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Chatbot for Promoting Best Crop Management Practices to Rice Farmers in Odisha, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author PB designed the study and wrote the first draft of the manuscript. Author EC did the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

The increasing penetration of mobile phones has made it easier to reach remote farmers and bridge the knowledge gap between them and researchers/extension workers and agricultural stakeholders. Farmers need concise, context-specific, information to address the challenges which arise due to lack of near-real time updates. Scaling up innovative agricultural technologies is essential to ensure these advancements reach the farmers for their benefit. Chatbots represent an

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informative tool for delivering the latest agricultural developments to farmers in a user-friendly and interactive format. Chatbots can deliver information on best agronomic practices, weather forecast, market information thereby improving the decision-making capacity of farmers. This paper discusses the development of a rule-based chatbot under a pilot-study and presents findings from a user study conducted with 102 farmers in Odisha, India in 2021. The content topics were decided using a participatory approach wherein farmers selected the topic of interests and information required. The content was developed using the digital tools Rice Crop Manager (RCM), Seed Cast and Rice Knowledge Bank (RKB), developed and deployed by International Rice Research Institute (IRRI). The chatbot is hosted on Facebook messenger platform and needs the internet support to operate. Farmers having this app can use the chatbot without any additional expense. The results indicate that farmers acknowledged and appreciated interactive features of chatbot and the content but expressed a desire for more comprehensive information on insect-pest management and other crop management practices. The findings highlight the potential of chatbot as a complementary channel to disseminate agro advisories, complementing the existing agricultural extension services. The study has its limitations in terms of small sample size which may or may not represent the variability of the entire population of the area.

Keywords: Chatbot; precision agriculture; rice cultivation; best management practices; agricultural extension; fertilizer; easy access to information; digital tool.

1. INTRODUCTION

In developing countries like India, agriculture is the backbone for generating livelihoods for the rural population. With 66% of the population living in rural areas and 42% dependent on agriculture for their livelihood [1], the agricultural sector shoulders the responsibility of feeding the country's 1.4 billion people. To maintain food security, efficient production measures are required within the agricultural system. Despite ongoing research to improve crop production and productivity, it takes years and sometimes decades for the new innovative technologies to reach the farmers. Transfer of new innovations from scientists and labs to farmers' fields mainly happens through the extension services, both private and public [2]. However, the agriculture extension system in India faces significant challenges, including manpower crunch as out of 143,863 positions in the Department of Agriculture, only 91,288 posts are filled [3]. Agriculture extension system needs supplementary support from other innovative approaches to accelerate the delivery and dissemination of new technologies being developed for the farmers [4].

Information and Communication Technology (ICT) has emerged as a crucial intervention, providing quick and timely access to innovative technologies and knowledge products through various digital tools [5]. With the increasing penetration of mobile phones and internet in the villages, agriculture advisories can be disseminated quickly with limited involvement of extension staff [6]. Farmers receive advisories through various digital communication platforms such as SMS, WhatsApp, Facebook messenger, and Kaizala [7]. However, most of these platforms use one-way communication to transfer advisories from experts to the farmers which lacks the human centric approach. This paper examines the development and deployment of a chatbot - a two-way communication platform designed to transfer agricultural advisories to the farmers of Odisha. The goal here is to reach farmers directly in their fields and homes, providing timely advice at their beck and call.

In Odisha, the rice production has increased from 46.14 Lakh MT during 2000-2001 to 115.00 Lakh MT during 2022-23 which is about 2.5 times over the base year, however the productivity remains low at 2.9 t/ha [8]. Most farmers practice rice production using traditional methods as the information on new technologies are limited [9]. Extension staff play an important role to co-create awareness on new technologies and encourage farmers to adopt those, in turn increasing the production and productivity of the cropping system [10]. However, the extension system in Odisha has its limitations in terms of resources. For instance, Odisha spends only 0.03 per cent of the GDPA on the extension system whereas the national average is 0.16 per cent. Further agriculture extension intensity in the state is one of the lowest in the country standing at Rs 19.1 per hectare as compared to the national average of Rs 95.2 per hectare [11]. An advisory tool like chatbot can help the extension staff in quick and timely dissemination of

information about the advances in science and technology. As per the TRAI report, the number of internet users are rising in Odisha. In the eastern region of India comprising of West Bengal, Bihar and Odisha, in rural regions, the number of subscribers of the internet users in hundred population is maximum in Odisha (29.54), followed by West Bengal (23.38) and Bihar (20.60), which indicates the potential to reach out to farmers through ICT [12]. However, in 2021, when the study was done, no significant number of conversational bots were available for the farmers of Odisha.

While timely access is crucial, it is equally important to select the content carefully to meet farmers' specific needs. Often, farmers are overwhelmed with irrelevant information, which can lead to scepticism about these services [13]. To address this gap, an interactive communication tool/chatbot was developed, specifically for the farmers in Odisha. The word chatbot is composed of two parts: “chat,” that means to converse, and “bot,” that comes from robot. Chatbot is a program capable of “conversing” with users, responding to specific questions, and automatically providing suggestions based on users’ needs and queries [14]. A tool that is convenient and practical, accessible to farmers and agricultural extension workers anytime of the day, delivering information on best management practices tailored to their needs [15]. The chatbot interface is menu-driven, with input options leading to synthesized text string and audio file. The same chat interface is used to deliver the content to the farmer. In agriculture, Chatbots are being used to provide information on crop management, analyzing market trends, detecting crop diseases and pests, and optimizing resource usage [16]. Chatbots are emerging as virtual agricultural advisors to disseminate best agricultural practices [17].

Different types of chatbots vary in features based on their application. Popular types include menu-based, rule-based, AI-based, voice chatbots, and generative AI chatbots [18]. Some of the popular chatbots available today for farmers are Plantix for plant diseases [19]; AgroBuddy for weather updates [20]; KisanSuvidha [21] for market information etc. This paper focuses on the development and evaluation of a rule-based chatbot, which uses if/then logic to develop conversation flow. With predefined question-and-answer combinations based on user input, this tool simulates a real-time conversation, making the interaction engaging and keeping the user interested. Users also have the option to pause the conversation and resume it later, based on the needs. The novelty in this chatbot is the use of RCM for providing site-specific advisories on nutrient management as well as information on the seed suitability and availability with detailed information on seed dealers.

2. MATERIAL AND METHODS

2.1 Selection of Platform for Hosting Chatbot

The first step in developing a chatbot was selecting a platform to host it. The chatbot can be developed as an independent application or integrated into existing messaging platforms. A survey was conducted in four villages to determine the digital communication platforms most commonly used by the farmers. WhatsApp and Facebook Messenger were the top two platforms for digital communication. Facebook Messenger was found to be the most suitable for hosting a chatbot due to its cost-effectiveness, support for the Odia language, and ability to handle audio files. Consequently, this platform was selected to host chatbot. The study is focused on the following research objectives:

1) Using user-centered design, identify the priority content of best crop management practices for farmers and agricultural extension workers in Odisha, India.
2) Design, develop and deploy a chatbot intended to increase the adoption of best crop management practices for farmers in rice-based agri-food systems in Odisha.
3) Conduct a user-test to collect the feedback of farmers for further improvement of chatbot and similar technologies.

2.2 Selection of Topics for Content

A survey was conducted using a structured questionnaire to identify the rice crop management information farmers were most interested in. The survey was conducted in two districts: Puri and Balasore, covering four villages with 32 farmers ranking crop management topics. The top four topics selected were seed availability, suitable seed varieties, crop loans, and fertilizer management. Based on these priorities, the content for the chatbot was selected from three main sources:

1. IRRI's Rice Knowledge Bank (RKB): A web-based digital extension service providing information on rice production techniques and crop management practices based on IRRI's research findings and other national research findings (www.knowledgebank.irri.org).
2. SeedCast: A mobile app developed by IRRI that collates demand for rice seeds from dealers and to provides information on suitable rice varieties for specific locations (www.irri.org/seedcast); and
3. Rice Crop Manager for Odisha: A web-based tool offering site specific advisories on nutrient management for rice fields (www.irri.org/crop-manager).

Content Details

a. Seed Suitability: Provides information on stress-tolerant varieties (STRVs) suitable for specific areas based on local stress conditions. The chatbot suggests a list of suitable STRVs that can be grown in the area based on the farmer's queries;
b. Seed Availability: Lists seed dealers in the area along with their contact details, allowing farmers to enquire about the availability of the desired varieties;
c. Nutrient Management: Offers site-specific advisories for nutrient management in rice fields, with details on the rate and timing of fertilizer application. These advisories can also be accessed in regional language, Odia, through audio clips; and
d.Links to Additional Resources: Links to the Rice Knowledge Bank (www.knowledgebank.irri.org) and Rice Doctor (www.irri.org/rice-doctor) were included in the menu for farmers seeking more detailed information on crop management and pest and control of insect-pest and diseases.

2.3 Technical Architecture of Chatbot

The chatbot was developed using Facebook Messenger to provide step-by-step instructions for input parameters and generate appropriate responses to farmers (Fig. 1). The chatbot supports both English and Odia languages, and all conversations, including audio files, are stored in a database at the server. The output is synthesized as a text string based on input parameters. An interactive dashboard was developed to present data and usage analytics. The paid version of Chatfuel (Facebook Messenger) was used to enable the chatbot service, with MySQL for database storage. Non-clustered indexes were applied where appropriate, and the application was developed using PHP and JavaScript.

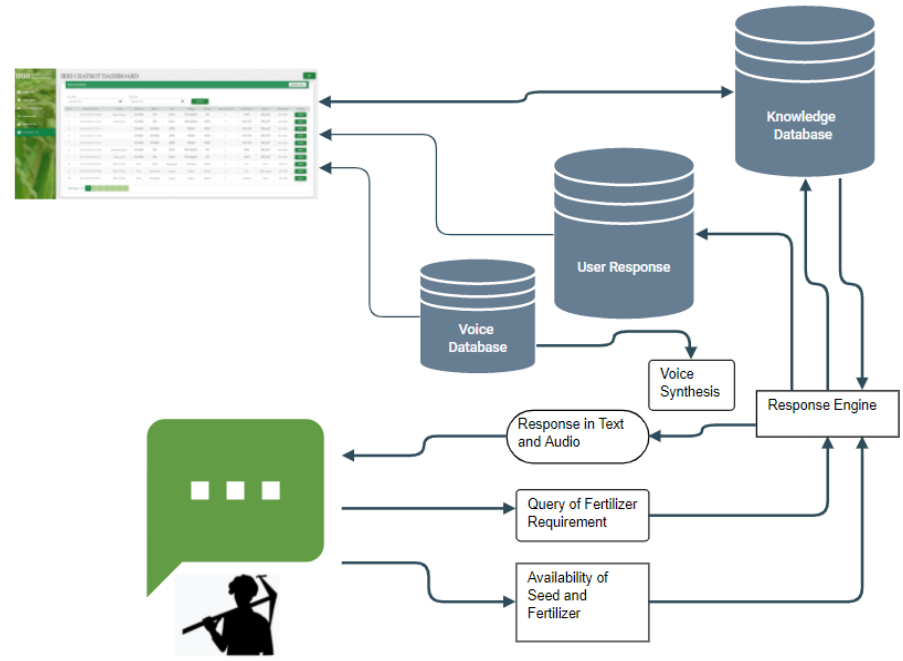

Fig. 1. Technical architecture of chatbot

2.4 Farm Chat Evaluation

For the pilot-study, the chatbot was made available to the facebook messenger users without any charges. User testing of chatbot was conducted in the selected villages of Balasore and Puri districts of Odisha. Farmers were invited in batches of 5-10, and the chatbot link was shared with them. They were asked to use chatbot, post specific queries, and share their experiences and feedback. The search data from farmers who used the chatbot was automatically captured in the dashboard for further analysis. A feedback survey was conducted at the end using questionnaires to record their responses.

3. RESULTS AND DISCUSSION

3.1 Profile of Participants

A total of 102 farmers from Odisha participated in the study, all of whom owned the mobile phones they used to request crop management information. Every participant reported having owned a mobile phone for more than 3 years. Majority (95%) were male, with an average age of 34, and farming served as their main source of income. The average years of schooling across all villages in both districts was secondary education. Seventy percent of the participants reported using the information for themselves, 4% for others (including family members and neighbors), and 26% did not specify who would use the information.

3.2 Farm Characteristics of Farmers

The average area of land used for rice production was 1.19 hectares and 0.63 hectares in Balasore and Puri, respectively. In Balasore, rice farm sizes ranged from 0.40 to 3.60 hectares, while in Puri, they ranged from 0.40 to 1.60 hectares. Majority (68%) of farmers preferred short-duration rice varieties. Although 20% of respondents did not specify their preferred variety, a small number reported using long and medium-duration varieties, and 4% used stress-tolerant varieties. Few farmers (8%) identified submergence as major stress affecting their rice fields. The reported yields were similar between the two districts, with 4,554 kg/ha in Balasore and 4,751 kg/ha in Puri during the 2019 Kharif season. Although 33% of farmers did not plant during 2019-2020 Rabi seasons, the average yield during Rabi was higher, with an average of 4,916 kg/ha in Balasore and 5,225 kg/ha in Puri. Most farmers in Odisha practiced manual harvesting.

3.3 Requested Crop Management Information

Twenty one percent of farmers in Balasore and Puri were mainly interested in seed availability and the amount of fertilizer and its timing of application in rice farming, respectively (Fig. 2). Apart from fertilizer advice, farmers in Balasore did not emphasize enough on the role of fertilizer (12%), while seed suitability was the least concern for farmers in Puri (12%). Overall, farmers in Odisha showed great interest in knowing about seed availability in their respective districts.

3.4 Participant's Satisfaction

The feedback from farmers who used the Chatbot was overwhelmingly positive, reflecting a strong potential for this technology in agricultural extension services. Majority (88%) of farmer-participants reported being very satisfied with the Chatbot's ability to provide them with useful information that would help in their rice farming activities. While 55% felt they received enough information, 45% believed that the information provided was limited to three topics and suggested adding more. These farmers expressed a desire for the inclusion of more diverse topics, particularly those related to insect-pest management, weed control, weather forecasts, agricultural machinery, and updated pesticide and herbicide recommendations. This feedback underscores the opportunity to expand the chatbot's content to better meet the comprehensive needs of farmers. In terms of usability, the chatbot was well-received, with 14% of participants finding it easy to use and 86% rating it as "somewhat easy." Farmers appreciated the interactive nature of the chatbot, which allowed them to ask specific questions and receive tailored responses (Fig. 3). The conversational style was particularly effective in maintaining engagement, as it made the interaction feel more personal and less mechanical.

The combination of text and audio delivery was highly favored, with 98% of participants preferring this dual approach. The audio clips, which were available in the regional language Odia, were particularly well-received, with 97% of users reporting that they liked this feature. The audio format was seen as an important tool for enhancing understanding, especially for those who may have literacy challenges or prefer auditory learning.

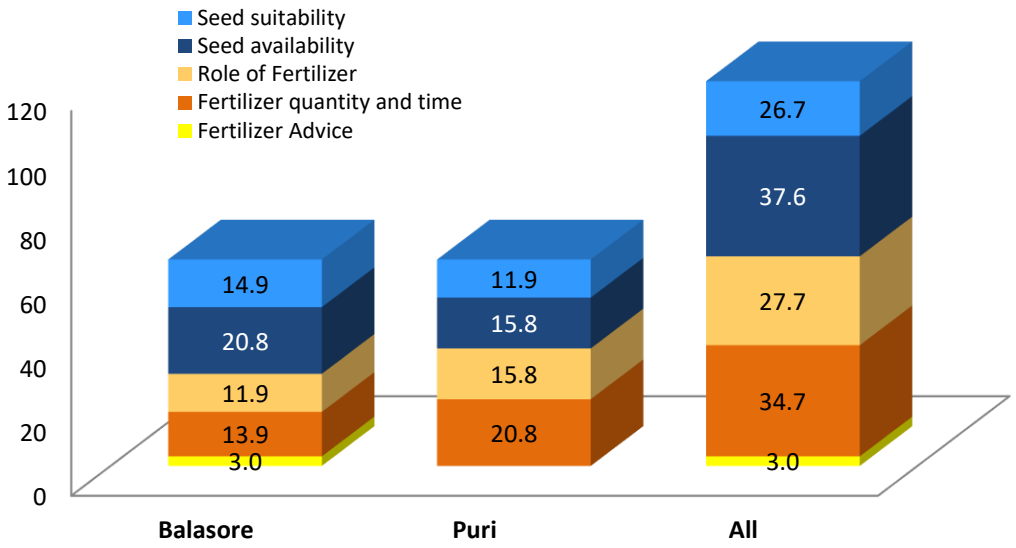

Fig. 2. Distribution of topics selected by farmers for near-real time advisories

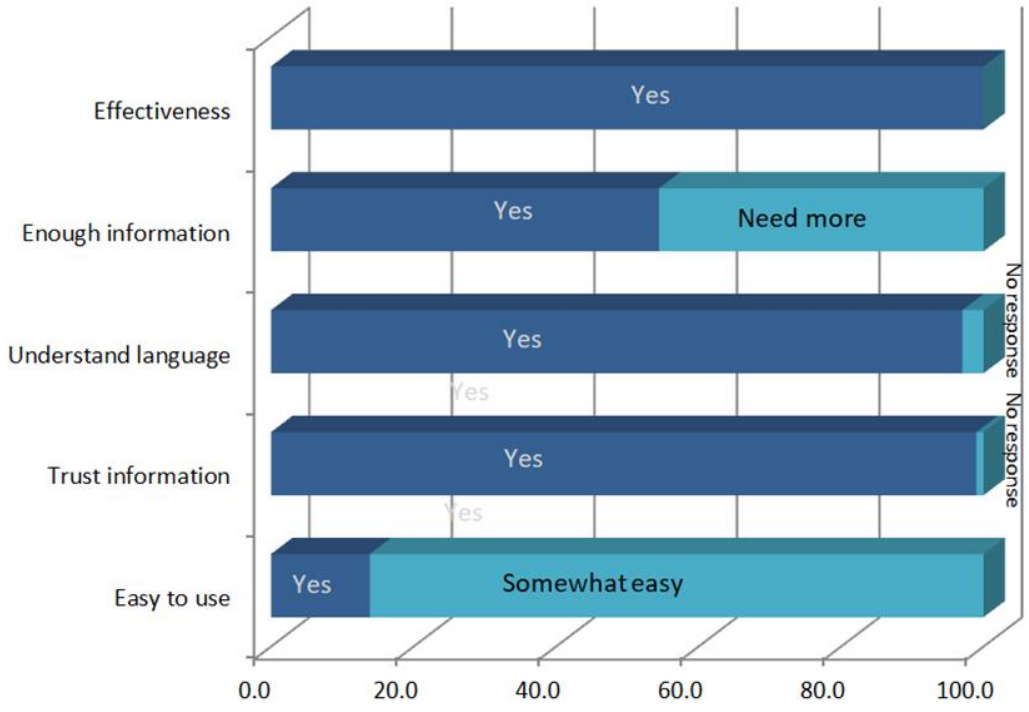

Fig. 3. Acceptability of the chatbot regarding the information provided, language used, effectiveness and if user-friendly

When evaluating the time it took to receive the information, 83% of farmers felt that the duration was just right—not too long or too short. This suggests that the chatbot's efficiency in delivering information meets the needs of the farmers without causing frustration due to delays or overload.

The clarity of the chatbot's responses was also highly rated, with all participants finding the

answers to be either mostly clear or very clear. This indicates that the chatbot effectively conveyed the information in a way that was easily understood by the users, which is crucial for ensuring that the advisories are actionable.

Regarding future use, 96% of the farmers expressed their intention to use the chatbot again, demonstrating strong acceptance and a positive outlook on the technology while the remaining 4% were unsure, possibly indicating a need for further refinement or additional features to fully meet their expectations.

Farmers also suggested several enhancements that could improve the chatbot's utility. These included real-time updates on seed availability and prices from local dealers, which would assist them in making timely purchasing decisions. Additionally, some farmers accessed the Rice Knowledge Bank (RKB) link provided by the chatbot to seek more detailed information, which shows the potential for integrating more in-depth resources within the chatbot's interface.

Overall, farmers were excited about using the chatbot, appreciating its conversational mode and two-way communication. They noted that as smartphone usage increases in villages, such applications will be increasingly sought after to enhance their knowledge.

4. CONCLUSION

The pilot study under the seed grant project highlighted the significant potential of using chatbot as an interactive medium to engage with farmers and deliver tailored agricultural advisories. Farmers appreciated the ability to access relevant content through the Messenger app and valued the option to choose specific topics that met their immediate needs, rather than being given irrelevant information. The positive feedback indicates that chatbot can enhance the effectiveness of agricultural extension services by providing timely, user-centered support.

Moreover, the study revealed a clear demand among farmers for expanded content, particularly in areas like insect-pest management, weed control, and other crop management practices. The findings support the results from study done in Nigeria to evaluate the chatgpt responses to help the extension staff in delivering information, and found it useful [22]. This suggests a strong opportunity to further develop and refine the chatbot, making it a more comprehensive tool that can address a broader range of agricultural challenges. The team is working to advance this chatbot to an AI-enabled chatbot by using the server data of digital tools developed by IRRI. The advanced chatbot will be able to provide weather-based advisories on nutrient management, pest management and weed management along with the information on seed suitability and availability. As smartphone penetration continues to grow in rural areas, the integration of such technology into the agricultural advisory system could play a crucial role in improving productivity and sustainability in farming communities. However, the small sample size is a limitation of the study. It diminishes the statistical power of the analysis and limits the generalizability of the findings. A smaller number of samples may or may not represent the diversity of the population leading to potential biases in the result. Further research with a wider sample size will confirm and expand upon these results.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during the manuscript development.

CONSENT

All authors declare that written informed consent was obtained from the farmers for publication of this paper. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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