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Does ShrimpKrishi mobile application facilitate smart shrimp farming? A field study

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Abstract

Shrimp farming is a proven commercial aquaculture model operated on business mode and needs a precision farming approach and real-time data-driven farm management to minimise the production risks and improve the techno-economic efficiencies. ShrimKrishi an android mobile application was developed and launched by ICAR-CIBA the nodal research institution to assist the shrimp farmers in managing their farms proficiently. The app is like a digital diary to record pond wise data and using the real-time data it facilitates smart decision making. A field study was conducted among 180 app-user farmers adopting a mixed approach-desktop and field investigations-to evaluate the efficiency of the mobile application using appropriate farming attributes. The Wilcoxon signed rank test was used to compare the farming performance of pre and post app support revealed that the application was well adopted by the farmer end-users in India and other countries, contributed for smart farming and significantly improved the farming efficiency after its adoption ($p \leq 0.01$). The investigation conveys that though the application was known to a large segment of shrimp farmers, its wider adoption was constrained due to end-user apprehension regarding the exposure of their real-time farming data (data safety) to someone else. Therefore, efforts may be taken to de-link the application from government agencies using cloud servers, ensuring adequate data safety measures at the user-end and large-scale sensitization among the shrimp farming community for its wider adoption.

Keywords: Smart shrimp farming, mobile application, software development, efficiency evaluation

Introduction

Shrimp farming, growing of delicate shrimp post larvae to a table size in controlled pond conditions is a proven aqua-business model practiced in different scales-extensive to intensive-with varying technology adoption and investments. The shrimp production in India was 0.845 MMT and it alone contributed 68% of the country's seafood export earnings with a value of 5 billion USD in 2023-24 (MPEDA, 2024). However, shrimp farming has been less profitable in recent years mainly due to volatile farm gate price, emerging diseases and climate related risks (Kumaran *et al.* 2021) ^[10]. Smart farming approach based on informed decision making using real-time data on pond parameters, incorporating precision farming principles for reduction in cost of production, disease prevention through adoption of better practices, and adoption of prudent crop planning in-tune with the market requirements is a viable strategy for profitable farming. Though the farmers document all the farming operations in their farm records, a smart digital application which can provide synthesized information based on real-time pond parameters is an innovative tool that aids in efficient farming. Ahamed *et al.* reported that smart farming approach with digital tools offer real-time insights into individual shrimp and overall farm conditions, facilitating proactive management and timely interventions. FAO (2024) ^[5] emphasized that the performance of aquaculture systems is functional to the adoption of technologies that promote precision farming, support

decision-making and farm management. A mobile phone-based shrimp farm management application-CIBA ShrimpKrishi was designed and launched to aid the shrimp farmers in their farm management. The application is downloaded from the Google play store free of cost. Through this application the shrimp farmers can digitally store their farm data regarding farming operations on real-time basis, access technical solutions based on the data given from the inbuilt expert systems, store, retrieve and share data for advanced recommendations.

Previous research has specified that the mobile phone based smart applications could bridge information gaps, increase crop yields, empower farmer decision-making, and enhance the overall farm productivity (Singh *et al.* 2023; Kareska, 2023; Saikant *et al.* 2023) ^[25, 8, 22] (Ndzi *et al.*, 2014; Aker and Ksoll, 2016; Sontakki and Subash, 2017; Karanasios and Slavova, 2018) ^[16, 2, 27, 7]. Smart mobile applications that provide solutions to specific needs and challenges of farmers with intuitive interfaces and direct navigation tend to have higher adoption rates (Peleg-Adler, 2018; Ni *et al.* 2023; Øksnebjerg, 2019; Lee, and Shin, 2020; Sennuga *et al.* 2023) ^[19, 17, 18, 12, 24]. Similarly, favourable experiences and peer group word-of-mouth endorsements contribute to the trust (Ishida, *et al.* 2016) ^[6]. However, apprehensions about data privacy, the safety of personal cum farm-related information, cyber security threats and data breaches can lead to hesitancy in using digital apps (Kenny and Regan, 2021; Demestichas, 2020) ^[9, 4]. In this backdrop, an

investigation was taken up to know its level of adoption by the farmers, their perception about its usefulness on real-time pond management and improving the efficiency of shrimp farming so that the application can be updated in tune with the end-user feedback.

Methods

1. Development of CIBA ShrimpKrishi smart mobile phone application

ShrimpKrishi app, an android-based mobile application, was developed following the Software Development Life Cycle (SLDC) approach (Fig-1) by developing a framework for data acquisition, design, coding and validation of decision support modules, and its implementation as depicted in Fig-2. The contents of the modules were coded into programming language wherein the programme specifications were transformed into software commands. The application was developed using the data bases created through Structured Query Language (MySQL) as back end and the latest version of Android Studio Ladybug with Java language as front end, the procedure followed by earlier studies in the farming sector (Kumaran *et al.* 2022) ^[11]. The internal reliability and validity of the app modules were assessed using pertinent consistency tests and content validation by the subject matter specialists.

2. Efficiency evaluation of the mobile application

The present investigation used a mixed approach to evaluate the efficiency of the developed mobile application, viz., (i) end user awareness in terms of cumulative user downloads, (ii) comparative analysis of farming attributes 'before and after' its adoption and (iii) perceived utility of the modules. Previously, Kumaran *et al.* (2022) ^[11] evaluated a mobile application on shrimp farming in terms of its awareness among the end users, knowledge acquisition in terms of knowledge gain, perceived utility of the mobile app modules, subject matter queries received and responded through the mobile application and desk-top review of the mobile application. Whereas, Pliakoura *et al.* (2018) ^[20] adopted a combination of both with and without user participation in the evaluation of an agricultural mobile application.

The perceived efficiency of the app was assessed based on its relative influence on twelve farming attributes as indicators. These attributes were identified through focus group discussions with a group of subject matter researchers as indicators to measure the efficacy of a farm management tool. The attributes selected include: farm productivity, cost of production, shrimp size at harvest, cropping duration in days, production risks, real-time data decision making, record keeping and traceability, resource use efficiency, farm income and profitability, capacity development, market-led farming and overall farming efficiency. The perceived efficiency was measured based on a three-point measurement procedure as given in the Table-1. In addition, the perceived usefulness of the app was measured as the perception of end users on identified functional attributes in terms of its utility in farm decision making, design functionality and extension service function. A Likert scale type perception index containing 16 statements reflecting the above stated attributes was designed in consultation with

the domain resource experts, extension education experts and innovative farmers and validated its content. The end-user perceptions were recorded in a three-point continuum, viz., 'greater extent', 'to some extent' and 'least extent' with the scores of three (3), two (2) and one (1) respectively. The scores of all the responses were added to arrive at the perception score of the individual respondent.

The mobile application has a cumulative download of 2853 in the year 2025 of which 84% was from India. Among the above population a sample of 180 end-user shrimp farmers who were found using it continuously were purposively selected from the states of Andhra Pradesh and Tamil Nadu as respondents to ascertain the perceived efficiency of the mobile application. A structured questionnaire was developed and used to collect the primary data directly contacting the identified farmer end-users. The anonymity of the respondent and ethical considerations pertaining to the data were taken into account by including a declaration in the questionnaire which stated that the information provided by a respondent is required for research purpose and will not be disclosed with any other person or entity. The null hypothesis postulated for the study was that the mobile application did not significantly contribute for smart shrimp farming after its adoption. Descriptive statistics like percentage analysis, mean and standard deviation were done using statistical software SPSS version 17.0 to clean and consolidate the data. The Shapiro-Wilk test was done to evaluate the normality of the primary data which indicated that the sample data did not follow the normal distribution. Therefore, non-parametric Wilcoxon signed rank test was employed to compare the farming attributes 'before and after' use of mobile application for efficient farming. Wilcoxon Signed-Rank test is the non-parametric analysis commonly applied when the assumption of normality is not satisfied (Tan Kesgin, 2025; Q. Xing *et al.* 2022) ^[28, 21]. The average values of previous crops data on the selected attributes were collected from the farm records of the respondents and used as pre-app use data.

Results and Discussion

a. Development and modules of CIBA ShrimpKrishi mobile application

CIBA ShrimpKrishi app was developed in four vernacular languages viz., English, Hindi, Tamil and Telugu and available as cost-free download from the Google play store. It is a dynamic mobile application that works totally as per the data recorded by the end-user. The end user has to log-in by providing basic data about his/her personal profile, farm profile and farm-infrastructure inventory to complete the registration. Once registered, the dash board of the app appears and shows four modules viz., Pond wise one-time entry, Pond wise daily entry, recommendations and post a query (Fig-3). Based on the farm profile data already entered, the app displays pond wise data capturing forms for further data entry. The user can record pond wise data on the listed parameters whenever an operation or activity is done in that pond. The recording of farming data is of three kinds:

1. Pond wise entry-once in a crop: Parameters like pond preparation practices, seed selection and stocking

details (stocking density, seed size), harvesting and production are done only once during the crop, hence need to be recorded and saved only once.

2. Pond wise entry-whenver the data available: Data on water quality parameters, input applications etc. are done periodically (eg. weekly once) and such data need to be recorded and saved whenever they are practiced.
3. Pond wise entry-mandatory daily entry: Data on water quality parameters like DO, pH, ammonia, feed rationing and application, animal health monitoring and the cost associated with the inputs applied/practices are to be recorded and saved every time as per their applications.

The end user has to enter operational data pond wise from the first day of culture (DoC-1) compulsorily. The most important aspect is that whenever any data is entered in any of the forms clicking the SAVE button in each page is mandatory, then only the data are saved and added with the existing data on that parameter. As the data are accumulated on each pond parameter as per the crop duration, the app started displaying the status of pond parameters as graphs on shrimp survival%, FCR and biomass, water quality parameters and the cost incurred on various aspects for every pond by a finger stroke in the dash board itself. This is the unique feature of this mobile app (Fig-4). Additionally, three expert systems respectively on shrimp feed management, water quality management and shrimp disease management are integrated in to the mobile application under the daily entry module. When the data entered by the end-user on the water quality, feed management and health management deviate from the optimum parameters the recommendations module displays alert messages to the end-user along with technical advisories to be followed to correct the deviations (Fig-5). The application can store the complete data of a crop cycle pond wise in it and end-user farmer can re-check the data on any day of culture by choosing the DoC calendar in the data entry menu. The other unique feature of the app is that the end user can download the data pond wise during any DoC in the form of an excel sheet or PDF document and can share it with anyone for their decision making (Fig-6). Similarly, the data can be downloaded and saved after the crop for further reference and decision making. Through this option the application extended the scope for accessing the real-time data from remotely located shrimp farms to remotely observe, provide customized technical advisories and plan for a harvesting decision in tune with market demand.

ShrimpKrishiApp in Windows platform: Based on the field feedback rendered by the end-users regarding difficulty in entering the data in the mobile phones, the app was converted to work in windows platform subsequently (Fig-6). Presently, the end-users can enter and view the data using their lap-top for ease of entry. Both the Android and Windows platforms are synchronized so that the data entered and saved in one mode can be seen in the other mode. Whatever be the platform 'saving of each data entered' is crucial for displaying the correct results.

Assessing the efficiency of mobile application

1. Awareness among the primary stakeholders

Adequate efforts were taken to create awareness among the end users about the modules of the app and its usefulness through presentations in farmers' conclaves, seminars, display of app profiles in exhibitions and other stakeholder conventions. As a result of it as on date the app has a cumulative download of 3039 (Fig-7). However, which needs to be enhanced by creating awareness among the potential users. The play console showed that app was mostly used in India (85.60%) followed by Indonesia (1.50%), Ecuador (1.33%), Bangladesh (1.25%) and Philippines (0.87%). Anand and Kumaran (2017) reported that shrimp farmers regularly seek technical advisories even from online sources and are receptive towards accessing technology information through mobile applications. During the field investigation several key informant farmers reported that though the farmers were aware of the app and its usefulness, its rate of adoption for farm management was inadequate due to their apprehension that through this app their farming data including the economics were remotely monitored which they felt may threaten the privacy of their farming operations. This may be because the app is hosted at the host institution's server. Earlier studies on mobile app use efficiency also reported that concerns about data privacy, farm-related information, cyber security threats and data breaches can lead to reluctance in using certain apps (Kenny and Regan, 2021; Demestichas, 2020) [9, 4]. Therefore, sharing of information on farming operations to get advisories needs to be kept as optional. Further, the application may be delinked from the host institution and hosted in an open cloud server so that it is adopted extensively.

2. Efficiency of the mobile application on farming parameters

The Wilcoxon signed rank analysis indicated that adoption of ShrimpKrishi application for managing the shrimp farms has significantly enhanced the overall efficiency of the farming ($p \leq 0.01$) (Table-2) and contributed for smart shrimp farming. All the 12 farming attributes taken for assessment have shown significant improvement after the app was used for real-time data-based farm management. Farms that adopted this app significantly improved pond productivity (up to 0.5t/ha), harvested larger shrimp size (up to 3 g), improved the real-time decision making, record keeping and traceability, resource use efficiency, farming income, market led farming and capacity development. Similarly, adoption of the app facilitated in reduction of cropping duration, production risks and production cost significantly. These results are in line with the earlier findings which stated that mobile applications have facilitated in precision farming with enhanced farming efficiency, premium market, improved financial control, bridge information gaps, greater resilience to climate-related challenges and providing access to knowledge and services (Saikanth *et al.* 2023; Singh *et al.* 2023; Kareska, 2023; FAO, 2024) [22, 25, 8, 5]. The respondent farmers reported that

in recent times shrimp farmers were asked to submit their farming records to meet the traceability requirements of the farm produced shrimps to meet the food safety requirements of shrimp importing countries. Similarly, many insurance companies have launched their insurance products for supporting shrimp farming in India and they needed such farm monitoring applications to monitor their client farms. Considering these developments, the ShrimpKrishi application need to be customized to meet the traceability requirements of shrimp farmers and facilitate the insurance companies who started providing insurance support to shrimp farmers to monitor their client farms.

3. End users perception on the efficiency of mobile application

It may be seen from the Table-3 that majority of the mobile app end-user respondents felt that the ShrimpKrishi app facilitated in precision farming through efficient pond management (87%), selection of quality shrimp seed (80%), disease prevention and management (77%), optimizing water quality parameters (75%), contributing for cost reduction (73%), improving the productivity and income (70%), supplement the extension workers function of advisory service (68%), providing pond specific solutions based on the real-time data (67%) and in pond management

and decision making (65%). Further, the end-users opined that the app modules are interconnected and aided in digital record keeping (65%), the design and navigation are user friendly (65%), availability of the app in vernacular language helped in easy operation (63%), aided in data sharing and getting quality farm advisories (61%), working of app in windows platform aids in easy data entry and use (60%) and it paved for accessing updated scientific information from a reliable source (58%). Bidit opined that Bangladesh farmers faced difficulty in using mobile phone advisories which are not given in their vernacular language. Digital extension tools on shrimp farming revealed positive findings on their efficiency, content and functionality (Alagappan and Kumaran, 2016; Kumaran *et al.* 2022) [3, 11]. Therefore, the results on the efficiency of the mobile application on farming parameters, perception of the end-users on its functional usefulness and the awareness among the stakeholders indicated that the CIBA ShrimpKrishi mobile application aided the farmers in achieving maximum potential output with given inputs and technology *i.e.* technical efficiency and contributed for the smart farming. Above all, the results and field experiences indicated that the app needs to be periodically updated and hosted in an open-source platform for its extensive adoption among the shrimp farmers not only in India but at the global level too.

Table 1: Efficiency parameters and their measurement

Sl. No.	Parameters	Measurement
1.	Production	Metric tonnes per hectare
2.	Production cost	Indian Rupees per Kg
3.	Shrimp size at harvest	In grams
4.	Cropping duration	In days
5.	Production risks	High-3; Same-2; Low-1
6.	Real-time data based decision making	Efficient-3; to some extent – 2; Low-1
7.	Record keeping and traceability	Efficient-3; to some extent – 2; Low-1
8.	Resource use efficiency	Efficient-3; to some extent – 2; Low-1
9.	Farm income & profitability	High-3; Same-2; Low-1
10.	Capacity development	Efficient-3; to some extent – 2; Low-1
11.	Market-led farming	High-3; Same-2; Low-1
12.	Overall farming efficiency	Efficient-3; to some extent – 2; Low-1

Table 2: Farming parameters before and after use of CIBA ShrimpKrishiApp (n = 180)

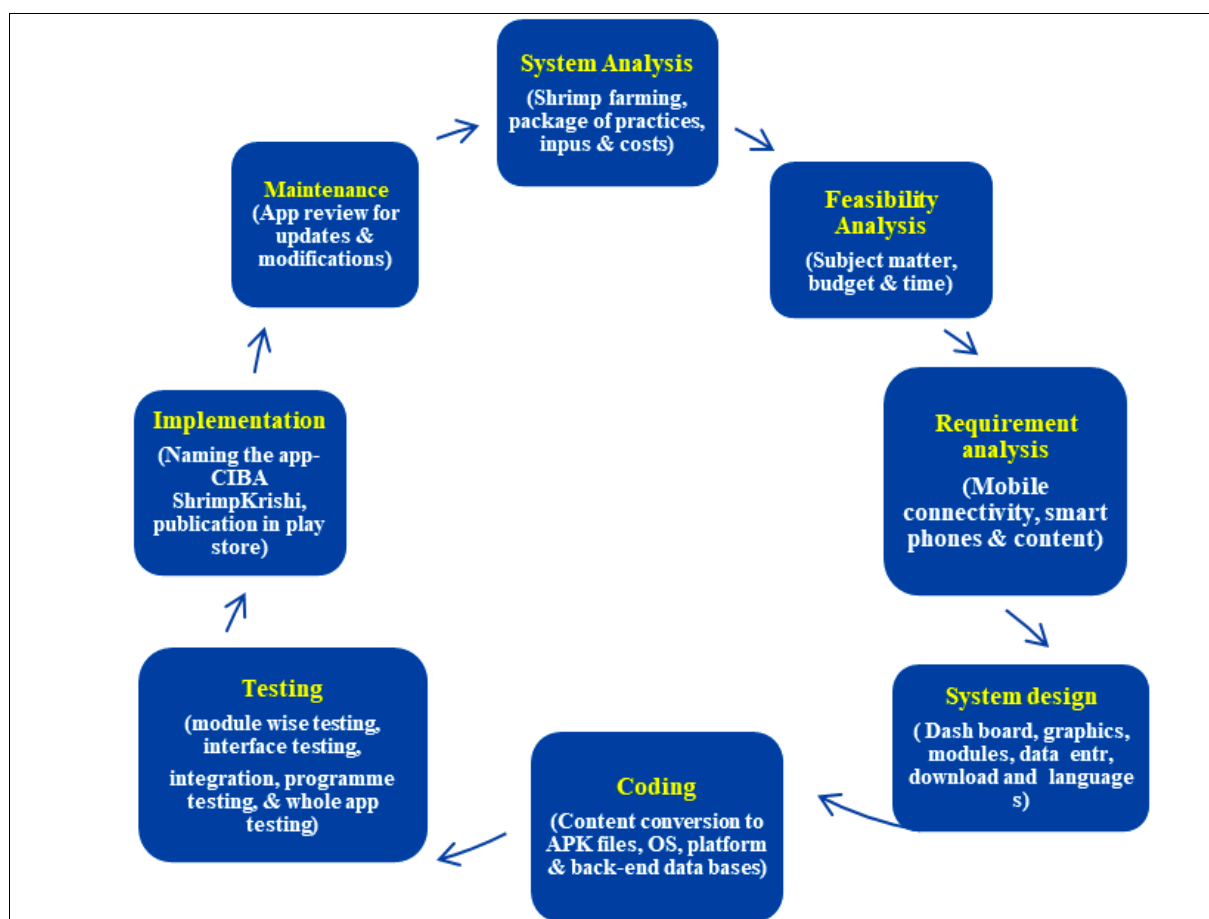
Sl. No	Parameters	Before App use	After the App use	Wilcoxon signed rank test score ($p \leq 0.01$)
1.	Production /ha in tonnes	7.65 ± 0.96	8.19 ± 0.88	$p < 2.2e-16^{**}$
2.	Production cost per Kg	258.92 ± 12.38	232.17 ± 8.61	$p < 2.2e-16^{**}$
3.	Shrimp size at harvest in g	21.35 ± 1.48	24.65 ± 1.26	$p < 2.2e-16^{**}$
4.	Cropping duration in days	96.40 ± 10.22	102.72 ± 11.45	$p < 0.0000066^{**}$
5.	Production risks	2.63 ± 0.49	1.37 ± 0.49	$p < 2.2e-16^{**}$
6.	Real-time data-based decision making	1.43 ± 0.50	2.90 ± 0.30	$p < 2.2e-16^{**}$
7.	Record keeping and traceability	1.93 ± 0.52	2.82 ± 0.39	$p < 2.2e-16^{**}$
8.	Resource use efficiency	2.15 ± 0.36	2.63 ± 0.49	$p < 2.71e-14^{**}$
9.	Farm income & profitability	1.85 ± 0.61	2.68 ± 0.47	$p < 1.409e-14^{**}$
10.	Capacity development	1.15 ± 0.36	2.87 ± 0.34	$p < 2.2e-16^{**}$
11.	Market-led farming	1.83 ± 0.37	2.91 ± 0.29	$p < 2.2e-16^{**}$
12.	Overall farming efficiency	1.82 ± 0.39	2.85 ± 0.36	$p < 2.2e-16^{**}$

** Significant at 1% level ($p \leq 0.01$)

Table 2: End-user perception of the effectiveness of the mobile application ($n = 180^*$)

S. No.	Attributes of the Mobile application –CIBA ShrimpKrishi	% of respondents
1.	App aids in precision farming through efficient pond management	86.67 $\pm$ 6.66
2.	App helps in selection of quality shrimp seed	80.00 $\pm$ 8.83
3.	App aids in disease diagnostics to prevent and manage diseases	76.67 $\pm$ 6.66
4.	App aids in optimizing water quality parameters and their management	75.00 $\pm$ 5.00
5.	App aids in efficient pond management and reducing the production cost	73.33 $\pm$ 1.67
6.	App aids in improving the productivity and income	71.67 $\pm$ 3.33
7.	App facilitates in supply chain integration (inputs and market)	70.00 $\pm$ 3.33
8.	App can supplement the extension workers function of advisory service	68.33 $\pm$ 3.34
9.	App provides pond specific solutions based on the real-time data	68.33 $\pm$ 1.66
10.	App aids in real-time data based pond management and decision making	66.67 $\pm$ 3.32
11.	App modules are interconnected and aids in digital record keeping	65.00 $\pm$ 1.67
12.	App's design and functionality and navigation are user friendly	65.00 $\pm$ 3.34
13.	App is in vernacular language and helps in easy operation.	63.33 $\pm$ 6.66
14.	The app aids in data sharing and getting quality farm advisories	61.66 $\pm$ 5.01
15.	The working of app in windows platform aids in easy data entry and use.	60.00 $\pm$ 3.33
16.	App paved the way to access scientific information from the researchers.	58.33 $\pm$ 1.67

*Multiple responses

**Fig 1:** Software Development Life Cycle (SLDC)

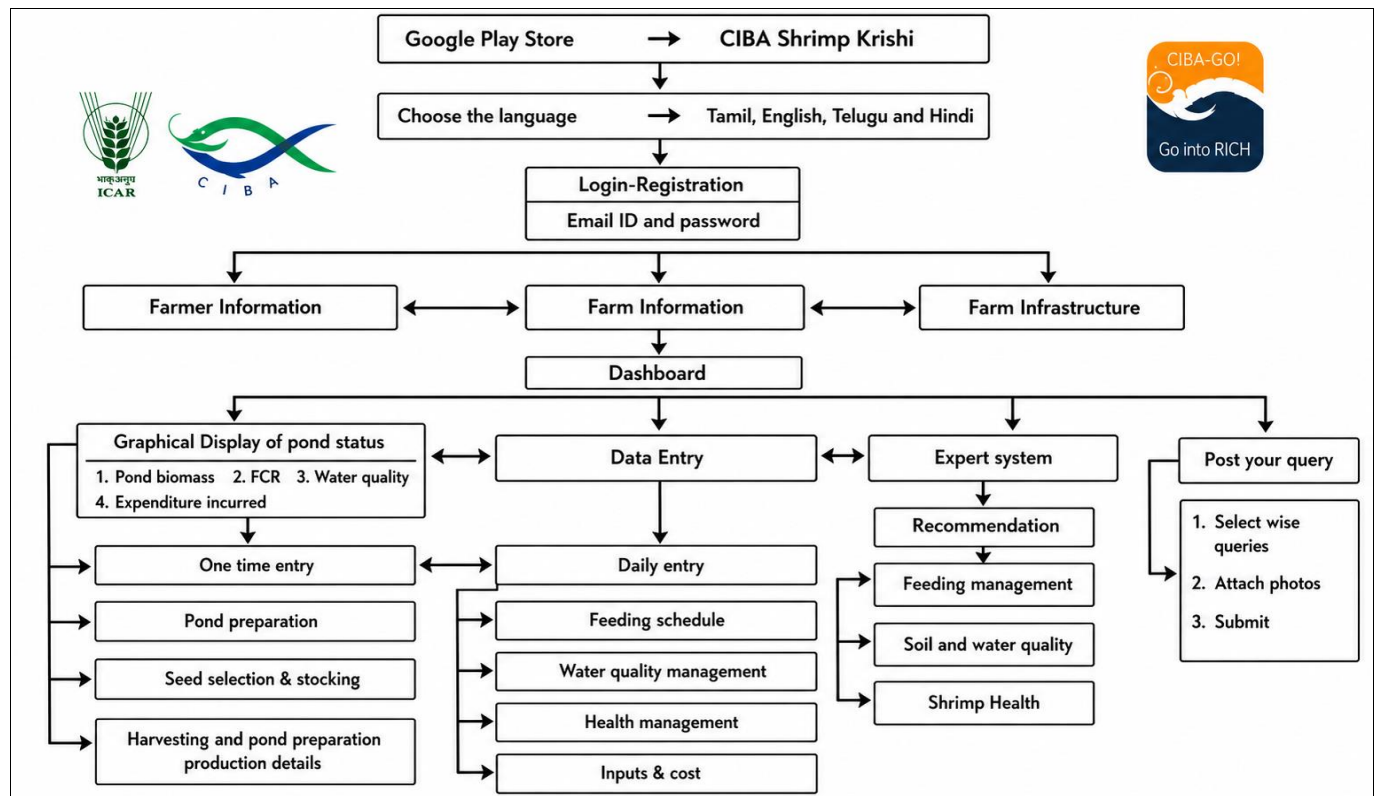


Fig 2: Framework of CIBA ShrimpKrishi mobile application

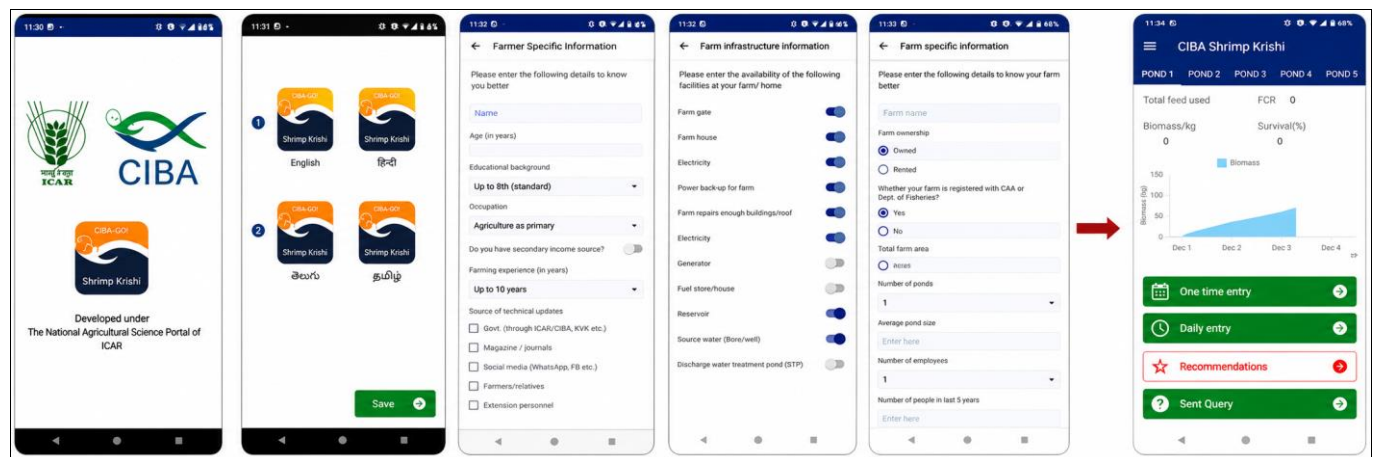


Fig 3: Registration pages and dash board of the mobile application

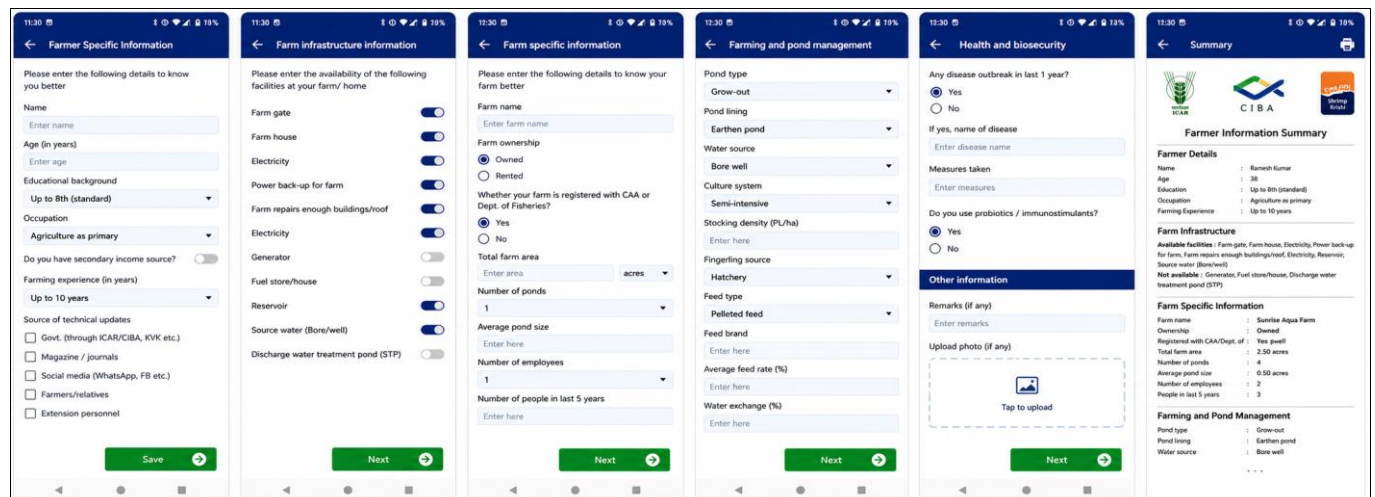


Fig 4: Daily data entry format on shrimp feeding, water quality and health & Recommendations based on real-time data

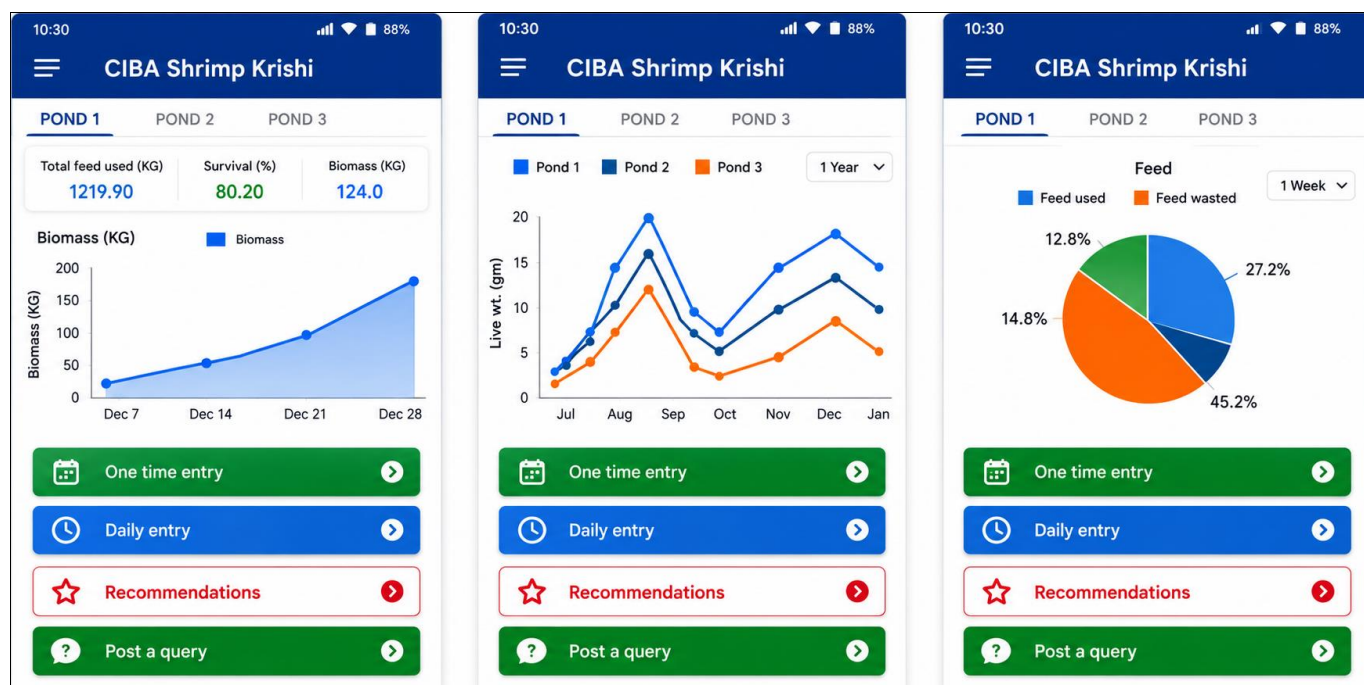


Fig 5: Graphical recommendations of shrimp pond parameters in the App

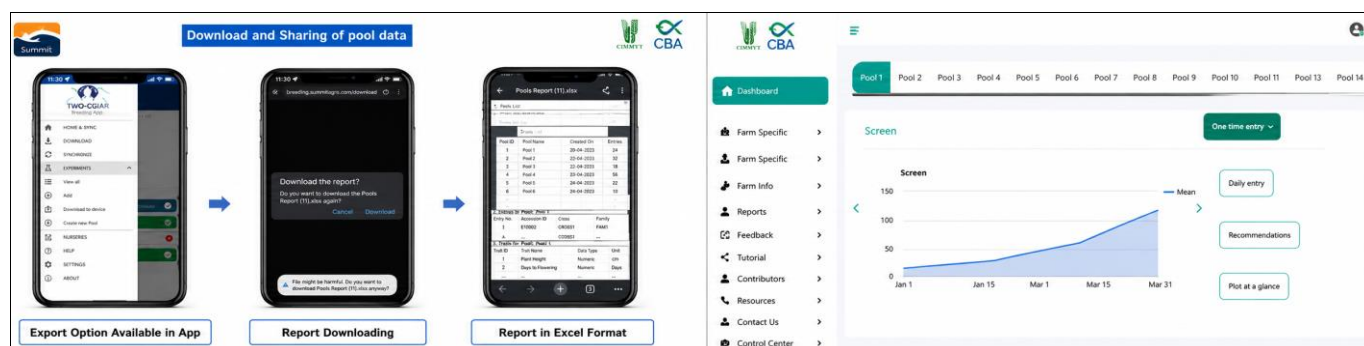


Fig 6: Download and sharing of data through the App & App module in windows platform

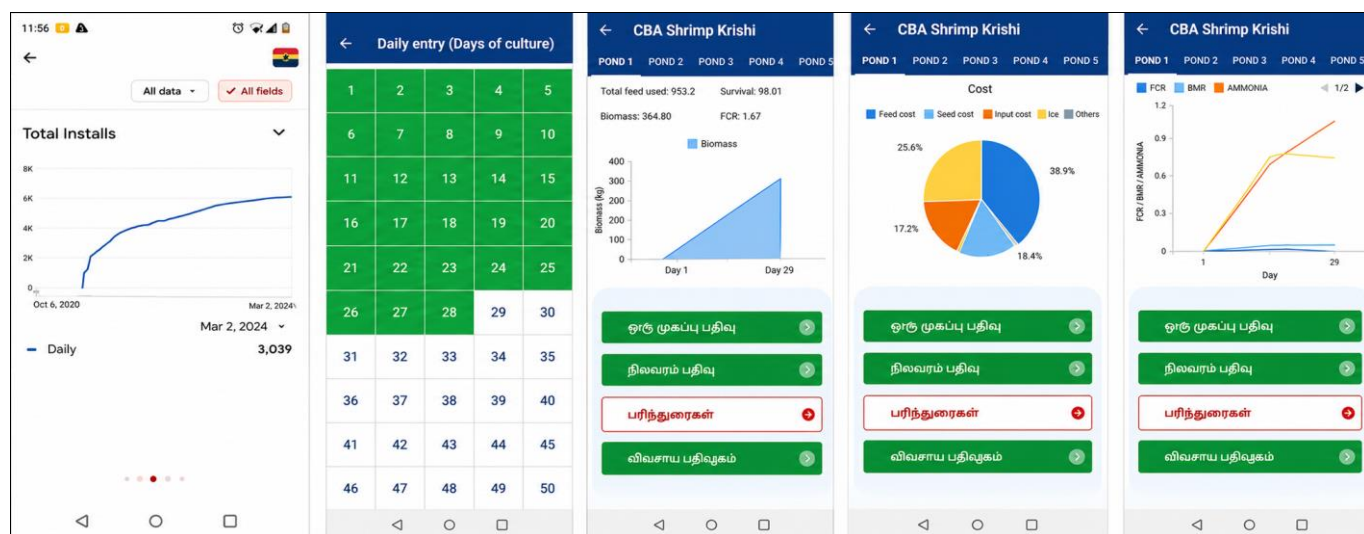


Fig 7: End-user downloads and graphical display of pond parameters in the app dashboard in vernacular Tamil language

Conclusion

Smart farming using digital tools are important to enhance the operational efficiency and profitability through real-time data enabled informed decision making. The ShrimpKrishi

mobile application developed to facilitate smart shrimp farming aided the farmers in achieving improved farming efficiency through real-time data-based decision making. Efforts need to be made to customize this application to

meet the traceability requirements of shrimp buyers and facilitate the insurance companies who started providing insurance support to shrimp farmers to monitor their client farms. Further, adequate efforts are needed to create awareness among the stakeholders and motivate them in adopting this useful tool for shrimp farm management at a wider scale. Additionally, it is important that the application needs to be updated periodically in line with the technology advancements and end-user requirements to sustain its usability.

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Clinical trial number: Not applicable.

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Clinical trial number: Not applicable

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions

Details of each author with their contribution in this research paper:

Name of the author	Types of contribution
M. Kumaran	Planning, app development, methodology, data collection, analysis and manuscript preparation.
K. Ramachandran	Field validation, data collection and validation.
A. Suresh	Field validation, data collection and validation.
J. Ashok Kumar	Development of app modules, field testing and data analysis.
K. Ambasankar	Development of app modules, field testing and manuscript editing.
A. Panigrahi	Development of app modules, field testing and manuscript editing.
M. Muralidhar	Development of app modules, field testing and manuscript editing.
S.K. Otta	Development of app modules, field testing and manuscript editing.
K.P. Kumaraguruvasagam	Development of app modules, field testing and manuscript editing.

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