Mobile Applications for Precision Agriculture Practices:
A Review

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Abstract—In most developing countries like Sri Lanka, agriculture plays a vital role in economic and social aspects. Paddy cultivation is considered the most economically significant field of agriculture. Since farmers are the backbones of the paddy and rice industry, their satisfaction and efficient involvement directly affects the development of the paddy cultivation industry. As a result of the timely necessity of accessing information for decision-making in paddy cultivation, numerous paddy cultivation advisory services implemented in different regions can be identified worldwide. Access to continuously updated information on matters such as weather, machinery, diseases, pests and fertilizers at the right time allow farmers to make effective decisions. This review paper enhances details about software applications in paddy cultivation, developed to benefit farmers and other related stakeholders. A review of the system modules, features and technologies of providing timely information on paddy cultivation is mentioned by comparing prevailing systems. Moreover, factors that affect the prominence in using these types of systems are discussed in detail. This review shows that agriculture-based applications are highly demanded in countries like India, Sri Lanka, Myanmar and Africa. These applications have been developed to fit into their specific domain. Inefficient module functions, limited real-time services, complexity and lack of usability of prevailing systems are the main gaps identified through this review.

Keywords: machine learning, mobile applications, paddy cultivation, precision agriculture, smartphone applications

I. INTRODUCTION

Agriculture is considered as the oldest profession learnt by humankind after hunting. With the advanced improvement in agricultural research and development process over the centuries, the field of agriculture has progressed up to the current commercially beneficial stage(Kuba & Jha, 2017). During last couple of decades agriculture in all around the world is progressively shifting from traditional practices to scientific methodologies. "Rice is life" is a very familiar slogan for developing countries where Paddy cultivation is closely linked to the cultural and socio-economic life of the entire population. In the prevailing state of Sri Lanka, the contribution of rice for the Gross Domestic Products is approximately 18%. More than 30% of labour force is dedicated for rice production industry in both direct and indirect ways. The main income of 1.8 million families in Sri Lanka is based on paddy cultivation(Adhikarinayake, 2005). However, due to several challenges which are currently existing with the paddy cultivation industry, farmers have to face many difficulties in obtaining a satisfactory harvest through the cultivation efforts. Climate variability in recent years has critically affected the usual aspects of human lives, where the agricultural sector can be considered as one of the most vulnerable(Alahakoon, 2017). In addition, insufficient knowledge, lack of interest and insufficient guidance are the main problems faced by the paddy cultivation industry. The positive outcome of these prevailing issues can be identified as the approach of prioritizing the rice industry development in Sri Lanka with the integration of modern technologies(Sylvester, 2016).

The rapid growth in information technology is contributing for the social empowerment and

innovations in developing countries from grassroots level(Rajput & Goyal, 2019). Not only in Sri Lanka, the emergence of new applications and services for paddy cultivation can be clearly recognized in worldwide(Norasma et al., 2013). These applications are trying to address the gap between farmers and the access to the agriculture-based information. Access to continuously updating information on weather, machineries, diseases, pests, fertilizers, etc. at the right time allow farmers to make effective decisions. This review paper enhances details about software applications in paddy cultivation developed for the benefit of farmers and other related stakeholders in worldwide. Review of the system modules, features, and technologies of providing timely information on paddy cultivation are mentioned through the comparison of the
prevailing systems.

The rest of this paper is organized as follows. Section II of the paper discusses the methodology used in this research. Section III includes a comprehensive review on the available applications for paddy cultivation advisory purposes. Section IV discusses about the results obtained through the review. Finally, section V concludes the overall research indicating the importance of this research.

II. Methodology

The purpose of this research is to review mobile applications related to paddy cultivation based of their functionalities and effectiveness. This research followed a systematic search strategy to find agriculture-based mobile apps available in Google and Apps stores.

Selected applications represent different regions, different technologies used, and different functionalities. Applications are critically reviewed based on these criteria.
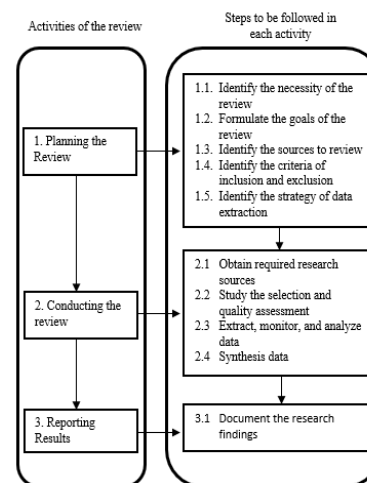Finally, depicted in Figure 1., research findings are summarized and discussed through this paper.

Figure **1**: Research Methodology

III. Mobile Applications Review

Selected mobile applications for this research include different types of agriculture-based systems. Paddy cultivating countries like India, Sri Lanka, Africa, and Myanmar have mainly focused in developing mobile applications to increase the effectiveness of paddy cultivation through farmers' satisfaction. Some of these applications have built exclusively for paddy cultivation while several applications include many other crops addition to paddy.

A mobile application comprises with a set of functionalities that are required to satisfy both functional and non-functional requirements. In order to provide a better experience for the users, these applications use number of latest technologies for different purposes such as front-end, back-end frame works, model building etc(Goonathilake & Kumara, 2020). This review focuses on the technologies used and different features provided by the selected applications.

A. TANU's Paddy Expert System

This application has developed to provide information on paddy cultivation to Indian farmers. Its functionalities allow farmers to access information on cultivation practices, nutrient management, crop protection, farming and harvesting machineries. And also, this mobile app provides details about marketing and related institutes for paddy cultivation. Since its first release in 2017, more than 5000 downloads have been recorded. The current rating and

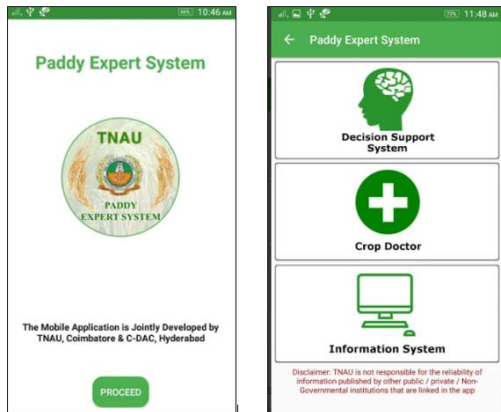application size are 4.6 and 88.00 MB, respectively(Paddy Expert System, 2017).

Figure 2: TANU's Paddy Expert System

B. riceXpert

riceXpert has developed by National Rice Research Institute (NRRI) in India with the purpose of providing real time information to farmers on rice varieties, nutrients, insect pests, weeds, disease-related problems, and machineries. In addition, it includes functionalities to deliver news, announcements and FAQs related to paddy cultivation in India. The most important feature in this app is ability to make customize queries by farmers through text, image, and voice. NRRI experts can address these issues on real time basis. More than 10000 downloads have been recorded since its first release in 2016 and currently riceXpert is 13.59 MB and has a 4.4 user rating(*RiceXpert*, 2016).
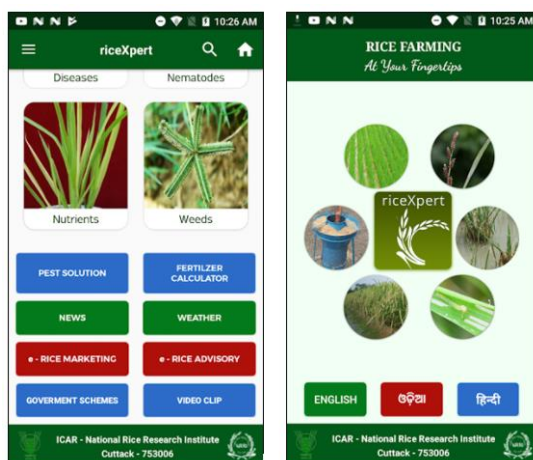

Figure 3: riceXpert

C. Krushi Advisor

This is an Android based agriculture app available in Sinhala language that provides advisory services for crop cultivation in Sri Lanka. Addition to the farmers, this app targets several other communities including agricultural entrepreneurs and researchers. This informative system comprises with knowledge required in different crop cultivations including paddy as one of the major crops. Users can directly connect with the 1920 hotline for agriculture advisory services. As well, this system can be used in offline by downloading reference data at the installation process. It has initially released in 2018 by the Department of Agriculture Sri Lanka and it has been downloaded by more than 10000 users. Current download size of this app is 3.42 MB and it has rated by users up to 4.5(Krushi Advisor, 2018).

Figure 4: Krushi Advisor

D. Agro Life Sri Lanka

This application also available in Sinhala language and provides informative services to crop farmers. Features like providing knowledge on impact of climate, storage procedures, communication for agriculture related queries are included addition to the common features that are available in the above-mentioned applications. This application has been released in 2020 by KOMA Labs currently its size in 4.2 MB. It has been achieved more than 1000 downloads with 4.7 user ratings(Agro Life Sri Lanka, 2020).
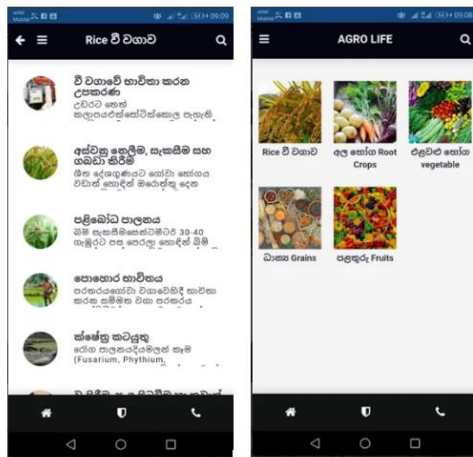
Figure 5: Agro Life Sri Lanka

E. RiceAdvice-WeedManager

AfricaRice and Co-Capacity has developed an Android based application named as RiceAdvice that includes decision support tools to provide guidelines in field-specific management related to paddy cultivation for African farmers. The two main tools available with the application are RiceAdvice and RiceAdvice-WeedManager. Relevant guidelines are provided by taking inputs from farmers through MCQs. Currently, this application supports for both English and French. More than 1000 downloads have been recorded since the first release in 2016(*RiceAdvice-WeedManager*, 2018).
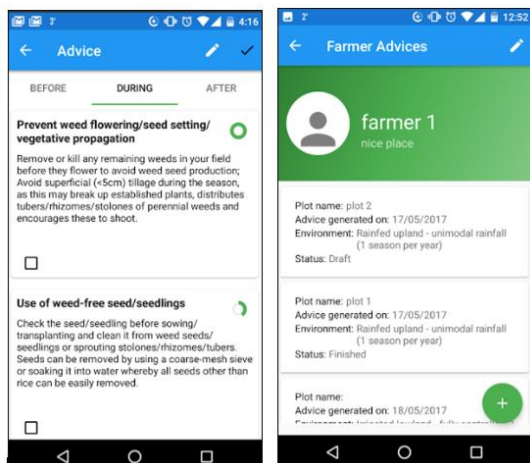

Figure 6: RiceAdvice-WeedManager

F. Golden Paddy

Golden Paddy is a mobile application developed for paddy farmers in Myanmar. It is available in Myanmar language, and it guide farmers in paddy

cultivation to increase their yields and income. Users can access to weather forecasts and paddy market rates in real time basis. Currently it has achieved more than 10000 downloads with 4.6 user rating. It has updated to newer version since its first release in 2016 and current size of the app is 11.62 MB(*Golden Paddy*, 2016).

Figure 7: Golden Paddy

Paddy cultivation is one of many fields in agriculture. Even there are some differences exist among paddy cultivation practices and other crop cultivation, some processes and informational requirements between these cultivation domains are similar and linked together. Therefore, this research has focused of most beneficial and popular mobile applications that have developed for other types of crop cultivation purposes excluding paddy cultivation. **OneSoil Scouting** one of the best farming applications, that can be commonly used for planting fruits and vegetables. The feature that allows farmers to access satellite views of their farming fields to detect areas with different problematic conditions is the most significant functionality. However, this feature does not perform perfectly during severe weather conditions. Farmers can maintain notes on their farming procedure to track the growing stages of crops. Access to social media and weather forecasts also, enhances the importance of this system. **Farm Dog** is another agriculture application similar to OneSoil Scouting app(*Farm Dog*, 2016). This system provides recommendations based on the cultivation notes made by the farmers.

In the field of agriculture, trade can be considered as an integral part. **Agrellus-Grower** is a buying

and selling application for agricultural products(*Agrellus - Grower*, 2021). Farmers can buy fertilizers, chemicals, equipment for their farming activities through different sellers available within the system. **Kugler Timing** App is useful in tracking and scheduling farming tasks in cultivating corn, barley, soybeans, wheat, etc(*Kugler Timing*, 2018). The most remarkable feature available in Agrivi app is the ability to monitor farming expenses based on sales, income, and other cost related factors. There are systems like **Crop Nutrient Advisor** that are dedicated for nutrient management for different crops and systems like **Plantix** are functioning as crop doctors which can detect and provide recommendations for crop related diseases(*Crop Nutrient Advisor*, 2020; *Plantix*, 2015). All these applications have built with the intension of provide facilities for farmers in different ways related to cultivation. Even these types of prevailing applications do not directly useful in paddy cultivation, the technologies, features and concepts of them can be effectively used to improve the effectiveness of paddy cultivation based mobile applications.

IV. DISCUSSION

The results of this research on reviewing paddy cultivation and other agriculture-based mobile applications shows that there are different types of systems have been implemented in different regions in world. Out of them, applications related to paddy cultivation are mostly available in countries such as India, Sri Lanka, Myanmar, Africa, etc. According to the summarized comparison depicted in Table 1., several features and functions can be recognised in common with all these applications while some of the features have been developed in regions-specific manner. Most of the features available in these applications are dedicated for knowledge delivery where some of the applications have been able to provide information in real time basis. User ratings of these apps which are more than 4.0 stars represent the effectiveness of their functionalities. Features like access to weather forecasts and ability to communicate with agriculture experts enhances the dynamic performances of these applications.

Mobile apps like OneSoil Scouting, Plantix, etc are also dedicated for different agricultural purposes including crop disease detection, crop nutrient advisories, agricultural trading etc. Even these types of applications are not specifically developed for the use of paddy farmers, the features, technologies, and concepts used in these systems also can be used for the advancement of prevailing paddy cultivation-based applications.

Agriculture based Application	Technologies Used	Feature						
		Crop and Machinery Details	Fertilizers	Diseases	News	Weather Forecasts	Experts' Advisory	Other
Paddy Expert System *India*	Data Analytics	✔	✔	✔	✗	✔	✗	Paddy marketing
riceXpert *India*	Mobile Networking	✔	✔	✔	✔	✔	✔	Paddy marketing
Krushi Advisor *Sri Lanka*	Mobile Networking	✔	✔	✔	✔	✗	✔	-
Agro Life *Sri Lanka*	Data Analytics	✔	✔	✔	✗	✔	✗	Storage process
RiceAdvice *Africa*	Data Analytics	✔	✔	✔	✗	✗	✔	Weed Managing
Golden Paddy *Myanmar*	Data Analytics e-commerce	✔	✔	✔	✔	✔	✗	Paddy marketing

V. CONCLUSION

This review paper provides insights into the existing mobile applications used for precision agricultural practices in particular paddy cultivation. From our study, we draw the following conclusions:

Firstly, we noted that mobile applications developed for facilitating precision agricultural practices particularly in the field of paddy cultivation are highly demanded in countries like India, Sri Lanka, Myanmar, Africa, etc. System features and functionalities of these applications are mostly based on their particular regional contexts.

Secondly, we recognized that the reviewed applications have limitations due to the inefficient module functions, limited real-time services, complexity, and lack of usability. Overall system complexity exists with these applications are considerably beyond the current level of digital literacy of rural farmers.

Thirdly, the applications that have been developed for Sri Lankan context, it can be seen that the user interactive features are either unavailable or poorly implemented. Absence of essential dynamic features to provide real time access to agricultural information has identified as the main reason for poor user interest and satisfaction.

For future research, since this study mainly focused on mobile applications used for precision agricultural practices in particular paddy cultivation, we suggest reviewing more applications related to other crop cultivation practices in the field of agriculture.

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