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Development of a mobile application for Pacific white shrimp (*Penaeus vannamei*) farming and evaluation of its efficiency in technology communication and feedback

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Abstract

Shrimp farming is a technology-driven and risk-intensive food production system. Shrimp farms are remotely located and farmers need customized farm advisories, which the conventional extension systems are not able to provide. To provide technology advisories to the stakeholders, an android mobile application, CIBA ShrimpApp, was developed in 2018, based on the information and format requirements of the shrimp farmers using Java language as front end and the data bases were created as back end through Structured Query Language (MySQL). The app contains eight modules, viz. better management practices of shrimp farming, quantification of inputs, on-farm disease diagnosis, on-farm risk assessment, Frequently Asked Questions (FAQs) in shrimp farming, regulations, advisories and updates and posting queries which were integrated as a mobile application. The app has more than 27,500 cumulative downloads and has a rating of 4.5 out of 5.0. The application was found to have improved the knowledge level of end users to the tune of 20–37%. The Google firebase application data showed that 98.4% of users of CIBA ShrimpApp were free from errors and crashes. An evaluation study conducted among sample regular users indicated that the app aided in farm decision-making and its design functionality and extension service function were perceived to be efficient. Considering the all-pervading mobile phone connectivity and affordability, smart phone-based mobile applications and data analytics can play a significant role in shrimp farm advisory services and its sustainability.

Keywords Shrimp farming · Farm advisory services · Mobile application · Communication · Efficiency · Feedback

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Introduction

Shrimp farming is a technology-intensive and high investment food production system. Shrimp is a high-value commodity alone contributing 71% of Indian seafood export earnings worth 5 billion USD. Introduction of specific pathogen free (SPF) Pacific white shrimp (*Penaeus vannamei*) farming in 2010 has quadrupled the Indian shrimp production from 0.15 MMT in 2008–2009 to 0.815 MMT in 2020–2021 with an enhanced average productivity of 6.0 tonnes/ha (MPEDA, 2021). Though profit is relatively higher in shrimp farming, it is equally susceptible to diseases and other production risks in the form of pond-driven stress factors. Therefore, farm advisory services are important to enhance the technical capabilities of the farmers to adopt appropriate farming practices and facilitate them to access quality farm inputs, diagnostic services and premium market (Joffre et al., 2017; Engle, 2017; Kumar and Padmaiah 2012; Ngugi et al., 2018; Obiero et al., 2019). Return to investment on farm advisory services is estimated at around 58% (Alston et al., 2000; Dercon, et al. 2009) and could be attributed for increased production and household income of farmers to the tune of 18–30% (Asres et al. 2013; Davis et al. 2013; Msangi and Batka 2015; Gideon et al., 2018). In India, fisheries are the provincial subject; hence, the states have the major responsibility in providing extension advisory services. Though fisheries and aquaculture contribute significantly to food production, employment generation, societal development and national economy, it has not been adequately supported with a formal dedicated extension service at state level (Kumaran et al. 2012; Sadamate et al. 2019).

The Departments of Fisheries (DoFs) of states due to their limited reach, welfare-centric functions, lack of manpower, extension service orientation and budgetary constraints are constrained to perform this role efficiently (Kumaran et al., 2012). Many ICT-aided projects were undertaken to provide extension support, but due to their narrow focus and limited geographical attention, they could not make an impact (Walsham, 2013; Evans, 2018a; Alagappan and Kumaran, 2016a, b; Vimala et al. 2017, Monica et al. 2019). Nevertheless, development of mobile networks that support greater data speeds and connectivity even in remote geographies and affordable prices of mobile handsets across the globe facilitated the exponential rise of mobile applications to bridge this communication gap in a relevant mode to the end users and facilitate research, extension, farmers, input and market integration (World Bank, 2012). Studies have revealed that mobile phone-based information pathway could ameliorate the major impediment, the access to farm advisory, for raising agricultural productivity among smallholders (Aker Christopher Ksoll 2016; Karanasios and Slavova, 2018; Sontakki and Subash, 2017). Furthermore, mobile applications were found to have ensured bidirectional information flow (Anand and Kumaran, 2017; Sontakki and Subash, 2017), customized advisories to the farmers, broken information asymmetry and enhanced knowledge level among the farmer segments (Aker, 2008; Kumar and Padmaiah, 2012; Lee and Bellemare, 2013; Ganesan et al., 2013; Katengeza et al., 2014; Mahedi Hasan, 2015; Reddy et al., 2017; Thokozani and Fredy Kilima 2019; Vimala et al. 2017).

Elfeky and Masadeh (2016) and Brize-Ponce (2016) confirmed that the use of mobile learning (apps) was more effective on end user's knowledge than the use of traditional teaching approaches, due to the availability of the device without the restrictions of time and place. Shrimp farmers constantly seek information from online sources and are positively receptive towards accessing technology information through mobile applications (Kumaran et al. 2012). In this context, an Android mobile application, with need-based information modules on Pacific white shrimp (*Penaeus vannamei*), was developed and launched. It is essential to assess the performance of mobile application in fulfilling the intended objectives. Earlier studies have assessed the effectiveness of mobile advisory models through farmer awareness of new practices, knowledge acquisition and retention and knowledge sharing (Elfeky and Masadeh 2016; Briz-Ponce et al. 2016; Monica et al. 2019). Similarly, knowledge gain by the end users and their perception on innovation attributes were the criteria used to evaluate the ICT-aided expert systems (Thammi Raju et al. 2006; Alagappan and Kumaran, 2016a, b). The present study was therefore taken up to ascertain the process of mobile application development and evaluate its effectiveness in terms of reachability, knowledge improvement and functional utility.

Methodology

Development of mobile application on shrimp farming

An android mobile application was developed adopting the Software Development Life Cycle (SLDC) approach comprised of eight phases and relevant methodologies as given in Table 1. Eight information modules, viz. better management practices of shrimp farming, quantification of inputs, on-farm disease diagnosis, on-farm risk assessment, Frequently Asked Questions (FAQs) in shrimp farming, regulations, advisories and updates and posting queries, were integrated in the mobile application. The internal consistency and validity of the modules were evaluated with appropriate reliability tests and judgement validation by domain subject matter specialists. The contents of the modules were translated into programming language wherein the programme specifications were converted into software instructions. Android Studio version 3.4.2 Integrated Development Environment was adopted for the development of mobile application with Java language as front end and the data bases were created as back end through Structured Query Language (MySQL) as adopted by earlier studies (Navjot Gaur, 2016; Monica et al., 2019). The framework for knowledge representation of the mobile application along with the modules is depicted in Fig. 1.

Assessing the efficiency of mobile application

The present investigation adopted a combination of methods to assess the efficiency of mobile application. Pliakoura et al. (2018) adopted a mixture of both with and without user participation in evaluation of an agricultural mobile application. The efficiency of CIBA ShrimpApp was studied based on (a) awareness about the mobile application measured as number of end users who accessed mobile app for information and its cumulative downloads, (b) knowledge acquisition in terms of knowledge gain (before vs after exposure to the app), (c) perceived utility of the mobile app modules, (d) subject matter queries received and responded through the mobile application and (e) desk-top review of the mobile application.

Knowledge test

Knowledge was operationalized as the quantum of scientific information known to the respondents, and ‘Knowledge gain’ was construed as the quantum of information newly learnt by an individual on exposure to the mobile application. A teacher-made knowledge test was prepared in consultation with the subject matter specialists. The knowledge test is

Table 1 Software Development Life Cycle (SLDC) approach and methodology

Sl.No	SDLC phase	Subject matter	Methodology
1	System analysis	Shrimp aquaculture sector, production systems, exiting information flow, mobile application for bidirectional flow of information, shrimp farmers profile analysis, information need assessment, formats, receptivity and sustainability	Farm survey, focus group discussions
2	Feasibility analysis	Availability of technical content, subject matter specialists, operational resources, time and budget requirement	Subject matter specialists
3	Requirement analysis	Availability of mobile networks, connectivity, access to smart phone by end users, technical information requirements, modules, format of delivery, preferred platform and language	Farm surveys using structured questionnaire and focus group discussions
4	System design	Modules and content: static/dynamic; end user access to app, login details, dashboard details, navigation details, module choosing, accessing the content and interacting with modules	Flow chart analysis
5	Coding	Translation of module content into programming language and software instructions. Operating system—Android Studio Integrated Development Environment with Java language as back end score and the data bases created through MySQL	Data base creation and linking, Android application file formatting and computer programmes
6	Testing	Testing to recognize the gaps, errors and missing necessities *vis-à-vis* the actual requirements. Unit/module wise testing for its functionality, integration testing for connectivity of modules, programme testing for coding and the whole app testing to ensure the user requirements. Each module interface of the app was tested to ensure its proper functioning	Content validation by domain subject matter specialists. Internal consistencies and validity of the modules evaluation with appropriate reliability tests
7	Implementation	Naming the mobile app "CIBA ShrimpApp" and display in the Google play store publisher for publication. Tutorial for end users	Awareness/sensitization workshops; social media and online communication
8	Maintenance	Review of module contents for updation and modification, design and visual improvements	Content review and updation analysis

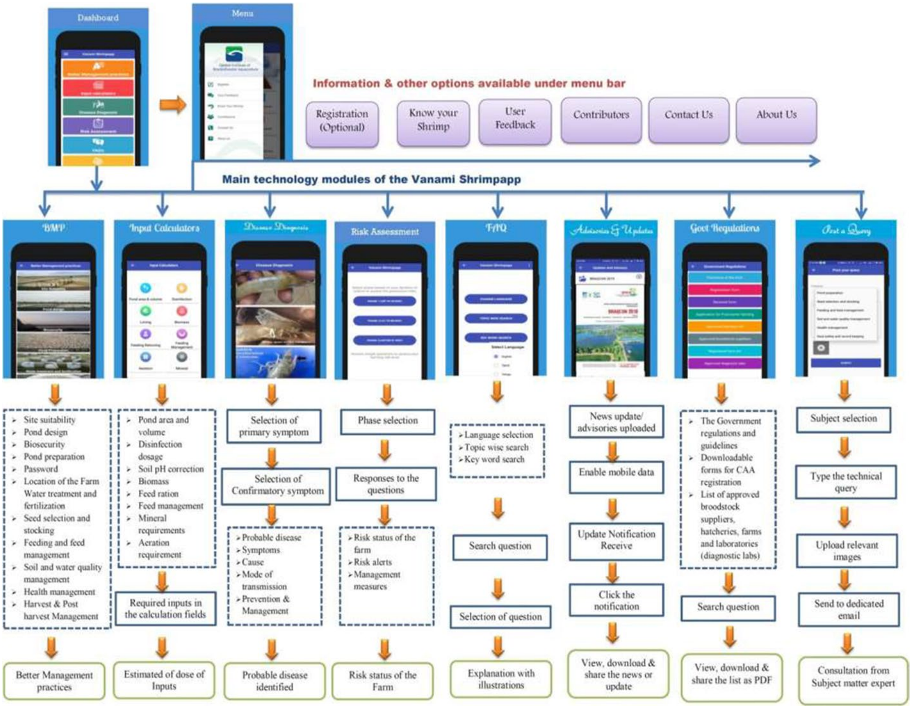


Fig. 1 Framework for knowledge representation in CIBA ShrimpApp

comprised of 35 questions covering the important aspects of the app modules. The test was content validated and pre-tested for its internal consistency and reliability.

Perception analysis

Perception is operationalized as the opinion of end users on the functional attributes of mobile application measured in terms of its usefulness in farm decision-making, design functionality and extension service function. A Likert type perception index containing 27 statements reflecting the above attributes was developed in consultation with the subject matter experts, extension specialists and progressive farmers. The responses were collected in a three point continuum, viz. 'greater extent', 'to some extent' and 'least extent' with scores of three (3), two (2) and one (1), respectively. The scores of the individual were added to arrive at the perception score of the individual respondent. Based on the scores, the perception index for each attribute was calculated using the following formula:

$$Perception\ Index = \frac{Individual\ respondent'\ s\ score}{Maximum\ possible\ score} \times 100$$

A purposive sample of 180 shrimp farmers in India who had used the mobile application on regular basis was chosen as respondents to ascertain the effectiveness of developed mobile application. The primary data were collected directly from the farmer users through a structured questionnaire. In addition to that, an online survey form was also designed and posted in app itself to ascertain the user perceptions. As per the institutional guidelines, the questionnaire used for data collection included a declaration which stated that the information provided by a respondent is required for research purpose and will not disclosed with any other person or entity, thereby the anonymity of the respondent and ethical considerations were taken in to account.

Desk-top assessment of the mobile application

Using in-app feedback module, Google analytics and Google play store review were carried out to assess the effectiveness of the application. In-app rating of major modules was taken for the content appropriateness, functionality of the application, user friendliness, layout design, speed, reliability and interactivity. Google analytics and Google play store data were used to ascertain the total down loads, country wide usage, cumulative rating, queries answered, frequency of usage, gender and age group usage, module wise usage, time taken to use the modules and users' review.

Descriptive statistics like percentage analysis, mean and standard deviation were used to analyze the data. Garret ranking procedure was used to rank the modules and the individual rankings were converted into scores based on the Garret table (Garret and Woodworth, 1969). Paired-sample 't' test was used to find out the knowledge improvement of respondents 'before vs after' exposure to the mobile application.

Results and discussion

Modules of the mobile application—CIBA ShrimpApp

The android mobile application 'CIBA ShrimpApp' was published in the Google play store in 2018 and can be installed free of cost, occupies 27 MB of internal space and operated in an off-line mode too. The dashboard of the app is like the window of the application, wherein eight technology modules have been listed for user friendly access. A brief description of the modules is given below.

i. *Module on better management practices (BMPs):* It contains textual as well as pictorial contents on shrimp farm site selection, pond design, pond preparation, seed selection, stocking, feeding, feed management, soil and water quality management, health management, farming regulations, food safety and record keeping which are lucidly explained with illustrations.
ii. *Input calculation module*: The module on input calculations contains eight calculators to estimate the critical inputs for shrimp farming, viz. the pond area and volume, total biomass in the pond, disinfection requirements, feed rationing, feed management, mineral requirement, soil pH adjustment and aeration requirement. The end user has to enter the relevant input parameters after which the results would be displayed with the respective units.
iii. *On-farm disease diagnosis module*: An image-based disease diagnosis module has been incorporated. The user can identify a disease infection on farmed shrimp probabilistically by comparing the symptoms of farmed shrimp with a given list of images of diseased shrimp. It contains two sets: common and confirmatory symptoms of known diseases. The end user has to choose the relevant images in both the categories

and if the symptoms are matching in both the sets, the application would display a probable disease (needs confirmation with lab tests) and display further information on causes, management, etc., which will enable the end user to make an informed decision. In case the symptoms do not match in both the sets, then the app would advise the user to upload the symptoms and other parameters as a query in the post-a-query option of the app.

iv. *On-farm risk assessment module*: The user can assess the production risk status of his/her shrimp farm by answering a sequence of multiple choice questions (MCQs). The module is further divided into three phases (phase 1, up to 40 days of culture; phase 2, between 41 and 80 days of culture; and phase 3, above 81 days of culture) and the user depending on his crop stage can choose the required phase. In each category, a set of MCQs are placed. Whenever the user chooses a wrong answer for critical questions, a pop-up menu automatically appears and displays that his farm is at risk. The user can continue answering, and at the end, the module displays the risk level of the farm and risk factors and recommends appropriate management measures to tackle those risk factors.

v. *Updates and advisories module*: A dynamic module on updates and advisories enables the user to receive real-time advisories and updates posted by the host institution. The updates are in the form of downloadable PDF files. The users receive notification when files are uploaded and can later be downloaded when the user connects with the mobile data.

vi. *Government of India regulations and guidelines module:* The regulations and guidelines for shrimp farming stipulated by the Government of India were summarized in a module along with downloadable utility forms for registration/renewal of farms with the Coastal Aquaculture Authority (CAA) of India, the regulatory body of the Government. The regulations and guidelines given in that module are applicable only to Indian shrimp farmers. In addition, it contains the lists of approved brood stock suppliers, hatcheries (seed sources), farms and laboratories (diagnostic labs) as posted in the CAA website. This compact information is extremely useful for the stakeholders.

vii. *FAQ module:* The FAQ module contains possible queries along with explanations related to *P. vannamei* shrimp farming from pond preparation to post-harvest handling. The user can choose the language (vernacular) and font size to make it easier to read and comprehend. Keyword-based search option is also available to list the queries on a particular topic.

viii. *Post-a-query module:* The important feature is the “Post a query” module, through which the end user can submit the query in the form of text or/and images of his shrimp or pond which is received as an e-mail message in the dedicated mailbox at the host institute. The expert advisory on the queries are responded to within two working days (48 h).

Efficiency assessment of CIBA ShrimpApp

i. *Awareness about the mobile application:* Perusal of Google play store console is carried out to know the awareness about the app among the stakeholders and it revealed a cumulative 27,587 downloads indicating the actual number of shrimp stakeholders who had seen and downloaded the app. Furthermore, the data analyses showed that it has maintained a Google cumulative rating of 4.5 out of 5.0. Data revealed that the application was utilized by the stakeholders from 173 different countries across

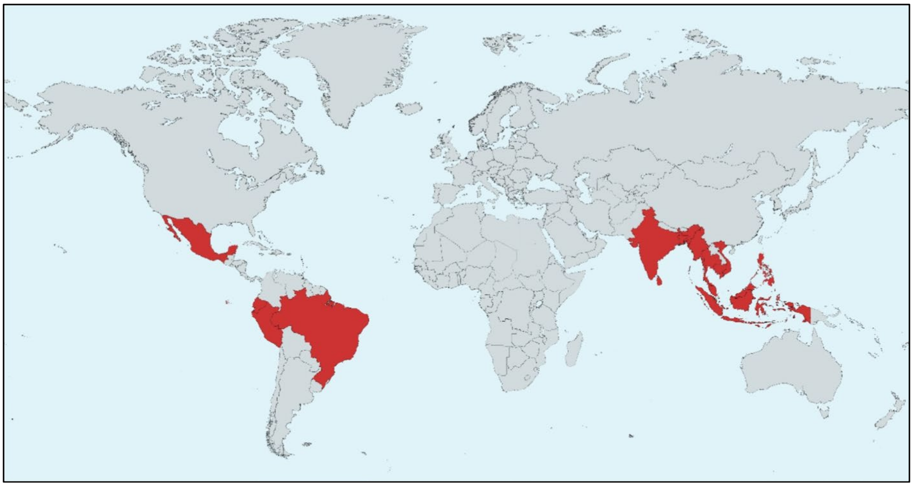


Fig. 2 CIBA ShrimpApp users across the countries highlighted in brownish-red colour

the world (Fig. 2), and among them, Indian users were the maximum (81.50%) followed by the Indonesians (3.9%). It further indicated that content given in the app is applicable to *P. vannamei* shrimp farming operated across the tropical belts of the globe. Monica et al. (2019) reported that Direct to Farmers (D2F) mobile extension service achieved a rapid and broad reach of agricultural information to farmers, across geographies and farmer categories. Other studies have also demonstrated the capability of mobile extension to reach previously excluded farmers at a very low marginal cost (Ricker-Gilbert et al., 2008; Shawn and Fernando, 2012; Mbo'o-Tchouawou and Colverson, 2014).

ii. *Knowledge acquisition in terms of knowledge gain*: The pre- and post-exposure knowledge score in Table 2 indicated that the mean pre-exposure knowledge scores of extension worker and farmer respondents, respectively, were 24.21 and 18.25. The mean post-exposure knowledge scores were 29.18 and 25.18 for extension workers and farmers, respectively. The mean percentage of enhancement in the knowledge level of respondents' post-exposure to the mobile application was 20.53% and 37.98%, respectively, for farmers and extension workers. The knowledge gain was higher for farmers than extension workers, possibly because the extension workers had an ex-ante higher knowledge acquired through their education and professional trainings. Statistical analysis showed that the knowledge gained due to mobile app is signifi-

Table 2 Knowledge level and knowledge gain of end users before and after exposure

S. No	Respondents	Mean score ± SD (Max 35)		Percentage of knowledge enhancement	Paired 't' score
		Pre-exposure	Post-exposure		
1	Fishery Extension Personnel	24.21 ± 2.45	29.18 ± 2.28	20.53%	16.73**
2	Shrimp Farmers	18.25 ± 2.90	25.18 ± 2.56	37.98%	31.32**

** Significance at 1% level ($p < 0.01$)

cant ($p < 0.01$). Previous studies using expert systems for knowledge improvement in agriculture and allied sectors also indicated that knowledge dissemination through mobile and ICT applications was rapid, wider and aided in significant improvements in the knowledge level of end users in India (Thammiraju et al., 2005; Sivagami and Karthikeyan 2009; Kumar and Padmaiah, 2012 and Alagappan and Kumaran, 2015).

iii. *Queries received and answered through the app:* Post a query module was used by the end users to submit their queries and get clarification from subject matter specialists. A dedicated email ID was assigned to receive the end user queries and about 5600 queries were received and the same were responded by experts within 48 working hours. Among the queries received, soil and water quality management (37.60%) and health management (29.20%) in shrimp farming were the major subjects (Fig. 3).

iv. *Perceived utility of the mobile app modules:* The users' perceptions on the application of the mobile application in their farming operations are presented in Table 3. The respondents perceived that the mobile application aided in quality seed selection (71%), estimation of various inputs (73%), disease diagnosis and prevention (65%) and water quality management (63%) to a major extent. Majority of the respondents (70%) felt that the mobile application established linkage between the scientific institution and the end users. Similarly, majority of the end users perceived positively on the application of the app design and functionality (62%), user friendliness (64%), connectivity (60%) and unambiguous technical content provided. Most of the respondents felt that the application served extension education function effectively. About 60% of respondents perceived that advisories given in the application were practically worked to a satisfactory level. About three-fourth of respondents (73%) felt that the application served as a knowledge improvement tool. Studies conducted to ascertain the user perceptions on expert systems on agriculture and shrimp farming revealed similar findings on their content and functionality (Sivakami and Karthikeyan, 2009; Alagappan and Kumaran, 2016a, b). Almost half of them (51%) opined that farmers required training to use the application and share the app information with their fellow farmers. Furthermore, it was also felt that the contents may be translated into vernacular languages for the benefit of small scale farmers. Therefore, awareness camps need to be conducted extensively on the mobile application among the stakeholders and convert the app into major vernacular languages which are important steps to enhance the wider usability of mobile application. Bidit et al. (2011) found that mobile phone use by Bangladesh farmers is hampered by language barriers. The user preferences

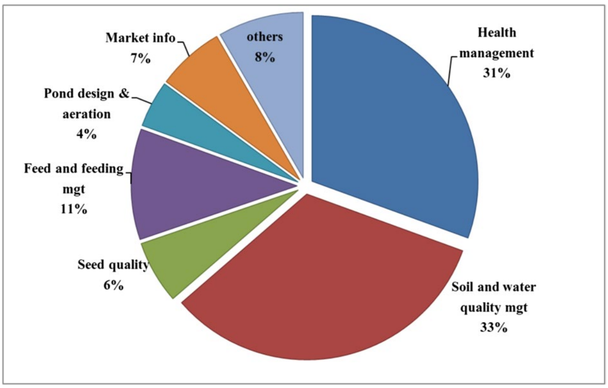


Fig. 3 Subject matter wise queries received and answered through the app

Table 3 End-user perception of the effectiveness of the mobile application

S.No	Attributes of the Mobile application—CIBAShrimpapp	% of respondents ($N=180$*)
Subject matter function		
9	App aids in selection of quality shrimp seed	71.11 ± 12.76
10	App aids in calculation of the input requirements accurately	73.15 ± 18.32
11	App aids in disease diagnostics to prevent and manage diseases	65.48 ± 13.06
12	App aids in optimizing water quality parameters and their management	62.96 ± 18.40
13	App aids in improving the productivity	65.92 ± 14.53
14	App aids in effective pond management & reducing the production cost	54.72 ± 16.72
15	App paved the way to access scientific information from the researchers	70.00 ± 15.10
16	App aids in supply chain integration (inputs and market)	68.63 ± 13.95
17	App can supplement the extension workers function	64.86 ± 14.19
18	Difficult to get farm specific solutions through Vanami Shrimpapp	39.51 ± 23.21
App design and functionality		
19	Functionality and navigation are user friendly	64.20 ± 18.25
20	The app modules are interconnected	60.49 ± 16.52
21	Layout and design are user friendly	74.07 ± 12.34
22	App works off line and is easy to access at anywhere anytime	69.14 ± 16.25
23	The app is getting updated as per the needs of the users	53.09 ± 24.32
24	The app is interactive and holds the attention of the farmer	54.32 ± 19.54
25	The contents are clear and unambiguous	67.90 ± 12.34
26	The contents are directly usable and actionable	59.26 ± 14.51
27	This app is an innovative tool	62.96 ± 16.52
Extension education function		
28	The advisories are practical and satisfactory	60.49 ± 14.25
29	The App helps in knowledge improvement	72.84 ± 08.54

Table 3 (continued)

S.No	Attributes of the Mobile application—CIBAShrimpapp	% of respondents ($N = 180$*)
30	App helps in saving time and cost in seeking technical advise	59.26 ± 24.60
31	Advantageous over the traditional methods of knowledge dissemination	59.26 ± 22.50
32	It is an educative tool for farmers and extension workers	61.73 ± 09.62
33	Farmers require training to use this app	51.85 ± 08.14
34	Mobile app is very useful and worthy contribution to the sector	65.43 ± 12.30
35	The queries raised are answered within two working days	50.62 ± 18.24

*Multiple responses

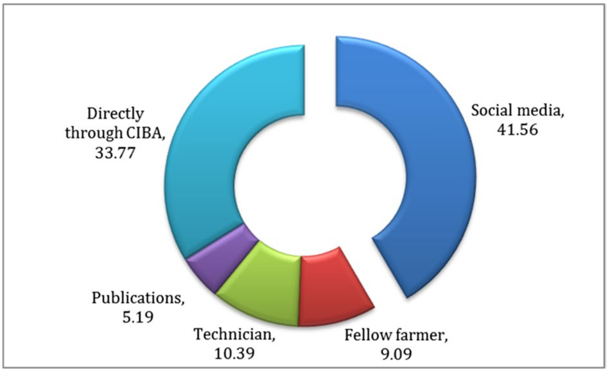
Table 4 Ranking of technology modules of CIBA Shrimpapp

Modules	Garret score	Percentage	Ranking
Input calculations	4702	68.10	I
BMPs	4233	61.30	III
Disease diagnosis	4243	61.50	II
Risk Assessment	4144	60.10	IV
Updates & Advisory	3914	56.70	VI
Govt. Regulations	3871	56.10	VII
Post a Query	3772	54.70	VIII
FAQs	3958	57.40	V

and ranking of modules are given in Table 4. Among the modules, input calculators module was ranked as the first (68.10%) followed by disease diagnosis (61.50%) and BMP module (60.10%). Successful and profitable shrimp farming is a function of input optimization and disease prevention; therefore, these modules were efficiently utilized for day-to-day operations in shrimp farming; hence, they ranked top among the modules.

v. *Desk-top review of the mobile application:* Google Firebase and Analytics platforms helped to access the overall performance of the mobile application. Google firebase application data revealed that 98.4% of users of CIBA ShrimpApp were free from errors and crashes. The main source of information about the CIBA Shrimpapp to users was social media (41.5%) like Facebook and WhatsApp followed by programmes of the host institution ICAR-CIBA (33.8%). One-third of the end users (36%) expressed that they consulted the mobile application on a daily basis and about 27% consulted it weekly. These results confirmed that CIBA Shrimpapp is being widely used by the stakeholders for accessing technology information (Figs. 4 and 5). Errors and crashes could negatively influence the usability of the application and might lead to uninstallation by end users. The Google Firebase application data showed that 98.4% of users were free from errors and crashes (Fig. 6). In view of the above findings, it could convincingly be stated that the mobile application was effective in disseminating the technology information among the stakeholders, knowledge and skill capacity enhancement and established a linkage between the technology institution

Fig. 4 Source of information about CIBA Shrimpapp



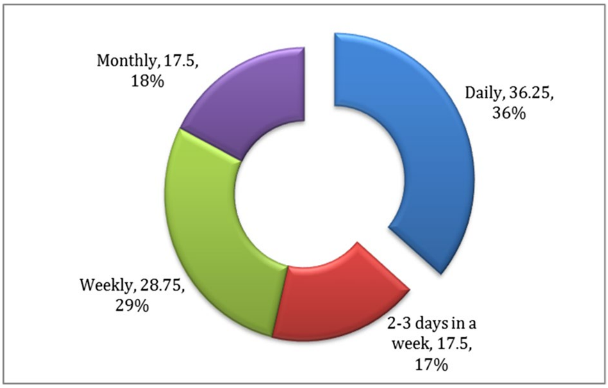


Fig. 5 CIBA Shrimpapp frequency of usage

and the end users. Pliakoura et al. (2018) in their study concluded that a smartphone or a tablet coupled with a data 'packet' is a valuable tool for the new age farmer, thereby saving time and money.

Conclusion

The present study has revealed that mobile application CIBA ShrimpApp is an important contribution to the shrimp farming sector and has been found to be effective in disseminating the technology information to the end users. The farmers and extension workers perceived mobile application as a potential tool for knowledge improvement. It enabled the bidirectional flow of information between the research institution and end users in getting field feedback through receiving and answering queries. Considering the all pervading mobilephone infrastructure, the mobile application based technology advisories play a major role in minimizing the information communication gap in shrimp aquaculture and it may help to a large extent to speedup and enhance the quality of farm extension services. However, the efficiency of mobile application for extension services would depend on constant updating of the modules based on field requirements and translation of the modules in vernacular languages to cater to a larger and wider clientele of shrimp farmers.

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2. PR. Anand: Mobile app content development, validation and data collection.
3. J. Ashok Kumar: Computer applications and files management.
4. M. Muralidhar: Content development, validation and responding to end users.
5. K. Ambasankar: Content development, validation and responding to end users.
6. A. Panigrahi: Content development, validation and responding to end users.
7. S.K. Otta: Content development, validation and responding to end users.

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Data availability The primary data sets collected and used for preparation of this manuscript is available with the team.

Code availability The software code/application used for developing the mobile application is available in public domain.

Declarations

Ethics approval No ethical issues are involved in the study.

Competing interests The authors declare no competing interests.

References

Aker, JC. (2008) Does Digital Divide or Provide? The impact of cell phones on grain markets in Niger, Centre for Global Development Working Paper No. 154.

Alagappan M, Kumaran M (2015) Expert system for shrimp aquaculture an ICT aided tool for knowledge management. Indian J Fish 62(2):56–61

Alagappan M, Kumaran M (2016) Status and scope of information communication technology aided tools for aquaculture extension service in India. Inter J Pure Sci and Agricul 2(5):117–124

Alagappan M, Kumaran M (2016) Perception of aquaculture extension personnel on information technology enabled expert system for shrimp aquaculture. J Inland Fish Soc India 48(2):38–47

Alston JM, Marra MC, Pardey PG and Wyatt TJ (2000) A meta-analysis of rates of return to agricultural R&D: expedeherculem? Res Rep 113, IFPRI, Washington, DC.

Briz-Ponce L, Juanes-Méndez JA, García-Peñalvo FJ, Pereira A (2016) Effects of mobile learning in medical education: a counterfactual evaluation. J Med Syst 40:1–6

Davis K, Nkonya E, Kato E, Mekonnen M, Odendo M, Miiro R and Nkuba J (2013) Impact of farmer field schools on agricultural productivity and poverty in East Africa. IFPRI Discussion Paper No. 00992. Washington, DC, International Food Policy Research\ Institute (IFPRI) 126p.

Dercon S, Gilligan DO, Hoddinott J, Woldenhanna T (2009) The Impact of Agricultural Extension and Roads on Poverty and Consumption Growth in Fifteen Ethiopian Villages. Am J Agric Econ 91(4):1007–1021

Elfeky AIM, Masadeh TSY (2016) The effect of mobile learning on students' achievement and conversational skills. International Journal of Higher Education 5(3):20–31. https://doi.org/10.1016/j.chb.2017.04.024

Engle C.R (2017) High-impact research: the critical need for strong engagement withaquaculture producers. J World Aquacult Soc 48(5)

Evans, O. (2018a). Connecting the poor: the internet, mobile phones and financial inclusion in Africa, Digital Policy, Regulation and Governance, https://doi.org/10.1108/DPRG-04-2018-0018

Ganesan M, Kavitha K, Suma P, Jayalakshmi U (2013) Use of mobile multimedia agricultural advisory systems by Indian farmers: results of a survey. J Agricu Extn Rur Develo 5(4):89–99

Garret HE, Woodworth RS (1969) Statistics in psychology and education, Vakils. Feffer and Simons Pvt. Ltd., Bombay, p 329

Gideon D, Dennis ES, Robert A (2018) Agricultural extension and its effects on farm productivity and income: Insight from Northern Ghana October 2018. Agric and Food Secu 7(74):2–10

Helen S, Kaleel FMH (2009) Perception of prospective users about the performance of agricultural expert system. Indian Res J Ext Edu 10(3):95–99

Joffre OM, Klerkx L, Dickson M, Verdegem M (2017) How is innovation in aquaculture conceptualized and managed? A systematic literature review and reflection framework to inform analysis and action. Aquacul 470:129–148

Karanasios, S. and Slavova, M. (2018). Understanding the impacts of mobile technology on small holder agriculture. Digital technologies for agricultural and rural development in the global south, 111 p.

Katengeza, S., J. Okello, E. Mensah , N. Jambo, N. (2014). Effect of participation in ICT based market information services on transaction costs and household income among smallholder farmers in Malawi. Technologies for Sustainable Development. 197–207.

Ksoll Aker Christopher (2016) Can mobile phones improve agricultural outcomes? Evidence from a randomized experiment in Niger. Food Policy 2016 60:44–51

Kumar, GDS , M. Padmaiah. (2012).Mobile basedagro-advisories on castor and sunflower. In: Proceedings of 8thConvention of Grameen Gyan Abhiyan: Rural Knowledge Movement, 28–29 October, 2012 by the M. S. Swaminathan Research Foundation at MSSRF, Chennai, India, 14–15.

Kumaran M, Vimala DD, Raja S, Alagappan M (2012) Information seeking behaviour of extension personnel in aquaculture sector. Fish Technol 49(2012):87–91

Lee KH, Bellemare M (2013) Look who's talking: the impacts of the intra household allocation of mobile phones on agricultural prices. J of Develop Stud 49(5):624–640

Mahedi Hasan I (2015) Mobile phone: an instrument of disseminating requisite agricultural information for the agricultural development of Bangladesh. Inter J of Res in Engine Techno 4(4):523–533

Monica KK, Alawya A, Allenb C, Subharwal M, Jadhavd A, Parr M (2019) Effectiveness of mobile agri-advisory service extension model: evidence from Direct2Farm program in India. World Development Perspectives 13:25–33

MPEDA.(2021). Shrimp Production and area under culture state wise data of India, www.mpeda.com. Accessed 21 Nov 2021

Muriithi, AG., E. Bett , SA. Ogaleh. (2009). Information technology for agriculture and rural development in Africa: experiences from Kenya. In Conference on International Research on Food Security, Natural Resource Management and Rural Development, Tropentag, 6–8th October, University of Humburg.

Navjot Gaur (2016) Development of mobile based agricultural scheduling system for farmers in regional language (Punjabi) using weather conditions. Unpub. M.Sc. thesis. Punjab Agricultural University, Ludhiana, India, 66p.

Ngugi CC, Fitzsimmons K, Manyala J, Bundi JM, Kimotho AN, Amadiva JM, Ndogoni JN, Munguti J (2018) Assessment of growth performance of monosex Nile tilapia (Oreochromis niloticus) in cages using low-cost, locally produced supplemental feeds and training fish farmers on best management practices in Kenya. Project Report. Sustainable feed technology and nutrient input systems / SFT/13SFT06AU

Obiero K, Meulenbroek P, Drexler S, Dagne A, Akoll P, Odong R, Kaunda-Arara B, Waidbacher H (2019) The contribution of fish to food and nutrition security in Eastern Africa: emerging trends and future outlooks. Sustainability 11:1636

Pliakoura A, Beligiannis G, Kontogeorgos A (2018) Mobile device applications usability assessment the example of an agricultural management application. J Agricultural Informatics 9(3):55–64

Reddy MM, K L, Sreenivasa Rao, Srinivasulu M, Satish Kumar GD (2017) Perception and usefulness of mobile phone based agro-advisories (MBAs). Int J Curr Microbiol. App Sci 6(7):866–872

Sadamate VV. (2019). Report on policies and action plan for a secure and sustainable agriculture, The Principal Scientific Adviser to the Government of India, New Delhi, 224 p.

Sivakami S, Karthikeyan C (2009) Evaluating the effectiveness of expert system for performing agricultural extension services in India. Exp Sys Appl 36:9634–9636

Sontakki BS , SP. Subash. (2017). Farmer innovation system: rethinking the way we look at farmer innovations1, Agriculture Under Climate Change: Threats, Strategies and Policies, 383–391 pp.

Thammi Raju, D., B. Sudhakar Rao , MS. Reddy. (2006). Methodology for development of information technology enabled extension advisory system under Indian conditions. In Proceedings 3rd workshop national on ICT in Agriculture from potential to prosperity in a global perspective, organized by IAITA and DA-IICT from 15th to 16th June 2006 at Gandhi Nagar, Gujarat.

Thokozani C, FredyKilima TM (2019) Smallholder farmers' market participation and mobile phone based market information services in Lilongwe, Malawi. The Elect J Inf Sys in Develo Countri 85(6):1–13

Vimala DD, Ravichandran P, Kumar KR, Ravisankar T, Kumaran M, Jangam AK, Mahalakshmi P (2017) Mobile based initiatives for e-Extension Services for Fisheries and Aquaculture. Agricultural Situation in India 74(1):25–31

Walsham G (2013) Development informatics in a changing world: reflections from ICTD2010/2012. Informa Technolo Internati Develo 9(1):49–54

World Bank (2012). Mobile Applications for rural development by Christine Zhenwei Qiang, Siou Chew Kuek, Andrew Dymond and Steve Esselaar.