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RESEARCH PAPER

Mobile Phones in Agriculture: Understanding the Role of Perceived Awareness in Shaping Farmers' Adoption Decisions in Punjab, Pakistan

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ABSTRACT

Moving beyond the traditional technology adoption framework, this research investigates the complex relation between farmers' existing awareness and internal factors such as mobile phone adoption in Pakistan's agricultural sector. The present study has drawn a total random sample of 416 farmers from the five different agro-ecological zones of the Punjab Province in Pakistan through survey for data collection on mobile phone awareness and adoption intentions. The results show that farmers are aware of the benefits of mobile phones, but still need to improve their use of specialized apps and services for important farming tasks. The findings complement traditional adoption models, showing that behavioral intentions are formed by a direct combination of attitudes, prior awareness, and internal factors. The findings of the study highlight the importance of targeted interventions by extension professionals and policy makers to equip farmers with the necessary skills to use mobile phones, digital inclusion and promote agricultural development.

KEYWORDS Adoption Decisions, Agricultural Development, ICT, Mobile Phones

Introduction

Leveraging mobile phones and ICT can open up many opportunities, such as better information sharing, better customer interactions, new virtual market channels, and increased support for medium-scale farmers, ultimately leading to a healthier and Leads to more resilient agro-ecosystems (Kumar Panda et al., 2020). With the rise of the mobile phone, many traditionally operated approaches set aside; it brings in a new generation of communication, information sharing, and digital interaction, which cannot be rivaled even by the existing, fixed method. This, in the final analysis, is quite dependent on how much the users are aware and conscious about the existence of this technology and their desire to use it and incorporate it into their daily life. According to Aparo et al. (2024) It typically observed that technologies bring consumers huge financial or performance advantages over available practice, thus being adopted and used quickly since they easily identify and capitalize on the gains.

The adoption of technology is governed by characteristics of the technology, more relevant benefits of the process of its adoption, greater efficiency, perceived value, and ease of ease in accomplishing tasks and level of accomplishment of objectives. Resource allocation and management-capacity, time, and budget-play a crucial role in making innovations adopted and accepted, thereby deciding the success and impact created by them (Zulfikhar et al., 2024).

Rizzo et al. (2023) pointed out that adoption of innovations depends on individual differences in knowledge, awareness, and willingness to change. The categories of adopters, ranging from innovators to laggards, describe different degrees of knowledge and acceptance that shape the speed of diffusion of innovations.

Before outlining the marketing strategy to promote the adoption of mobile phones in agriculture, it is necessary to establish how farmers perceive and are aware of technology (de Jesus Mendes et al., 2024). This would be used to inform the design of effective marketing initiatives that could highlight gaps in knowledge and prove the benefits of mobile phones in leveraging other ICTs for agricultural development. Kabirigi et al. (2023) pointed out that the in this context, the challenge is to identify what are the core features of mobile phone technology that it appeals to farmers because awareness is relatively different across the segments. This makes it a challenge to develop specific marketing strategies and communicate the value proposition of mobile phones in agriculture.

Hence, the main objective of the current study was to first look at the influence that the current awareness of mobile applications in agriculture on the part of the farmers has on acceptance, adoption, and use of this technology. Additionally, investigation into whether farmers with different awareness levels of innovative products and technologies have considerably different adoption rates as well as whether there is a relationship between awareness and adoption propensity.

The awareness and expectations of innovative farmers mean understanding the same, hence ensuring tailored strategies towards their needs for maximum adoption and usage of ICT innovations in agriculture. The task of stakeholders will then be to effectively engage and assist this strategic and major group targetted for adequate enhancement of agricultural productivity and innovation.

Literature Review

Understanding Farmer Awareness: Concepts and Measures

Traditionally, technology adoption decisions have been viewed as factors beyond an individual's control, influenced by external circumstances rather than personal choices or characteristics. Additionally, Fahad et al. (2023) enforsed that as studies show that internal factors, including personal characteristics and beliefs, are as influential as external factors, such as farm size, type, or operator characteristics, contradict traditional theories, in determining an individual's interest.

Because research indicates that internal factors, including awareness, attitude, and skills, complement external factors to influence technology adoption, these constructs are informative in understanding consumer decision-making processes and the adoption of new technologies (Po et al., 2022). These lead to important considerations for predicting their probabilities.

The concept of awareness, according to technology acceptance research, refers to users' understanding of the characteristics, benefits, and limitations of a given technology (Do et al., 2023; Mdoda et al., 2024; Mollick et al., 2023). However, Ahmad Rizal et al. (2021)suggests that the rational choice approach, on the other hand, combines sociological and rational perspectives that take into account general and specific contexts. According to this approach, persons' awareness and attitudes are relatively stable but context-dependent, with variation across different areas of

interest. This also implies that in any respect, people determine their use of an innovation based on whether the costs outweigh the benefits, and the associated behavior of individuals will always be influenced by situational factors and circumstances at a given time.

While many different metrics have been used to assess the awareness of adopters (Fisher et al., 2018; Gichuki & Mulu-Mutuku, 2018; Mandari et al., 2017), a report of great scale that encompasses the world's leading economies used a 10-item scale in order to assess different cognitive aspects. Ultimately, seven critical dimensions were found, and through factor analysis were presented, whereby considerable detail was provided with respect to the awareness of adopters. Therefore, there exist seven key dimensions: productivity, knowledge, organization, resource optimization, performance, user experience, and applicability. The seven dimensions offer a foundation for a better understanding of consumer awareness and the impact that it has on technology adoptio(Gao et al., 2011).

The first two dimensions are about more effective work outcomes-working output and know-how on related information-while the third is about financial gain through efficient resource use (Mdoda et al., 2024). To be specific, our findings suggest that better work is not much of a reason for taking up technology, whereas economic gains are stronger reasons. Using the findings from these key questions, we developed a contextual survey questionnaire to assess the degree of know-how among farmers, consisting of seven carefully crafted questions that summarize the essence of these dimensions .

The studies shown here reveal that innovative consumers have a specific view of technology; therefore, they wish to exploit it to rationalize and enhance their activities and workflows (Adesiji et al., 2024). It is therefore essential to be accurate in this kind of knowledge identification for marketers because it leads them to adopt targeted marketing strategies, suitable messages, and opportunities to influence the adoption and growth of technology (Eyike Mbongo & Djoumessi, 2024). However, Aparo et al. (2024) viewed it as this would imply that despite their efforts at standardizing what consumer awareness is all about, the lack of consensus on the concept among researchers has also fragmented our understanding of how the interconnectivity and shaping of consumer awareness takes place as a result of the features of technology.

There is much less clarity around the relationship between consumer awareness and behavioral intentions, given that the outcomes vary widely and often are opposing in many studies (Nguyen et al., 2024). Differences show the interaction between consumer awareness and behavioral intentions to be complex and require continued probing into unraveling and explaining mechanisms underpinning such dynamics as well as the drivers behind consumer behavior. Similarly McCampbell et al. (2023) pointed out that although sometimes important correlations are reported to exist in other consumer-related demographic variables like gender, age, education level, income, and mobility, there are instances where no significant associations were established, thus indicating a rather delicate and complex relationship. It points to something more than simple demographic associations.

Considering the fact that a substantial proportion of extant literature contains discrepancies and gaps, this research study examines the relationship of awareness with behavioral intentions on the part of Punjab's farmers of Pakistan. Considering this specific context, this study attempts to clarify the nature of this relationship, as well as

correlates that may lead to a much deeper understanding regarding what factors influence farmers' intent and behavior.

Leveraging mobile technology to support agricultural innovation and farmers

The agricultural sector is at the crossroads, facing hundreds of problems that may affect its sustainability and productivity (Kamal, 2023). The "yield performance," "soil health," "seasonal trends, crop growth, pest management, and field-level insight into farm operations" explosion of data on modern farms because of the digital revolution stand at a crossroads of real agronomic concerns for stakeholders of agricultural production. With this information, the future of sustainable agriculture is ensured, which will enhance the precision, productivity, and profitability of farming. And in much the same way, through mobile phones, hope is offered to transform farmers to be more innovative about efficiency, innovation, and environmental responsibility (Singh et al., 2024). This is no different as far as the promises of mobile phones bringing about change as they would to a better future for agriculture, confronting human needs less with environmental sustainability; large volumes of farm data need to be turned into useful, implementable insights to inform and improve farming decisions and create a data-driven farmer, now a real potential to lead to higher yields, low levels of waste, and more sustainable agricultural practices (Khan et al., 2019). ICTs change the face of agriculture by making precision farming possible, increasing efficiency, data-driven insight, automation, optimal allocation of resources, and promotion of environmental responsibility through data-informed decision-making. In this regard, integration of mobile phones in farming is both timely and essential to be at the forefront of agricultural innovation and sustainability (Shahzad et al., 2021).

Jayaraman et al. (2016) argued that mobile phones transformed agriculture in Southeast Asia, giving farmers access to news, education, and e-commerce. So it is with low adoption rates in farming that comes a call for focused efforts to bridge the digital divide and help equip farming communities to become better producers of their own welfare and productivity in agriculture.

This also includes a sharp growth in the adoption of mobile phones by farming producers. Interestingly, 67% of the respondents use the phone daily to mean that the way these agricultural producers engage digitally has deeply changed (Gichuki & Mulu-Mutuku, 2018). With the advent of mobiles widely in agriculture, history witnesses a turn where the farmers optimally utilize the access to important information that technology brings, thereby increasing efficiency while making the process environmentally friendly, paving the way toward a more sustainable, and food-secure future. Kabirigi et al. (2023) discussed that although mobile phone penetration among farmers has increased significantly, use is mainly for entertainment purposes, social media platforms are largely used for non-agricultural purposes, that are agricultural development and growth. Authors have provided prescriptive recommendations on how mobile phones may be used for productivity in agriculture and the streamlining of processes within agricultural development, providing a model framework through which farmers can use their mobile phones primarily for entertainment purposes. Usage as a powerful tool in agricultural development Mobile technology holds the secrets of the agricultural revolution, empowering farmers to seize unprecedented opportunities for growth, innovation, and competitiveness, thus unleashing an agricultural landscape of increased dynamism, resilience, and strength.

In a little over two decades, the cell phone has had an epochal transformation-from merely a basic communication device to a multifunctional device that has

transformed the very fabric of our society, changing how we interact with each other. How are, communicate and put the world's information at your fingertips. And the mobile phone, by becoming the most accepted and influential means of communication in human history, connects around billions of people around the world and provides for the rapid flow of information, ideas, and innovations that shape our world. The convergence of mobile phones with social media, fueled by Web 2.0, has produced a revolutionary force in the modern communication stage, speeding up information transference, creating relationships globally, and increasing engagement, collaboration, and social interaction. Example levels are facilitated. The ubiquity of mobile phones and social media has changed the face of modern life. The way we communicate, access information, and share perspectives completely altered the course and human communication, information exchange, and has for ever changed the landscape of social interaction (Mani & Nandan, 2020).

Theoretical Framework

A number of theoretical models have been developed since the 1980s to research consumer perception and adoption intention toward new technologies. The three most notable of which are: Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT) and Unified Theory of Acceptance and Use of Technology (Gao et al., 2011). TAM: This technology acceptance model is based on a Theory of Reasoned Action by Davis. As per his theory, the two major factors that determine usage are Perceived Usefulness PU: These are measurements of expected benefits or value associated with adopting this technology. Through ease of use, EI: an evaluation of how much of a breeze it is for the user to learn and operate with. Hence, PU and PE have a high influence on the intention of consumers to assume attitudes toward consumer technology (Sahin & Rogers, 2006).

The theory of innovation diffusion by Roger (1962) describes five specific characteristics of an innovation which stimulate consumer acceptance: relative advantage, compatibility, complexity, trialability and observability. By researching these traits, researchers can understand the facilitators of adoption, predict the diffusion rate of new products and create strategies for successful innovation diffusion. Venkatesh research UTAUT, (2003) focuses on modeling user acceptance of information technologies by persons or users for adopting new software system into use with the postulated constructs including behavior intention, usage behavior and performance expectations. According to Venkatesh et al (2003) four direct determinants of technology adoption can be established: performance expectancy, effort expectancy, social influence and facilitating conditions forming the UTAUT model for explaining information behavior (Engotoit et al., 2016).

This study analyses the awareness-adoption intention relationship of mobile phone-based solutions for farmers. It seeks to gauge if awareness helps intervene to what extent in farmers' adoption behavior. Awareness pertains to the perception by farmers of benefit accruals from applying the technology in agriculture, while usage intentions refer to the likelihood of adoption and application of the technology in agricultural practice. This study intends to find out how prior awareness about technology adoption determines acceptance and use and, hence, reveals the key drivers of adoption. Kabbiri et al. (2018) pointed out that real growth in agriculture demands adoption of new technology. Adoption of rapid innovation tends to require ongoing awareness and education in its wake. An assessment of the awareness level of mobile phone users is an essential step toward adoption and integration of technology in agriculture.

The three constructs identified by technology acceptance models TAM, UTAUT, IDT are perceived usefulness, performance expectation, and relative advantage. These three constructs indicate the awareness of the adopters. These constructs affect the attitudes of adopters, and it may be applied subsequently in the evaluation of their BI to use any technology. Perceived usefulness (PU) is the degree to which any technology is perceived as a valuable tool for workplace productivity. On the other hand, it is defined as performance expectancy (PE) - the expected effect of technology that is going to enhance job performance and outcome. Any kind of technology that serves better benefit than existing solutions can be termed as relative advantage or RA.

The study have following hypotheses for testing:

H1: Awareness does not influence mobile phone usage behavior of farmers.

H2: Awareness positively predicts farmers' intention to use mobile phones.

Material and Methods

The study has aimed at investigating the relationship between farmers' awareness of the mobile phone and its adoption to agriculture; this is also seeing whether changes in farmers' awareness affect their adoption behavior.

This research study was based on 416 random samples drawn from five distinctive agroecological zones of Punjab, the most populous province of Pakistan. The data was collected using a survey research design and non-standardized questionnaire. The empirical study was meant to investigate farmers' behavioural intentions to adopt mobile phones in different agro-ecological regions of Punjab and augment the existing literature in agricultural research.

Data analysis used SPSS, where descriptive statistics were used for the description of data; Pearson's correlation coefficient for correlation analysis; and simple linear regression was used for model relationships. The results are numerically provided in the tables below for clarity on the survey results.

Results and Discussion

Table 1 shows the consensus results of farmers awareness relating to mobile phone characteristics.

Table 1
Farmer Awareness

No	Question	Response Categories	Count	Percent %
1	**Productivity** Productivity of your daily work would increase by using mobile phones	Strongly Disagree	13	3.1
		Disagree	14	3.4
		Neutral	53	12.7
		Agree	189	45.4
		Strongly Agree	118	28.4
		No Response	29	7.0
2	**Knowledge** Mobile phones could allow you to access relevant agricultural knowledge	Strongly Disagree	17	4.1
		Disagree	22	5.3
		Neutral	48	11.5
		Agree	166	39.9
		Strongly Agree	131	31.5
		No Response	32	7.7
3	**Organization**	Strongly Disagree	12	2.9

	That is something that, with mobile phones, will make it very easy to monitor what one has done in the farm	Disagree	14	3.4
		Neutral	62	14.9
		Agree	164	39.4
		Strongly Agree	133	32.0
		No Response	31	7.5
4	**Resource Optimization** The cell phones would help you to schedule your time and to use them cost-effectively	Strongly Disagree	19	4.6
		Disagree	20	4.8
		Neutral	68	16.3
		Agree	148	35.6
		Strongly Agree	129	31.0
		No Response	32	7.7
5	**Performance** The use of the mobile phone brings you a sense of achievement	Strongly Disagree	14	3.4
		Disagree	17	4.1
		Neutral	59	14.2
		Agree	160	38.5
		Strongly Agree	129	31.0
		No Response	37	8.9
6	**User Experience** It is prudent to use a cell phone	Strongly Disagree	11	2.6
		Disagree	24	5.8
		Neutral	45	10.8
		Agree	163	39.2
		Strongly Agree	142	34.1
		No Response	31	7.5
7	**Applicability** Farmers may find usefulness of mobile phones in daily farming activities	Strongly Disagree	44	10.6
		Disagree	50	12.0
		Neutral	89	21.4
		Agree	98	23.6
		Strongly Agree	65	15.6
		No Response	70	16.8

According to Table 1, there is a high degree of consensus among farmers over the relevance of mobile phones to agriculture; this shows a collective awareness of their potential. While there are slight variations, data indicates that farmers are more aware when the data is evaluated in terms of productivity compared to their view about applicability. This difference suggests a subjective bias where people give more emphasis on satisfaction rather than practical considerations while evaluating the adoption of technology.

Subsequently, farmers' responses were analyzed by calculating arithmetic means for each of the seven questions. Such an approach has allowed the classification of farmers' awareness levels about the selected attributes. Applicability emerged as a highly ranked attribute, with a mean value of 3.88. User experience followed at a close second, with a mean value of 3.72, suggesting that farmers very well recognize it can be a good experience if they use mobile phones to meet their needs. It was followed by performance, with a mean of 3.66 and knowledge with a mean of 3.63, showing farmers appreciate the usefulness of the mobile phone in supporting agricultural activities. Productivity and organization had ratings relatively lower, with means at 3.72 and 3.66, respectively, while resource optimization received a rating of 3.61, thus indicating areas in which farmers could do better in terms of the mobile phone's use to allocate resources. More guidance is required. The findings reflect that farmers emphasize more subjective experiences than practical applications and therefore have to be specifically supported and educated.

Table 2
Behavioral Intentions for Mobile Phone Use

No	Question	Response Categories	Count	Percent %
1	**Current**	Strongly Disagree	4	1.0

	Supposing you have access to the mobile phone, you be going to use it.	Disagree	10	2.4
		Neutral	46	11.1
		Agree	145	34.9
		Strongly Agree	170	40.9
		No Response	41	9.9
2	**Upcoming** Assumed that you have access to the mobile phone, you foresee that you would use it.	Strongly Disagree	6	1.4
		Disagree	16	3.8
		Neutral	47	11.3
		Agree	135	32.5
		Strongly Agree	180	43.3
		No Response	32	7.7

Table 2 represents farmers' behavioural intention about the adoption of mobile phones for agricultural activities. Two statements were posed to the respondents-first, their intended use of mobile phones if the access to it was available and, second, their predicted use if the access to a mobile phone was provided. The results indicate that there is a fairly good willingness among farmers to use mobile phones as nearly 80 per cent of the sample reported their intention to use it. This result indicates the very important role that rural access to mobile phones can play in agricultural development and diversification, but also in promoting promising potential for farmers' ICT adoption.

Table 3
Pearson's Correlation Coefficient

No	Knowledge	Coefficients
1	Productivity	.432**
2	knowledge	.411**
3	Organization	.535**
4	Resource Optimization	.351**
5	Performance	.324**
6	User Experience	.497**
7	Applicability	.295**

Table 3 presents the Pearson's correlation, showing a positive relation between all the characteristics of mobile phones and their behavioral intentions. The results, therefore, confirm the first hypothesis: there is a significant and positive relationship between the farmers' awareness of the features of mobile phones and their behavioral intentions. This acts as an assurance that farmers are aware of the potentials of the mobile phones and consider its feature helpful for farming efficiency improvement. Results especially show that farmers perceive the mobile phone as offering a relative advantage, leading to increased intentions to adopt and use.

The second hypothesis tests farmers' awareness of the influence of mobile phones on their intention to adopt and attitudinal changes on the likelihood of adoption. This study was, therefore, designed to identify the major characteristics of mobile phones that have a high influence on its adoption to guide policymakers on what specific characteristic should be emphasized in their promotional activities so as to influence adoption effectively.

This will contribute to the ability of policymakers in designing appropriate programs that encourage the adoption of mobile phones among farmers by identifying the most important features. As described here, the subsequent table summarizes the findings of the simple linear regression analysis, underlining the major factors driving this significant relationship.

Table 4
Simple Linear Regression

Model	Unstandardized Coefficients		t	Sig
	B	Std. Error		
(Constant)	1.228	.195	6.293	.000

Productivity	.107	.050	2.148	.001**
Knowledge	1.516	.196	7.734	.013**
Organization	.310	.052	5.997	.000*
Resource Optimization	1.081	.263	4.110	.011**
Performance	.050	.021	2.380	.006**
User Experience	.254	.049	5.222	.000*
Applicability	.067	.011	6.090	.001**

Dependent: Behavioral Intentions (Adoption) R=.612 F(7, 408) =34.964, P=.000**

The regression analysis resulted in a robust model, which explained 61.2% of the variance in farmers' behavioral intention to use mobile phones [$F(7, 408) = 34.964$, $p < 0.001$]. It identifies organizational support, user experience, productivity, and applicability as critical attributes that determine farmers' intentions. More precisely, with every one-unit increase in each of these variables, farmers' intention to adopt mobile phones in farming increases significantly. Conversely, knowledge, resource optimization, and performance are not strong factors. Findings indicate something very important: there is an awareness gap in that farmers are able to recognize the potential benefits of mobile phones but unable to develop the required skills for their use toward better efficiency and streamlining of operations that would result in cost reduction. That is why specific training and capacity-building programs should be implemented.

Conclusions

This study develops an understanding of the adoption of mobile phones by farmers for agricultural purposes and intends to provide valuable insights about the effectiveness of technology adoption models. The key variables of interest in this study are drawn from some widely acknowledged frameworks: UTAUT, IDT, and TAM. These include performance expectancy, relative advantage, and perceived usefulness. The key objective of the paper is to determine whether farmers' awareness of cell phone technology affects the intensity at which it is adopted for agricultural purposes. This study will also explore the interaction between internal factors, prior technology awareness of users, and their behavioral intention to adopt the technology. While most prior studies focused on external factors that influence technology acceptance and use, this study will look into the role of internal factors in this context and argue that internal factors, too, form the basis for adoption decisions. This research considered farmers' awareness of the different attributes of mobile phones on productivity, knowledge, organization, optimization of resources, performance, user experience, and applicability to gauge such awareness on adoption intentions. The integration of mobile phones into agriculture through technologies allows for farmers to share information, transact business with third-party companies, and be exposed to more customers in order to enhance agriculture practices and livelihoods. The use of mobile phones has been increasing for the past years in rural Pakistan; however, data indicates that the phenomenally low rates of adoption raise the interest in this study. The importance of mobile phones in agriculture cannot be divorced, and this means mobile phones are indispensable and crucial for agricultural development. The results obtained also revealed that factors influencing adaptability are relatively strong in some cases and negligible in others. Results from this study show that prior knowledge of the potential adopter should be taken into consideration in the dissemination of any new technology. Extension agents are thus challenged from two fronts: having themselves to adapt to a relatively new technology and having their clients equipped with it. In discharging this responsibility, extension personnel have to be properly suited to demonstrate the advantages of mobile phone technology for farmers to take advantage of in realizing its

full benefits. Prior knowledge in the current study brings to light that other variables, which become very important in adoption models. Specifically, the results of regression reveal that those attributes, which require skill to use the technology for optimization of resources or maintenance of administrative works with the use of mobile phones, are not significant on behavioral intention to adopt. The results of this study have also disagreed with conventional wisdom on the basis that pre-existing attitudes, which in most adoption models, have been a key emphasis in driving technology adoption. Results from the present study show that prior awareness may affect the intention to use directly. Further analyses revealed that, though farmers were aware of the advantage of the mobile phone in agriculture, such as saving time and cost, easy access to relevant information, and timely solution of problems, they did not possess the necessary skills to make use of these advantages. These findings have two implications: on the one hand, there is no need for a full implementation of more complex models concerning technology adoption; on the other hand, it means that mostly adopters are aware of the usefulness of technology itself but often they need to be guided on its practical use.

Recommendations

The major constraint to adoption is a skills gap, hence a specific need for extension programs to educate farmers on the use of technology. It is recommended that policymakers develop projects to capture the practical benefits of this technology. The paper contributes significantly to the extant literature by pointing to the limitation of theoretical frameworks in contexts where there are regional differences in social structure. Further research should be done to build upon the ideas presented here, incorporating additional social variables to further explain the nature of the adoption dynamics: social status, norms, values, and land ownership.

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