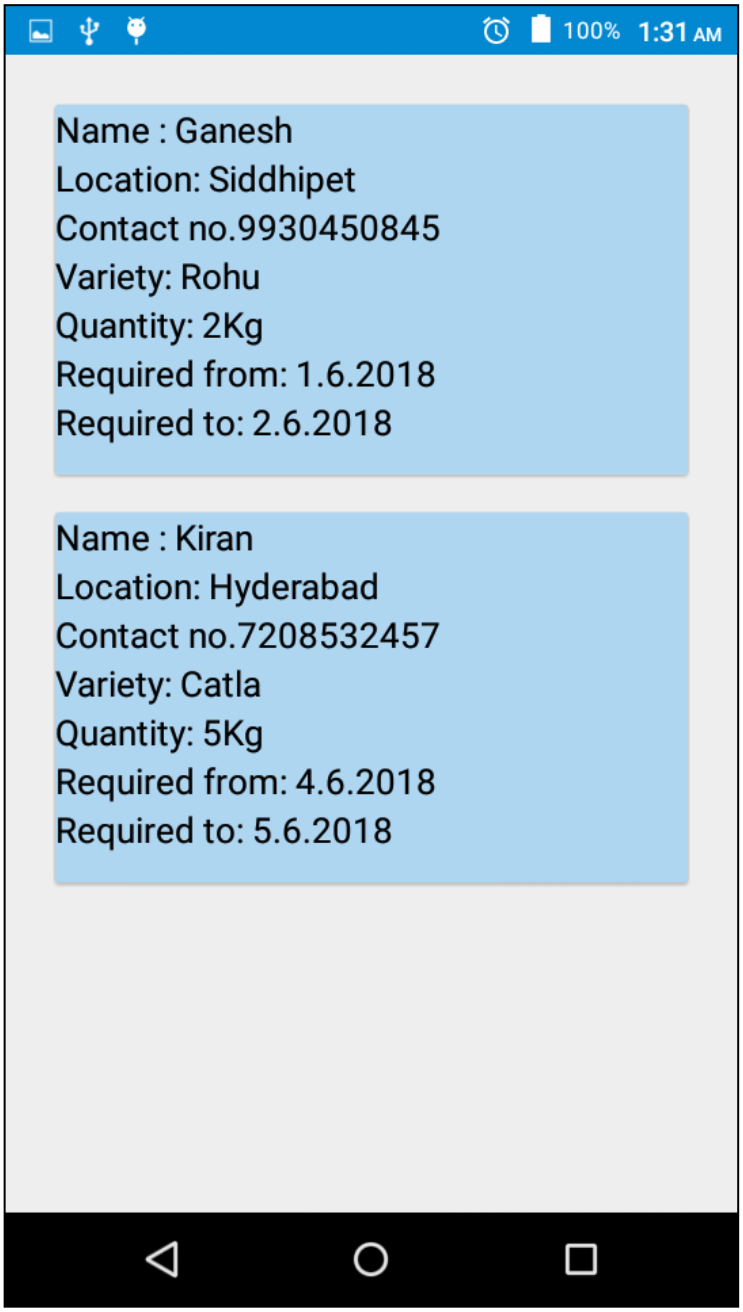


Figure 93: Screen Shot of Buyers

The prototype thus developed was tested at four levels by CIFE committee with scientists then by the fisheries professionals from aquaculture, pathology and social science. After this it was tested by the mobile app developer and finally by five progressive fish farmers. Feedback was taken from fisheries professionals and progressive fish farmers. The results of the feedback are given in table 22.

Table 22: Feedback of the mobile app

Parameter	Average Scores out of 3
Design	
Color	2.9
Font	2.8
Imagery	2.9
Simplicity	2.9
Visual	2.8
Clarity of icon	2.9
Layout	2.9
Interface	2.9
Information	
Quality	2.8
Quantity	2.6
Technical content	2.8
Relevance	2.8
Appropriateness	2.9
Clarity	2.9
Ease of learning	2.8
Functionality	
Performance	2.8
Navigation	2.9
Ease of use	3
Gestural design	2.9
Consistency	2.8
Name of app	2.8

Others	
Recommend to others	2.8
Pay for the app	1.8
Increase Awareness	2.7
Increase Knowledge	2.8
Motivate other people to take up fish farming	2.5

Ease of Use had a maximum score. Colour, imagery, clarity of icon, layout, interface, simplicity, appropriateness, ease of use, clarity, navigation, gestural design also scored high. Scores for font, visual, quality, technical content, relevance, ease of learning, performance, consistency, name of app, recommending others had an average score of 2.8. If the mobile app will be able to increase awareness also scored high i.e., 2.7. However, most felt that the app should be freely available and not be charged. Respondents felt that the best part of the app was that once it is downloaded information can be availed any time, any where even without internet connection. Many names were suggested by the respondents during the feedback but the name 'Matsya Kiran'/Fish Kiran was preferred by maximum. The app thus developed is of potential use for stake holders like fish farmers, students and anyone who is interested in fisheries.

There are few apps developed for Indian fish farmers. So there is immense scope to develop more apps based on the need of farmers. It is expected that this app will be able to provide scientific information on fisheries among the fish farmers of Telangana as well as other states. This android based app is an easy, fast and convenient gateway of information on inland fisheries in text and image format. The illustrations make it more interesting. This app is user friendly and provides information which is free of cost, anytime, anywhere using Android smart phone. The app initializes on clicking the app icon and it displays a dash board with main features like culture practices, management practices, post harvest practices, modern farming techniques, T-fish info and buy or sell facilitating the user to buy or sell the fish in required quantities.

With the increase of smart phones by the Indian population and advent of social media, mobile apps and internet there is an urgent need to use the handy device. Mobile as a tool to disseminate adequate information to fishers/fish farmers, students, youth, cooperatives, SHGs etc. To achieve this, there will be a need to orient the students of fisheries towards the modern developments in ICTs, computer science, programming, Artificial Intelligence, Data Analytics, Block Chain and the latest trends. It is suggested that optional courses in some of these fields should be introduced for students in fisheries sciences so that the students are well versed with the latest development happening in the world. In addition, developers of Information Technology also should focus on fisheries sciences. This will be beneficial for the fisheries sector which has an immense potential for improving the livelihood and nutritional security.

5. SUMMARY AND CONCLUSION

Amongst the ICT applications, mobile phones are gaining more attention with many benefits such as less price, easy portability and user friendly appearance. The mobile devices are not only used for the communication purpose, these devices have come up with a lot of handy tools known as 'app' that are widely used by the common people in their day to day life. Mobile apps are becoming popular in agriculture and allied sectors too, with the potential for further advancement. However, mobile apps from India related to fisheries are few. With the increase of mobile users it is expected that more user-specific apps will be developed.

However, there are lack of studies on mobile apps in fisheries and aquaculture. A comprehensive search as reported by Sharma (2018) had resulted in 85 mobile apps in the field of angling, aquaculture, aquarium management, marine fisheries governance, marketing and fish biology. Out of this, 17.65% of the apps were of Indian origin. She has reported in her study that apps for fish farming are few and with software market for precision farming tools expected to grow, there is a need for fisheries organisations to partner with Information Technology providers and come out with sustainable solutions.

Thus, there is a need to do comprehensive study on mobile apps. Accordingly a study entitled "Design of Mobile App Prototype for Fish Farmers of Telangana" was undertaken with the objectives to conceptualize the features required in the mobile app for fish farmers, to aggregate scientific information for relevant features to be included in the mobile app and to develop mobile app prototype based on these features.

For the study, state of Telangana was selected purposively. The rationale for selecting Telangana, lies in the fact that the state has a great potential of ₹4,500 crore to ₹5,000 crore in fisheries sector under reservoirs, tank and ponds and ranked 8th in fisheries production with approximately 2,60,010 metric tonnes of production during 2014-15 as per Department of Fisheries (DoF), Telangana (2016).

Among all the districts of Telangana, Karimnagar and Khammam are important with reference to fisheries with highest fish and seed production and also relatively higher number of aquaculture farms. Hence these two districts were selected for the present study. A total of 60 farmers from these two districts were selected as respondents.

For conceptualizing the features required in the mobile app for fish farmers a questionnaire was designed to elicit information on farmers' profile like age, income, fisheries experience, farm size, species cultivated, production and constraints faced. For gathering information about mobile phones enquiry was done regarding usage of phones/smart phones by farmers, most common apps available/downloaded by them, frequency of usage of these apps, awareness/usage of any apps related to agriculture/fisheries, sources of information related to fisheries and their attitude towards app on fisheries.

All farmers reported that they were interested in using a mobile app which would provide information on fisheries that they were looking for. On basis of the positive response, an interview schedule was designed which had open-ended questions in order to collect what specific features and information heads they would be interested to be included in the mobile app. Farmers reported that they needed information on culture practices, water quality management, feed management, bacterial, parasitic, viral, fungal and environmental diseases, fish seed suppliers and fish markets.

These heads were grouped in to 6 heads. Simple percentage analysis was done to analyse Yes/No response for inclusion of these heads. After this, a discussion was held with 25 experts with an objective of conceptualizing the features required in the mobile app for fish farmers.

Experts were shown the list of features suggested by the farmers and these features were discussed for which all experts agreed. In addition, the experts suggested that information on additional features should be added. These additional features were Cage culture, Recirculatory Aquaculture System, Fish cum Agriculture, Fish cum Horticulture, Fish cum pig, Fish cum duck, Fish cum poultry, Fish cum cattle, Fishermen cooperative societies, Fishermen population and Farm

registration guidelines. Following this, all features suggested by Farmer Group and the Expert Group were compiled. As the list had many features, a decision was made to do a Relevancy Test for the compiled features. Relevancy in this study is defined as “The degree to which something is related or useful”. To conduct a relevancy test, Farmers and Experts were asked to rate each listed feature on a four point scale of Relevancy. All features which had an average score of more than 2 were included in the prototype of mobile app. Features with average scores less than 2 were few and were not included. The features included were grouped in 6 broad heads. These were Culture practices, Management practices, Post harvest practices, Modern farming techniques, Telangana information and Buy and Sell. Based on the 6 broad information heads, decisions were taken about the subheads. Relevancy Test was done again for each sub- head.

Mann- Whitney U test indicated that there was no significant difference between the relevancy scores given by farmer group and expert group. Kendall’s coefficient of concordance was more than 0.65 showing that the experts were in agreement.

In order to aggregate the scientific information for relevant features to be included in the app, information was collected from different sources, rewritten in a simple language. It was checked for its content by the advisory committee. Grammarly software was used for checking for plagiarism and grammar. The percentage of plagiarism was found negligible for the contents and suggested corrections were done for grammar. Once the contents were finalized, the same was validated by writeshop process in three drafts by advisory members along with illustrations and photos. Content validity was established and the Content Validity Ratio (CVR) was more than 0.75.

To develop the mobile app prototype, a course on Android Application Development was done. Based on the skill achieved from internship, the mobile app was developed. First, wire framing and story board were created based on the selected features, as this helps as the back-end structure of the app. Once the skeletal frame work was designed, it was decided to develop the app in the software. App was developed using the Android Studio IDE an interactive environment for developing the android apps with support of JDK-8 (Java

Development Kit) installed in the developing computer system. Android studio provides a facility of in-built gradle, app preview, testing and compiling of the app, etc. Every single screen of the application is considered as activity to the user, which is the important component of the application.

Thus a prototype of this app was developed. The prototype was tested at four levels by CIFE committee with scientists from genetics, aquaculture, post harvest technology, then by the fisheries professionals from aquaculture, pathology and social science, then by the mobile app developer and finally by five progressive fish farmers in the field. The feedback provided in field conditions was positive and few modifications suggested were included. In order to take feedback of the mobile app prototype, the prototype was displayed by screen mirroring on the screen using cast screen app to 30 young fisheries professionals comprising 17 males and 13 females to take initial feedback and review of app.

Results indicated that the farmers' age ranged from 35 to 50 years and average age was 42 years. Majority of the farmers (73%) were found to be in the middle age group (35-50), followed by young age group (25%). Only few farmers were found to be in the old age group, constituting 2% of the total farmers. Average income of farmers was found to be Rs. 2.5 lakhs per annum with 75% of them earning between Rs. 2-5 lakhs. Range of income was Rs. 1,00,000 to Rs. 10,00,000/- They are involved in fisheries activities during culture period i.e. about 8 months. Average fish farming experience was found to be 22.5 years with a range of 0 to 32 years. Maximum farmers had fishing experience in the range 15 -30 years. Majority of the farmers (75.1%) had pond size of <1 ha , 16.6% of the farmers had 1-2 ha pond size and 8.3% of the farmers had >2 ha pond. Average size of the farm was found to be 0.12 ha. As reported by farmers the fish species which were cultured by them, were Catla, Rohu, Mrigal, Common carp, Grass carp, Murrel and Fresh water prawn. Majority of the farmers reported that the fish production is around 1-2 tonnes per ha.

The major constraints faced by the farmers, as reported by them, were Lack of scientific knowledge on culture management and modern farming methods, Lack of knowledge on fish processing, Lack of knowledge on feed management, Availability of quality fish seed of different varieties, Low fish yields and Lack of

marketing facilities. It was found that all the farmers used smart phones.

Most common apps used by farmers were Whatsapp, Facebook, Youtube and SBI personal banking app. It was found that no farmer used any agriculture/fisheries related app and they were not even aware of any such app. All the farmers showed positive attitude towards the mobile app in fisheries.

They responded in positive that there is a need of a mobile app which provides any information on fish culture, post harvest, marketing, cage culture, integrated farming etc. Opinions were taken from experts to add more features if required. Members of the expert group agreed to the features listed by the farmers. However to make the mobile app more comprehensive, they added ore features namely, Registration guidelines, Modern farming techniques, Water quality management, Buy and sell option, Processing, Transportation, Value added products, Fisheries statistics, and Water resources. The features listed by farmers and expert group were clubbed under different heads.

To make the findings more robust, Relevancy test was done. Relevancy of each feature was scored on a 4 point scale and those features with score more than 2 were included. Based on these, 21 features under 6 broad heads were finalized. These features were Culture practices, Management practices, Post harvest practices, Modern farming techniques, Telangana information and Buy and sell. The next step was to include the sub-heads in each of the features which were included. For each subhead the list was prepared and after discussion with Experts and Farmers these were listed.

A mobile app was thus, developed. This app is an information retrieval system which provides scientific information to the farmers. This application contains mainly following 6 features as follows:

- Culture practices of carps, murrels, magur, tilapia, prawn in ponds and GIFT tilapia, pangassius in cage
- Management practices such as water quality, feed and health
- Post harvest practices such as handling, transportation, processing and value added products.

- Modern farming techniques such as Cage culture, Recirculatory Aquaculture System and Integrated farming.
- T- fish info which provides details of registration guidelines, fish seed suppliers and markets.
- Buy or sell which helps the farmer to sell the farm produced fish and an individual/wholesaler to buy the farm produce.

Feed-back was taken and it was seen that Ease of Use had a maximum score. Colour, imagery, clarity of icon, layout, interface, simplicity, appropriateness, ease of use, clarity, navigation, gestural design also scored high. Scores for font, visual, quality, technical content, relevance, ease of learning, performance, consistency, name of app, recommending others had an average score of 2.8. Whether the mobile app will be able to increase awareness component also scored high i.e., 2.7.

However, most of the respondents felt that the app should be freely available and should not be charged. Respondents felt that the best part of the app was that once it is downloaded information can be availed any time, anywhere even without internet connection. Many names were suggested by the respondents during the feedback but the name 'Matsya Kiran'/'Fish Kiran' was preferred by maximum. The app, thus developed is of potential use for stakeholders such as fish farmers, students and others who are interested in fisheries.

There are few apps developed for Indian fish farmers. So there is immense scope to develop more apps based on the need of farmers. It is expected that this app would be able to provide scientific information on fisheries among the fish farmers of Telangana as well as of other states. This android based app is an easy, fast and convenient gateway of information on inland fisheries in text and image format. The illustrations make it more interesting. This app is user-friendly and provides information which is free of cost, anytime, anywhere using Android smart phone. The app initializes on clicking the app icon and it displays a dash board with main features like culture practices, management practices, post harvest practices, modern farming techniques, T-fish info and buy or sell facilitating the user to buy or sell the fish in required quantities.

With the increase of smart phones by the Indian population and advent of social media, mobile apps and internet, there is an urgent need to use the handy device Mobile as a tool to disseminate adequate information to fishers/fish farmers, students, youth, cooperatives, SHGs, etc. To achieve this, there will be a need to orient the students of fisheries towards the modern developments in ICTs, computer science, programming, Artificial Intelligence, Data Analytics, Block Chain, and the latest trends. It is suggested that optional courses in some of these fields should be introduced for students in fisheries sciences so that the students are well versed with the latest development happening in the world. In addition, developers of Information Technology also should focus on fisheries sciences. This will be beneficial for the fisheries sector which has an immense potential for improving the livelihood and nutritional security of the fish farmers.

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PLATES

Plate 1: Data Collection in Karimnagar district

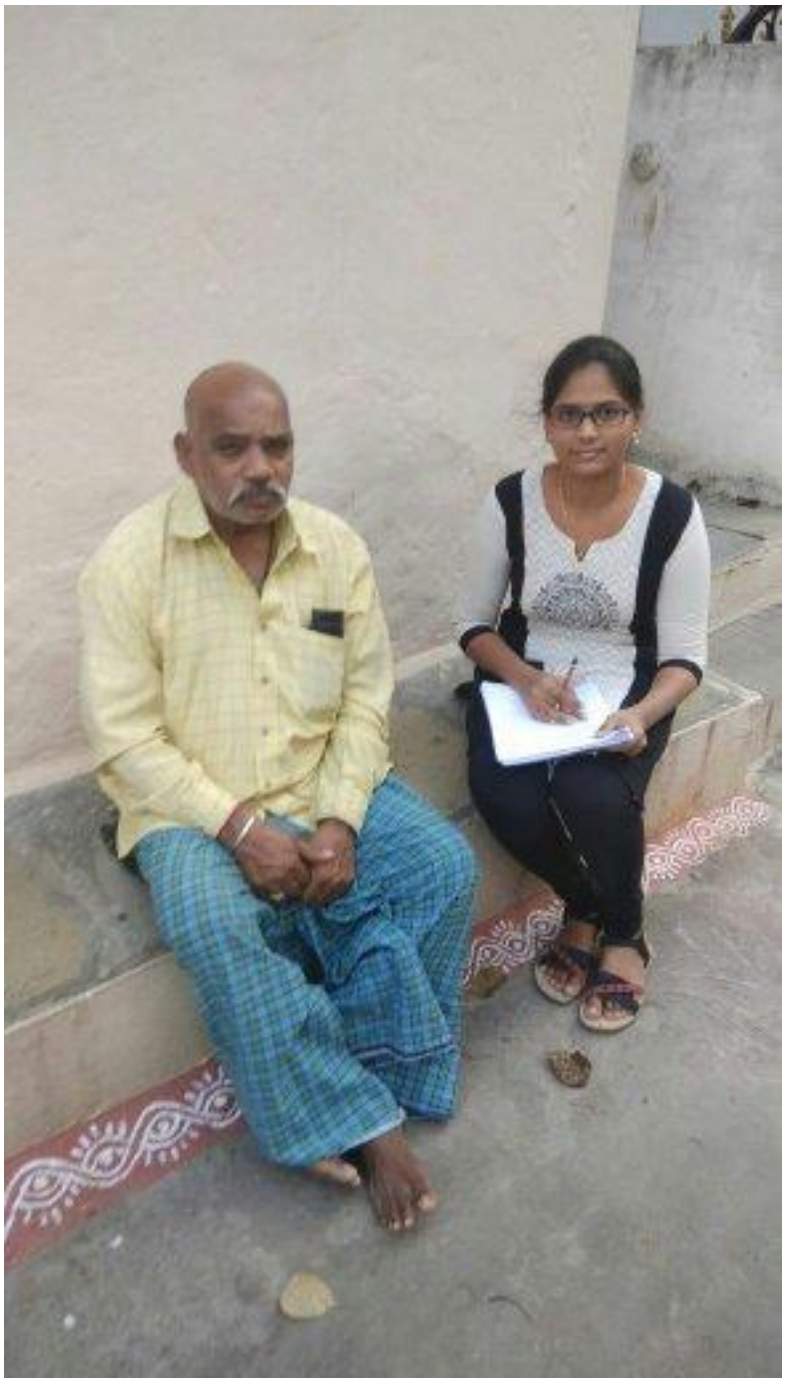

Plate 2: Data collection in Khammam district

Plate 3: Discussion with Key Informant in Karimnagar district

Plate 4: Training Institute for Android Application Development

ANNEXURE 1

INTERVIEW SCHEDULE

General Information

1. Name
2. Age
3. Address
4. Mobile number
5. Email id if any
6. Languages known Telugu/ Hindi/English/others

Economical information

1. Primary occupation Fish culture, Agriculture, Business , Services, Daily labours, Poultry raising/any others
2. Secondary occupation: Fish culture, Agriculture, Business , Services, Daily labours, Poultry raising/any others
3. Family Income
4. Income from fisheries(monthly/yearly)
5. Income from other sources(monthly/yearly)
6. Fisheries Assets: Boat, Net, Aerators, Generators, Engines, farm, hatchery, others

Communication media usage:

Source of communication	**Usage(yes/no)**	**Frequency (daily,ocasionally,never)**	**Cost incurred**	**Type of usage**
Mobile				
Telephone				
Magazines				

Internet				
News papers				
Community Radio				
Social media				

1. Do you have a mobile phone
2. Do u have a smart phone
3. Which mobile do you use: android/ non android/ iphone
4. Which mobile network do you use: Airtel/ jio/Tata docomo/BSNL/Vodafone/Idea/ others
5. What is the speed of the internet you subscribe to
6. Frequency on usage of internet: daily, occasionally, never

Usage of Apps:

Apps	**Usage (yes/no)**	**Frequency (daily,occasionally,never)**	**Type of usage**
Facebook			
Watsapp			
Instagram			
Twitter			
Telegram			
You tube			
Others			

7. Are you comfortable using apps? Highly comfortable/ moderately comfortable/comfortable/not comfortable
8. Do you use any banking app? Yes /no
9. Which app do you use for banking?
10. Do you use any financial app? Yes /no
11. Which financial app do you use?
12. What type of content you like on app: video/ audio/ text/ photographs/all/others
13. Do you know any app on fisheries? Yes/ no
14. Which fisheries app do you know?
15. Do you know any app on farming? Yes/ no
16. Which farming app do you know?
17. Do you use any app for fisheries/farming? Yes/no
18. If yes, which app do you use?
19. How many hours you spent in a day on usage of app?
20. For what purpose you use the app?
21. Which websites do you browse?
22. For what purpose you browse those websites?
23. When do you browse?

Which source do you use to access information on fisheries

Mobile/Telephone/Newspaper/Magazines/Internet/Communitymeetings/Cooperatives/SHGs/KVKs/Department of Fisheries/Govt. Depts/Social media/add other/community radios

Apps	**Features you like**	**Features you don't like**
Facebook		
Watsapp		
Twitter		

Telegram		
Instagram		
Others		

Perceptions on fisheries app:

1. Do you think you need an app for fisheries information? Yes/no
2. Why do you think it is needed?
3. How do you think it will be helpful?
4. How many times will you use the app?
5. When will you use?
6. How much you are ready to pay for app related to fisheries in a month?
7. Should app be different for men and women? Yes/ no
8. Do you want training on app usage? Yes/no

Information on fisheries:

1. Farm area:
2. Farm productivity hac/year:
3. Type of culture practiced:
    a. Extensive
    b. Semi intensive
    c. Intensive
4. Mostly cultured species: 1.---------- 2.----------3.----------
5. Source of credit: self, bank, others
6. How much expenditure is incurred on one crop of fish?
7. How much Loss is incurred in the last crop?
8. How much profit did you get from the last crop?
9. How many middlemen are there in the marketing channel?
10. Major constraints faced during culture?

ANNEXURE 2

QUESTIONNAIRE ON FEATURES

General information

1. Name
2. Age
3. Sex
4. Address
5. List out the features required in mobile app
    a. _____
    b. _____
    c. _____
    d. _____
    e. _____
    f. _____
    g. _____
    h. _____
    i. _____
    j. _____

You may list as many points you wish to have information on

Example: Culture information like carps, murrels, magur, pangassius, tilapia, climbing perch, prawn, feeding, water quality, fertilization, diseases, schemes, seed suppliers, feed suppliers, weather, markets etc.

ANNEXURE 3

RELEVANCY TEST

Name: Age:

Relevance: Degree to which something is related or useful

These are features suggested by fishers fish farmers, Expert group which are to be included on the mobile app less rate them on a scale of 4

Features	Very relevant	Moderately relevant	Less relevant	Not relevant
Score	**4**	**3**	**2**	**1**
Imc culture				
Composite culture				
Murrel culture				
Tilapia				
GIFT tilapia (Cage)				
Pangasius (Cage)				
Fresh water prawn				
Water Quality management				
Feed management				
Bacterial Diseases				
Parasitic Diseases				
Fungal diseases				

Viral diseases				
Environmental Diseases				
Handling				
Transportation				
Drying				
Salting				
Freezing				
Smoking				
Canning				
Fish balls				
Fish cutlet				
Fish fingers				
Fish pickle				
Prawn pickle				
Cage Site selection				
Cage species selection				
Cage maintenance				
Buy or sell				
RAS water quality				
RAS feeding				

Fish cum agriculture				
Fish cum horticulture				
Fish cum pig				
Fish cum poultry				
Fish cum duck				
Fish cum dairy				
Registration guidelines				
Fish markets				
Seed suppliers				
Water resources				
Fishermen population				
Fishermen cooperative societies				
Fish production				
Schemes				

ANNEXURE 4

CONTENT VALIDITY

Name: Age:

Please rate the content provided for each feature that has to be placed in the mobile app.

Features	Essential	Not Essential
Imc culture		
Composite culture		
Murrel culture		
Tilapia		
GIFT tilapia (Cage)		
Pangasius (Cage)		
Fresh water prawn		
Water Quality management		
Feed management		
Bacterial Diseases		
Parasitic Diseases		
Fungal diseases		
Viral diseases		
Environmental Diseases		
Handling		

Transportation		
Drying		
Salting		
Freezing		
Smoking		
Canning		
Fish balls		
Fish cutlet		
Fish fingers		
Fish pickle		
Prawn pickle		
Cage Site selection		
Cage species selection		
Cage maintenance		
Buy or sell		
RAS water quality		
RAS feeding		
Fish cum agriculture		
Fish cum horticulture		
Fish cum pig		

Fish cum poultry		
Fish cum duck		
Fish cum dairy		
Registration guidelines		
Fish markets		
Seed suppliers		
Schemes		

ANNEXURE 5

FEEDBACK ON MOBILE APP FOR FISH FARMER

ICAR-CIFE, Mumbai

Name:_____ Age:_____ Male/Female Date: _____

A mobile app Mathsya Kiran has been developed based on the needs of fish farmers for which field work was done. This app is of potential use to stakeholders like farmers, students, policy makers and anyone who is interested in fish farming. This android based app is an easy, fast and convenient gateway of information on inland fisheries in text and image format. This app is user friendly and provides information which is free of cost, anytime, anywhere using Android smart phone. After initialization of the app, it displays a page showing the information on topics of Culture practices, Management practices, Post harvest practices, Modern farming techniques, T- fish info, Buy or sell. These further have many sub topics explained in simple text format and images.

PLEASE RATE THE MOBILE APP ON FOLLOWING

		Very Good	**Good**	**Fair**
I.	**DESIGN**			
1	Colour			
2	Font			
3	Imagery			
4	Simplicity			
5	Visual			
6	Clarity of icons			
7	Layout			

8	Interface			
II.	**INFORMATION**			
1	Quality			
2	Quantity			
3	Technical content			
4	Relevant			
5	Appropriate			
6	Clarity			
7	Ease of learning			
III.	**FUNCTIONALITY**			
1	Performance			
2	Navigation			
3	Ease of use			
4	Gestural design			
5	Consistency			
6	Name of mobile app Matsya Kiran			
IV.	**Others**	**Yes**	**No**	**Undecided**
1	Would you recommend this app to others ?			
2	Would you pay for this app?			
3	App is likely to increase awareness on fisheries			

4	App is likely to increase knowledge on fisheries			
5	App is likely to motivate people to take up fish farming			

1. Suggest any feature which should be replaced?

   _____

2. What do you like best in this app?

   _____

3. Suggest alternative name for this mobile app

   _____