ICT BASED FRAMEWORK TO EDUCATE FARMERS OF PAKISTAN

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ABSTRACT: Agriculture is the backbone of Pakistan's economy, but the yield is not meeting expectations. This research investigates the agriculture training sector, where the government has invested heavily. We conducted surveys, interviews, and ethnographic studies to identify problems in current training programs. Our research proposes an ICT framework for agricultural training based on the Technology Acceptance Model (TAM). The framework is designed to be easy, interactive, and adaptive, with a primary focus on supporting farmers' needs

Keywords: ICT (Information Communication Technology), TAM (Technology Acceptance Model), Agriculture, Agriculture training

INTRODUCTION

Pakistan, an agrarian economy, derives a significant portion of its GDP from agriculture, earning it the distinction of being the country's backbone. The agriculture sector contributes substantially to the national economy, accounting for 22.4% of GDP and providing employment opportunities to 37.4% of the labor force [1]. However, the sector has experienced a decline in growth, with a slow development in the recent year, primarily due to decreased production of major crops such as cotton, maize, and rice, exacerbated by adverse climate conditions and inadequate access to precise data [1]. Furthermore, the rural areas of Pakistan, where agriculture is predominantly practiced, are characterized by high illiteracy rates and limited educational attainment, with most farmers having an education level below or at matriculation [1].

Problem Statement: The agricultural sector in Pakistan faces a significant challenge in increasing crop yields. Despite its potential, the sector's productivity remains suboptimal, with farmers failing to achieve double the yield per acre. This research aims to investigate the underlying reasons for this phenomenon and propose a solution to address it.

LITERATURE REVIEW

Despite its significance, numerous attempts to provide training to farmers have yielded limited success. For instance, the government-initiated 'Farmer Field Schools' program [2,18] primarily caters to fruit and vegetable farmers, providing them with information on modern marketing techniques. However, the program's scope is limited, and its impact on the broader agricultural sector is negligible.

The agricultural sector in Pakistan continues to face challenges, with production levels falling short of potential [3]. The actual yield is significantly lower than the real potential, indicating that farmers are still reliant on traditional farming techniques and have not fully adopted modern technologies [4]. While electronic media is being utilized to disseminate valuable agricultural information, the information is often not delivered in a timely manner [5,15,16].

In rural Pakistan, information is primarily transferred through traditional means, such as word of mouth from neighbors, friends, and relatives [6]. Print media, including magazines, newspapers, books, and pamphlets, is also used to disseminate agricultural information [7, 8]. However, the role of field staff in providing information to farmers is limited, and their communication with farmers is often ineffective [9].

Small farmers, in particular, require access to relevant and updated market information to penetrate and fulfill market needs [9]. Climate change is another significant challenge facing the agricultural sector, with the United Nations predicting a decline in farming yields in Asia and Africa by 2050 [10]. Pakistani farmers are also facing financial difficulties due to increased costs of pesticides and fertilizers, leading to perpetual debt [11]. Furthermore, waterlogging and salinity are increasing, reducing water availability per acre [12]. To address these challenges, applications developed for farmers should provide multilingual support and minimize the digital divide in rural areas [13]. A study found that 63.58% and 58.6% of respondents considered extension methods such as group discussions and lectures to be average, while 31.93% of respondents rated the use of

signboards and slogans by FFS staff as below average [14].

Research methodology and analysis: Tis study employed a design science research methodology, which involves a sequence of iterative activities to develop and propose an innovative product. First phase of this methodology consist of ;problem identification. In the second phase, a conceptual framework is developed. A software artifact is developed in phase three, and in last(forth) phase the artifact is evaluated. In the following section, each phase is discussed in detail.

Phase 1: Identifying the problems and challenges in training farmers: This phase, both quantitative and qualitative research methods were used to investigate the reasons behind low agricultural yields due to inadequate training in Pakistan.
Data collection was conducted through surveys, interviews, and ethnography techniques.

Surveys: For surveys, questionnaires were designed with the help of a field expert, the field expert has more than 20 years of field experience in agriculture sector in Punjab, Pakistan. The survey was planned and structured so the information collected can be statistically inferred on a population. The data was collected from seven villages near Lahore district, these villages are located near border-line between India and Pakistan. Villages include Jandwala Darogewala, Thata Dewana, Bheen, Thatho Tararan, Wagarian, Dogech, and Makhan shareef. The survey was conducted with the help from government of Pakistan's agriculture Punjab department, where field experts assist in collecting data from farmers, Survey forms were distributed to farmers. The questions were of mixed type with nominal data such as yes/no as well as with Likert scale questions. The data has been collected from 85 respondents across different villages, two pilot studies were performed through field experts. Questions were written in local language Urdu so that every respondent understand about the questions they are answering, fifty-three (53) questions in total were finalized by mutual understanding between domain expert and researcher.

Interviews: The qualitative research is also conducted to gather facts and figures from the agriculture department. Interview were semi-structured, and were conducted from government officials belonging to two different departments. They were conducted in local language Urdu. First interview was conducted from Director of soil and research analysis Lahore laboratory. The questions asked were regarding departmental responsibilities, any private organization involvements, departmental trainings on best farming practices, what problems Pakistani farmers are facing in current scenario and as a department what are the duties they perform and how they measure their efforts and are their efforts effective or not. Second interview was conducted with FFT director Lahore. Series of questions asked were about the training they provide as a department, roles and responsibilities of department, techniques they use to communicate with farmers, and particular information regarding wheat crop in Punjab Pakistan. Both interviews were transcript in Urdu.

Ethnography: Observations were made in the fields of each selected village for the duration of four hours to study the nature of Pakistani farmers and to identify the issues pertaining to the training of farmers which causes low yield.

Analysis of first phase: This section presents the analysis of the data obtained using quantitative and qualitative research methods. It provides information about farmers' current knowledge and education, facilities provided by the government, and their training programs.

Analysis of Data collected using Surveys: Through surveys we collected data such as the education level of farmers, the training they had and their usage of technology. Following is the analysis of the data collected:

Education Level: The survey data revealed the educational background of the farmers, providing insights into their literacy levels and potential ability to access and utilize information. The results are presented in the frequency table (Table 1), which shows that:
- 36.5% of farmers have not attended any educational institution
- 2.4% of respondents have completed their education up to the primary level
- 4.7% of respondents have completed their middle school education
- 43.5% of respondents, the largest proportion, have completed their education up to the matric level
- A significant proportion of respondents (13.9%) have an educational level above matric

The data suggests that while a substantial number of farmers have not attended any educational institution, a majority of them have some level of formal education, with many able to read and write in their local language. This implies that farmers have the basic literacy skills necessary to access and utilize information, although there may be variations in their ability to comprehend complex information or navigate digital platforms.

The educational literacy levels of farmers have implications for the design and delivery of agricultural extension services, information dissemination, and training programs. By taking into account the educational background of farmers, these initiatives can be tailored to meet their needs, using language and formats that are accessible and easy to understand.

Table 1: Education Level.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Zero	31	36.5	36.5	36.5
	Primary	2	2.4	2.4	38.8
	Middle School	4	4.7	4.7	43.5
	Matric	37	43.5	43.5	87.1
	Above Matric	11	12.9	12.9	100.0
	Total	85	100.0	100.0	

Attending Farmer Field Training Program (FFT):The survey data revealed the attendance patterns of farmers in the Farmer Field Training (FFT) program. The results are presented in the table, which shows that:

- 60.0% of total respondents reported not attending the FFT program
- 40% of total respondents reported attending the FFT program

This finding suggests that a significant majority of farmers (60.0%) are not participating in the FFT program, indicating a trend of low attendance among farmers in government-organized training programs. In contrast, a smaller proportion of farmers (40%) are attending the FFT program, highlighting a missed opportunity for knowledge sharing and skill development among a larger segment of the farming community.

The data implies that there may be barriers or disincentives that prevent farmers from attending the FFT program, such as lack of awareness, inconvenient scheduling, or perceived lack of relevance. To improve attendance and engagement, it is essential to identify and address these underlying issues, making the FFT program more accessible, relevant, and beneficial to a broader range of farmers.

Table: Attending Farmer Training Programs.

		Frequency	Percent	Valid Percent	Cumulative Percent
+Valid	Yes	34	40.0	40.0	40.0
	No	51	60.0	60.0	100.0
	Total	85	100.0	100.0	

Use of Internet: The survey data revealed insights into the internet usage habits of farmers. The results showed that:

- 70.6% of respondents use the internet for various purposes, including:
  - Surfing the web
  - Using social networking sites
  - Accessing information from multiple websites
- 29.4% of respondents reported not using the internet at all

This finding suggests that a significant proportion of farmers are already familiar with the internet and use it to access information, connect with others, and explore online resources. However, a notable percentage of farmers (29.4%) do not use the internet, highlighting the need for alternative channels to reach and engage with this group.

The data implies that online platforms and digital tools can be effective channels for disseminating information and supporting farmers, but it is essential to consider the needs and preferences of non-internet users as well. By developing a comprehensive approach that incorporates both online and offline strategies, we can ensure that all farmers have access to relevant information and resources, regardless of their internet usage habits.

Table: Use of Internet.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	60	70.6	70.6	70.6
	No	25	29.4	29.4	100.0
	Total	85	100.0	100.0	

Frequency of Smartphone Usage

To inform the design of our tool, it was essential to understand the frequency of smartphone usage among farmers. The data revealed that:

- 69.4% of respondents use smartphones for less than 6 hours a day
- 9.4% of respondents use smartphones for more than 6 hours a day
- The remaining 21.2% of respondents fell into other categories, which may include varying levels of smartphone usage

These findings suggest that the majority of farmers (69.4%) have limited time to devote to smartphone usage, highlighting the need for a tool that provides precise and concise information. Given the time constraints faced by farmers, it is crucial to develop a tool that is easy to use, intuitive, and provides relevant information in a timely manner.

The data implies that farmers are likely to benefit from a tool that:

Table: Smart phone usage.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	,No response	18	21.2	21.2	21.2
	Less than 6 hours	59	69.4	69.4	90.6
	More than 6 hours	8	9.4	9.4	100.0
	Total	85	100.0	100.0	

Interview Analysis: Exploring Punjab's Agriculture Department Training Programs: This study examined the Agriculture Department of Punjab's training programs through semi-structured interviews with two key officials: the Director of the Soil and Research Analysis Laboratory and the Assistant Director of the Farm Field Training Program.

The interviews revealed a hierarchical framework within the Agriculture Department, comprising multiple wings, including marketing, water/irrigation, training and soil research. This structure facilitates effective communication and resource allocation. The Rabi and Kharif campaigns were highlighted as key training programs, with phased training addressing specific agricultural needs.

Furthermore, field officer-farmer relationships emerged as crucial, with trust-building initiatives fostering effective knowledge transfer. Limited private sector involvement and small farmers' adaptability were identified as challenges. However, collaborations with USAID and UNO (IFAD project) demonstrate potential avenues for public-private partnerships.

The findings suggest effective communication channels within the Agriculture Department and targeted training programs addressing seasonal agricultural needs. The importance of field officer-farmer relationships and the need for modern technology integration were also underscored.

These interviews highlighted the strengths, challenges and areas for improvement within Punjab's Agriculture Department training programs. Enhancing farmer engagement through trust-building initiatives, fostering public-private collaborations and addressing small farmers' adaptability challenges are recommended.

This study provides valuable insights into Punjab's Agriculture Department training programs. Further research is recommended to investigate the impact of technology integration on training efficacy, explore public-private partnership models and analyze the role of field officers in farmer engagement.

Analysis of the result obtained through Ethnography: This ethnographic study aimed to observe and confirm the information provided by senior officers of Punjab's Agriculture Department, focusing on training programs and farmer engagement. Through participant observation, the study examined mosque announcements inviting farmers to training sessions, field officer-farmer interactions, training sessions conducted by field experts, and distribution of brochures.

The findings reveal that interested farmers connect with field officers, who coordinate training sessions. These sessions are supervised by field experts trained at Faisalabad University of Agriculture Sciences. Field experts play a crucial role in delivering training, announcing awareness programs, and promoting government content. However, they face significant challenges, including hectic schedules covering 50-85 villages.

Discussion on Phase 1: The data analysis revealed nine key factors. Most farmers have completed primary school education and possess basic Urdu. They use smartphones for basic internet activities, and 67.1% rely on the Agriculture Department However, farmers lack awareness about maximum yield potential. and pesticide knowledge. Furthermore, attendance at FFT programs is low, and farmers primarily acquire information from media sources and fellow farmers (Interview 2). They use the internet for less than six hours daily and face financial constraints.

These findings highlight the need for targeted training programs addressing yield awareness and pesticide knowledge. The importance of field officer-farmer relationships and potential for digital platforms to enhance training and information dissemination are also underscored. To address these challenges, enhancing

farmer engagement through trust-building initiatives, fostering public-private collaborations, addressing small farmers' adaptability challenges, and integrating modern technology training are recommended.

This study provides valuable insights into Punjab's Agriculture Department training programs, highlighting areas for improvement and potential solutions. Further research is recommended to explore these factors in greater depth.

Gaps identified: . **T**he above analysis and discussion has indicated that there are several gaps that need to be filled in order to increase quality of training which will lead to better yield. these gaps are :

- Unstructured educational training system.
- Lack of interest of farmers in attending training sessions.
- Unavailability of interactive training sessions.
- Shortage of time for farmers to attend training session.
- Cast differences make difficult to gather farmers at one place.
- No attendance of attendee are taken, thus trainer have no process to know previously farmer took training or not.
- Farmers who missed announcement are not be able to attend training from Punjab Government.
- Difficult for government trainers to go at distance villages.

By understanding the frequency of smartphone usage among farmers, we can design a tool that meets their unique needs and constraints, ultimately enhancing their productivity and decision-making capabilities.

Phase 2: Proposed Conceptual Framework: The proposed framework, illustrated in Figure [1], is built upon the EIA Framework 1.0 and incorporates a set of features that are essential for effective mobile learning tools. The framework is designed to address the unique needs of farmers in Pakistan, taking into account the country's diverse cultural and regional context.
The framework consists of three key layers:

1. *Ease*: The application should be simple, intuitive, and easy to use, requiring minimal time and effort from farmers. A complex interface can be overwhelming and may lead to disengagement. Therefore, the application should be designed with a user-friendly interface that is easy to navigate.

2. *Interactive*: Interactivity is crucial for the success of any digital solution, particularly in the agricultural domain where farmers have limited time to devote to learning. The application should be engaging, using a combination of multimedia elements such as images, videos, and audio to convey information in an interesting and interactive way.

3. *Adaptive*: The application should be adaptable to the diverse needs of farmers across different regions and cultures. This includes adjusting the language, content, and interface to accommodate regional differences and preferences. For example, in the Punjab region, the application should be available in Punjabi, while in southern Pakistan, Saraiki should be the primary language.

The proposed framework's application is designed using the EIA framework, which prioritizes ease of use, interactivity, and adaptability. By providing precise and relevant information to farmers in a timely and engaging manner, the application aims to support their learning needs and improve their agricultural practices.

Overall, the conceptual framework provides a solid foundation for the development of a mobile learning application that is tailored to the unique needs of farmers in Pakistan. By incorporating the principles of ease, interactivity, and adaptability, the application has the potential to make a positive impact on the agricultural sector and contribute to the country's sustainable development goals.

A. Phase 3: Development of ICT-based Tool*: Based on the proposed conceptual framework, the ICT-based tool is designed to support three types of roles: Support/Higher Management, Field Experts, and Farmers. The tool allows for the creation of multiple admins by the Super Admin, catering to the departmental needs.

Super Admin: The Super Admin has comprehensive control over the system, with the ability to:
- Login using a secure login module, with passwords stored in hash encrypted format
- Create, update, and delete admin records
- Add, update, and delete CNIC records of individuals, which will be used for farmer registrations
- Create and update content, including audio files, videos, and text
- Create categories and subcategories
- Generate notifications to registered farmers, which will be displayed on the application and sent via SMS to non-smartphone users
- Deactivate users, including admins and farmers.

Admin
Admins can:
- Login using the login module and request password resets via the forgot password feature
- Access a dashboard page displaying information on farmer registrations and other relevant data
- Create and update content based on higher management decisions
- Monitor farmer progress

- Generate notifications to registered users, sharing information on new announcements, schemes, subsidies, and other relevant updates
- Provide assistance to farmers' queries

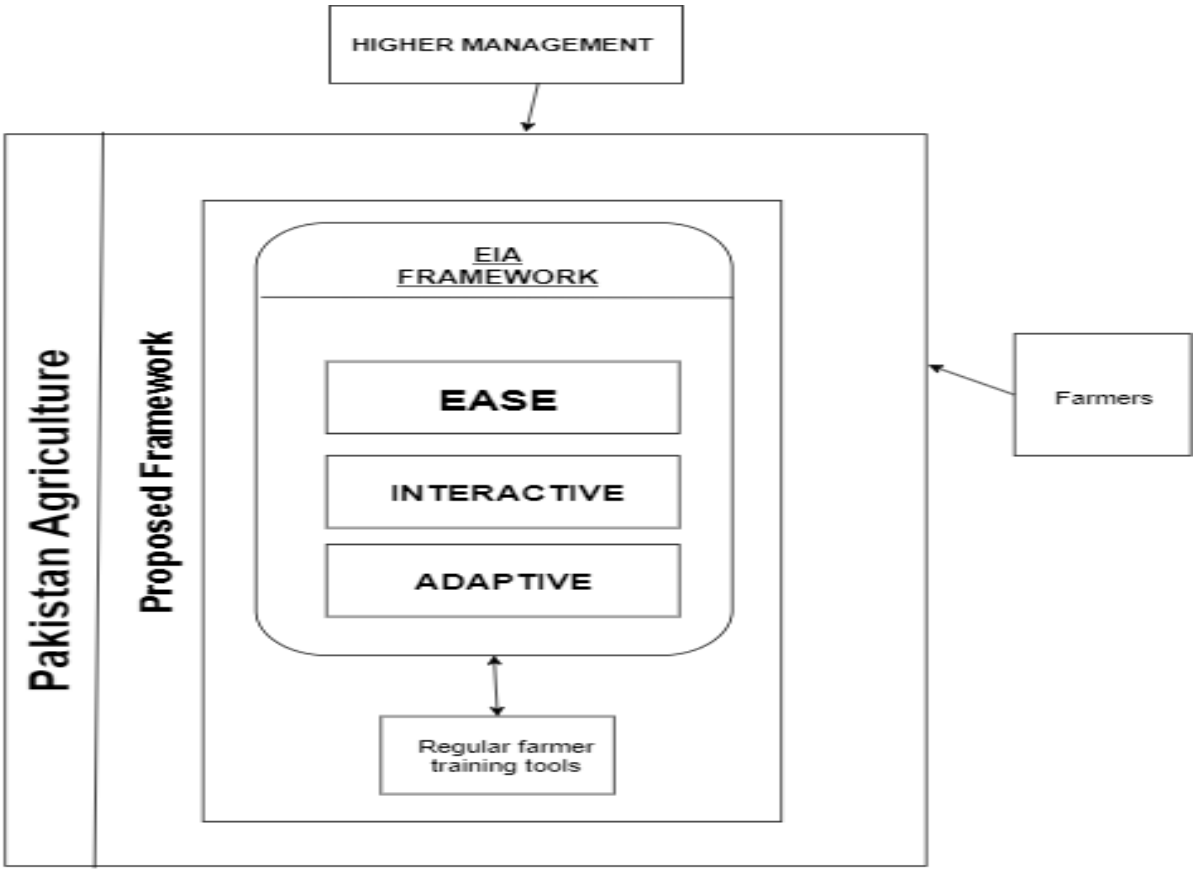

Figure 1. Proposed Conceptual Framework

Farmers

Farmers can:

- Login to the mobile application using their CNIC number
- Access categories and content, which are dynamic and can be updated by management
- Attempt a mandatory pre-quiz, which assesses their basic knowledge of farming
- Postpone the quiz, but will be prompted to attempt it again later
- View attempted quiz results, which will be saved to the database and accessible to admins and super admins
- Listen to audio content uploaded by admins and view content in various formats, including videos, text, and images

The application is designed to accommodate changes and updates, ensuring that farmers with limited time can interact with the tool efficiently. The generalized categories and subcategories enable users to respond quickly and easily.

B. Phase 4: Evaluation of Proposed Framework: To assess the effectiveness of our proposed framework, we conducted an experimental evaluation with two groups of 5 farmers each. The first group, the control group, did not use our application and took a pre-quiz with basic wheat-related questions. The second group, the experimental group, received our application on their mobile phones, which contained content related to wheat cultivation. After using the application, they took the same quiz as the control group.

The results showed a significant difference between the two groups. None of the farmers in the control group achieved a perfect score (100%) on the quiz, whereas 4 out of 5 farmers in the experimental group answered all questions correctly. This indicates that our application had a positive impact on the farmers' knowledge and understanding of wheat cultivation.

We evaluated our application based on the following criteria: ease of use, interactivity, adaptability, and content quality. The evaluation form is shown in Figure 5.3.

Ease of Use: Farmers found our application very easy to use, with no difficulties navigating through the pages and accessing the content.

Interactivity: The application was highly interactive, responding well to user actions and providing clear instructions.

Adaptability: We tested the application's adaptability by switching off the internet connection after it was downloaded. The farmers did not experience any issues with application instability, indicating that our application can sustain its context even without internet connectivity.

Content Quality: Farmers reviewed the content and found it to be reliable, accountable, and relevant to their needs. They reported learning a significant amount from the application and found it to be a useful tool for knowledge acquisition.

Overall, our application passed the end-user testing, demonstrating its effectiveness in improving farmers' knowledge and understanding of wheat cultivation. The positive feedback from farmers suggests that our application has the potential to be a valuable tool for agricultural extension services.

DISCUSSION

Our research has yielded promising results, demonstrating a positive shift in the learning process of farmers. The evaluation of our solution with real farmers has confirmed that they are eager to learn and can effectively adopt innovative technology solutions with minimal instructions, even in the absence of field experts This finding has significant implications for the FFT learning program, which has been struggling to deliver content to farmers in an efficient and effective manner (FFTP, 2019).

Through our research, we have identified several drawbacks of the traditional FFT program. The government of Pakistan incurs substantial expenses on field experts, vehicles, and staff salaries (GOP, 2020), yet the program faces challenges in monitoring the effective learning of farmers. The process of gathering farmers at a common location and distributing content is cumbersome and time-. Our solution addresses these issues by automating the content delivery process, thereby bridging the gap between farmers and the agriculture department.

Moreover, our research suggests that the role of expert farmers will undergo a significant transformation. Instead of being responsible for delivering content, they will assume a support role, focusing on providing assistance to end-users. This shift in responsibility will enable expert farmers to concentrate on high-touch, high-value tasks, such as mentoring and guiding farmers, rather than simply disseminating information.

Notably, our research is pioneering in the context of the FFT program, as there is a lack of existing literature on this topic (. Therefore, our qualitative and quantitative approaches have provided valuable insights into the challenges and opportunities associated with the program. By highlighting the drawbacks of the traditional FFT program and demonstrating the potential of our solution, we aim to inform future initiatives and contribute to the development of more effective and sustainable agricultural extension services should all be submitted individually in one of these formats along with the manuscript.

Some key takeaways from our discussion include:

- The importance of leveraging technology to enhance the learning process of farmers
- The need to redefine the role of expert farmers in the context of agricultural extension services
- The potential for automated content delivery systems to improve the efficiency and effectiveness of agricultural extension programs
- The value of qualitative and quantitative research approaches in identifying challenges and opportunities in agricultural extension services.

Conclusion: In conclusion, this research addresses the contemporary challenges faced by farmers and management teams in organizing content and performing daily duties. By proposing a novel framework tool grounded in the Technology Acceptance Model (TAM) approach, this study provides a practical solution to enhance the efficiency and effectiveness of farming operations. The TAM approach was deliberately chosen to inform the design of our framework, as it acknowledges the importance of user acceptance and adoption, particularly among less educated individuals. By leveraging the TAM framework, our solution aims to facilitate the adoption of technology among farmers, thereby bridging the gap between technological advancements and practical applications. The proposed framework tool has the potential to empower farmers and management teams to streamline their daily tasks, make informed decisions, and ultimately improve their overall productivity. This research contributes to the existing body of knowledge by offering a tailored solution that addresses the specific needs of farmers and management teams, paving the way for further research and development in this critical area.

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