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RESEARCH PAPER

Exploring the Effects of Knowledge about the Internet on Adoption Intentions of Farmers in Punjab, Pakistan: A Behavioral Analysis

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ABSTRACT

This study goes beyond traditional technology adoption models to explore how farmers' existing knowledge and internal factors influence agricultural technology adoption among Pakistani farmers by focusing on Internet use. In this study, 416 farmers were randomly selected from five agricultural zones of Punjab province of Pakistan and information about their knowledge and practices was collected. Descriptive and regression analysis revealed that farmers have a good grasp of Internet features, but struggle with advanced skills such as cost reduction, online transactions, and prospecting for new customers. The results of the study show that attitudes alone do not drive behavioral intentions, but rather prior knowledge and internal factors do. Practically, this highlights the need for extension professionals and policy makers to address the Internet skills gap among farmers. Future research should consider additional social factors such as social status and land distribution to better understand Internet adoption behavior.

Keywords: Behavioral Intentions, Internet Adoption, Prior Knowledge, Technology Transfer

Introduction

Improving information delivery, improving customer engagement and promotion, creating new innovative virtual markets, empowering medium-scale farmers, and implementing health in agriculture are some of the benefits that can be achieved by promoting the use of internet and other ICT (Cole & Fernando, 2021). Therefore, the Internet cannot be associated with the traditional methods because generally the use of the internet introduces a new method apart from the traditional methods. Consequently their adoption depends on how consumers keep knowledge about this technology and its adoption. According to Eastwood et al., (2019) it has generally been observed that if a technology can provide greater financial or performance benefits than existing practices or techniques, the faster their adoption and implementation will occur.

A number of factors such as the characteristics of the technology or the characteristics of the innovation, the relative advantage of its use, the improvement in performance resulting from its use, the perceived usefulness of its use, the ability to achieve the relevant tasks, the achievement of the relevant objective can foster the adoption of any technology. Proper utilization of capacity, time and money helps in the adoption of any innovation. These factors contribute to the adoption and acceptance of any innovations (Gollakota et al., 2020)

Sahin & Rogers, (2006) states that people differ from each other regarding their knowledge to accept innovation. Adopters of any technology are divided into innovators, early adopters, early majority, late majority and laggards based on the knowledge of the innovation.

In order to introduce a basic innovation like the Internet into agriculture, which enables farmers to use a variety of other ICTs, a proper marketing strategy is needed, but before that, identifying their knowledge about it is inevitable. Aldosari et al. (2019) pointed out the main problem in this regard is that it is a difficult process to identify some important characteristics for this medium of technology because the knowledge of such technology vary in their adoption among different groups.

Therefore, the objective of this paper was, first, to determine whether farmers' pre-existing knowledge about the use of the Internet in agriculture would influence its acceptance and use. And it is also important to know whether there is any difference in the propensity of farmers who exhibit different levels of knowledge to adopt innovative products and technologies.

Answers to these questions will help identify awareness of innovative farmers. So the expectations of especially those who are innovative farmers can be identified. This finding will allow stakeholders involved in the implementation of ICT innovations in agriculture to effectively target and cater to this key segment.

Literature Review

Farmer Knowledge and its Measurement

Traditionally, technology adoption decisions were viewed as external circumstances of the individual. Additionally, Meijer et al. (2015) refuted this view, suggesting that external factors, such as farmer and farm characteristics, do not play a more significant role in shaping adopters' interest in specific technologies than individual internal attributes.

Considering that research shows that external factors are not the only factors affecting the decision making process of adopters but internal factors also play an important role. Therefore, other key constructs such as knowledge, attitude and skills become equally important in consumers' technology adoption decisions (Meijer et al., 2015).

Technology acceptance studies view knowledge as the user's understanding of the technology and its attributes (Mazur, 2015; Rani et al., 2014; Šūmane et al., 2018). The rational choice approach combines the social and rational approaches, the general and the specific approach. It posits that adopter knowledge is relatively constant and internal, yet context dependent and varies across areas of interest. According to this approach, individuals may perform cost-benefit analysis to adopt an innovation within specific domains. Moreover, their attitudes depend on situational factors and the perceived need for change at a given time (Bruch & Feinberg, 2017).

Researchers have established various measures to assess adoptive knowledge (Gao et al., 2011). A comprehensive study conducted in the world's major economies used a 10-item scale that captured several cognitive constructs. Through factor analysis, the study emphasized seven key dimensions: efficiency, information, management, time and cost, effectiveness, satisfaction and relevance. These dimensions provide valuable insight into consumer knowledge and its impact on technology adoption (Ćirić et al., 2018).

The first two dimensions, efficiency and search for relevant information, reflect work improvements, while cost and time reflect financial benefits. In particular, the analysis revealed that items reflecting work improvements are not more important for technology adoption, while items with financial benefits are more important for technology adoption (Hall & Khan, 2003). Based on these findings, we developed a questionnaire to assess farmers' knowledge, consisting of seven carefully designed questions.

Researchers have long recognized that innovative users exhibit unique knowledge of technology in terms of their ability to manage their daily tasks (Lee & Heo, 2020). Accurately identifying this type of adopter knowledge about technology is critical for marketers to make informed targeting decisions (Kabbiri et al., 2018). However, Sahin & Rogers, (2006) argued that diverse conceptualizations of consumer knowledge among researchers have hindered the development of a coherent understanding of how technology properties interconnect consumer knowledge.

Several studies have investigated the relationship between consumer knowledge and behavioral intentions, with mixed results (Abdel, 2015; Lee & Heo, 2020). While some research has established significant correlations between consumer knowledge and variables such as gender, age, education, income and mobility. Others have found no significant association between consumer knowledge and these demographic factors, suggesting a more complex and important relationship.

Given the conflicting findings in the scientific literature, it is important to investigate the relationship between knowledge and behavioral intentions among farmers in Punjab, Pakistan. The purpose of this study is to clarify whether there are significant correlations between these two constructs in this particular context.

The Role of Internet for Agricultural Development and Local Farmers

The agricultural sector faces multiple challenges, from climate change and sustainable resource management to food security, water scarcity, land limitations, and changing consumer needs. To address these issues, ICTs offer a transformative solution, enabling efficient and innovative farming practices that will define the future of agriculture. Gorli & G, (2018) highlighted that modern farms are embracing modern technology, generating a wide range of data, including field information, yield mapping, soil moisture and nutrient levels, weather patterns, leaf area index, pest activity, and includes farm management data. To unlock its full potential, this data must be transformed into actionable insights, supporting informed farming practices. Šūmane et al., (2018) argued that Information and Communication Technologies (ICTs) are now shaping the future of farming, precision agriculture. . Enablement, data analytics, automation, resource optimization, and better decision making are critical. By harnessing the power of ICT, farmers can benefit from data-driven insights, productivity, efficiency and sustainability in agricultural practices.

Ćirić et al. (2018) pointed out that research conducted in Pakistan, India and Sri Lanka has shown that the Internet provides a wealth of information and educational resources for agricultural producers. While e-trade is gaining traction in agriculture, facilitating essential activities like online trading and market updates, the adoption rate among farmers is surprisingly low, bridging the digital gap in agriculture.

The study conducted by Jayaraman et al., (2016) showed a significant increase in Internet adoption among agricultural producers, with 61.25 percent of respondents using the Internet daily. This result is remarkable, as it approaches the levels seen in European countries, although still behind the United States. Despite this significant increase, the primary purpose of Internet use among farmers is recreational rather than business or professional development. Especially the use of social media is mainly for entertainment and not for agricultural development. To address this gap, the authors offer recommendations aimed at shifting the focus of Internet use toward increasing agricultural productivity and efficiency. By leveraging the potential of the Internet, farmers can open up new opportunities for growth, innovation and competitiveness.

Internet has experienced phenomenal growth over the past few decades, becoming an integral part of daily life for individuals in both developed and developing countries. Today, it forms the largest global communications network, enabling the rapid sharing of

information, including files, images and videos. Beyond its reach, internet offers a platform to foster meaningful relationships. It can be defined as a web-based platform (Web 2.0) that integrates modern Internet technology with user interaction, facilitating connection and engagement. The impact of social media is multifaceted, for example it is a tool for mass communication, for building relationships, information exchange center, and a catalyst for global connectivity. Its evolution has revolutionized the way people interact, access information, and share ideas, making it an indispensable aspect of modern life (Mani & Nandan, 2020).

Theoretical Framework

A number of models have been developed to test user perceptions and adoption intentions of any technology. In these models, the Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT), and Unified Theory of Acceptance and Use of Technology (UTAUT) are notable. In TAM, which is an extension of the Theory of Reasoned Action and developed by Davis in (1989) includes two constructs, Perceived Usefulness (PU) and Perceived Ease of Use (PE), which together describe the user's attitude towards any technology and based on this attitude, the user will form behavioral intentions to adopt (Kabbiri et al., 2018). The second is innovation diffusion theory proposed by Roger in 1962. In this theory, Roger described five innovation characteristics: relative advantage, compatibility, complexity, trial ability and observability. These characteristics help explain user adoption and decision-making. This theory predicts the likelihood and rate of adoption of any innovation among different adopter groups (Ibrahim et al., 2018). The third most influential is the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh in 2003. This theory explains the intention and subsequent usage behavior to use any information system. According to this theory, four key constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions are direct determinants of technology usage intention and behavior (Gao et al., 2011).

In the present study, knowledge is taken as the predictor variable and behavioral intentions to use as the criterion variable. Knowledge in the present study refers to the understanding of the phenomenon. That is, what is the adopter's understanding of any given technology's beneficial properties in the workplace. While behavioral intention to use refers to the farmer's likelihood to engage the internet in farming. Many studies on technology adoption have focused on prior consumer knowledge in terms of technology characteristics, and potential consumer responses (Engotoit et al., 2016; Kuehne et al., 2017; Onaolapo & Oyewole, 2018). In agriculture, adoption of new technologies is critical to growth. However, technological innovations emerge rapidly, which requires constant awareness. Despite constant innovation in product design, marketing, supply chain, and service delivery, many new technologies fail early (Mani & Nandan, 2020). However, as an Internet users, analysis of their prior knowledge of Internet technology is essential.

Technology acceptance models (TAM, UTAUT, and IDT) identify three primary constructs of the adopter's preconceived knowledge of the technology: perceived usefulness (PU) the degree to which an innovation is perceived as useful in the workplace, performance expectancy (PE) the degree to which an innovation increases job performance, and Relative advantage (RA) the degree to which an innovation offers advantages over existing practices or technologies, which influences behavioral intentions (BI) the likelihood that user will engage in any technology use.

Therefore, the main objective of this study is to explore the relationship between farmers' knowledge of the Internet and its adoption for agriculture, and to determine whether changes in farmers' knowledge affect their adoption behavior.

The articulated hypothesis which we tested are:

H1: There is a significant positive correlation between the knowledge of farmer and behavioral intention to use internet

H2: There is no significant statistical variation in behavioral intention of farmer when there is an increase in knowledge of farmer.

Materail and Methods

The study intended to explore the relationship between farmers' knowledge of the Internet and its adoption for agriculture, and to determine whether changes in farmers' knowledge affect their adoption behavior.

A doctoral research study was conducted among farmers in Punjab, the most populous province of Pakistan, involving a random sample of 416 respondents from five distinct agro-ecological zones. Using a survey research design, a non-standardized questionnaire was used to collect data. The objective of this empirical study was to examine the behavioral intentions of farmers to adopt internet in diverse agro-ecological regions of Punjab, contributing to the existing body of knowledge in agricultural research.

Data were analyzed using SPSS software, using descriptive statistics, Pearson's correlation coefficient for correlation analysis, and simple linear regression for model relationships. The results are presented numerically in tables, which provide a clear overview of the survey results.

Results and Discussion

The results of farmer prior knowledge regarding the attributes of internet were summarized and shown in Table 1.

Table 1
Farmer Knowledge

No	Question	Response Categories	Count	Percent %
1	**Efficiency** Using the internet would increase the efficiency of your daily work.	Strongly Disagree	29	7.0
		Disagree	27	6.5
		Neutral	78	18.8
		Agree	105	25.2
		Strongly Agree	135	32.5
		No Response	42	10.1
2	**Information** The internet would allow you to find relevant agricultural information.	Strongly Disagree	24	5.8
		Disagree	26	6.3
		Neutral	58	13.9
		Agree	129	31.0
		Strongly Agree	124	29.8
		No Response	55	13.2
3	**Management** The internet would make it easier to keep track of your farming tasks.	Strongly Disagree	23	5.5
		Disagree	39	9.4
		Neutral	69	16.6
		Agree	108	26.0
		Strongly Agree	134	32.2
		No Response	43	10.3
4	**Time & Cost** The internet would allow you to better schedule your time and cost.	Strongly Disagree	33	7.9
		Disagree	32	7.7
		Neutral	63	15.1

		Agree	131	31.5
		Strongly Agree	117	28.1
		No Response	40	9.6
5	**Effectiveness** You find it rewarding to use the internet.	Strongly Disagree	25	6.0
		Disagree	37	8.9
		Neutral	55	13.2
		Agree	109	26.2
		Strongly Agree	137	32.9
		No Response	53	12.7
6	**Satisfaction** Using the internet is a good idea.	Strongly Disagree	22	5.3
		Disagree	19	4.6
		Neutral	58	13.9
		Agree	114	27.4
		Strongly Agree	161	38.7
		No Response	42	10.1
7	**Compatibility** The internet would be useful for you as a farmer.	Strongly Disagree	19	4.6
		Disagree	31	7.5
		Neutral	59	14.2
		Agree	107	25.7
		Strongly Agree	154	37.0
		No Response	46	11.1

Analysis of Table 1 shows a high level of agreement among farmers regarding their perceptions of Internet features, indicating a collective understanding of Internet adoption in agriculture. Although slight variations exist, the data show that farmers demonstrate higher levels of knowledge when evaluating their satisfaction with Internet use, compared to their ability to improve time and cost management. This disparity indicates a subjective bias, in which individuals prioritize satisfaction over practical considerations when evaluating technology adoption.

Farmers' responses were analyzed by calculating the arithmetic means for each of the seven questions, which enabled a classification of farmers' knowledge levels. Satisfaction emerged as a highly ranked attribute with a mean value of 4.00, indicating a strong positive perception among farmers about their Internet usage experience. Relevance followed closely behind, with a mean value of 3.94, suggesting that farmers recognize the adaptability of the Internet to their needs. Relevance (mean: 3.84) and effectiveness (mean: 3.82) were also rated highly, indicating that farmers recognize the usefulness of the Internet in supporting their agricultural activities. Conversely, administration and efficiency (mean: 3.78) and time and cost (mean: 3.71) were rated low, indicating areas where farmers could improve the use of the Internet for resource allocation. Further guidance is required. These results suggest that farmers prefer subjective experiences over practical applications, highlighting the need for targeted support and education.

Table 2
Farmer Behavioral Intentions

No	Question	Response Categories	Count	Percent %
1	**Present** Assuming you have access to the internet, you intend to use it.	Strongly Disagree	12	2.9
		Disagree	27	6.5
		Neutral	63	15.1
		Agree	107	25.7
		Strongly Agree	184	44.2
		No Response	23	5.5

2	**Future** Given that you have access to the ICT, you predict that you would use it.	Strongly Disagree	14	3.4
		Disagree	36	8.7
		Neutral	52	12.5
		Agree	106	25.5
		Strongly Agree	183	44.0
		No Response	25	6.0

Table 2 presents the behavioral intentions of farmers regarding adoption of Internet for agricultural activities. Respondents were presented with two scenarios: first, their intended Internet use if access was available, and second, their predicted use if Internet access was provided. The results indicate that there is a strong willingness among farmers to use the Internet as nearly 70 percent expressed their intention to use it. This overwhelming response underscores the importance of rural Internet access for agricultural development and diversification and also indicates a promising potential for promoting ICT adoption among farmers.

Table 3
Pearson's Correlation Coefficient

No	Knowledge	Coefficients
1	Efficiency	.390**
2	Information	.377**
3	Management	.442**
4	Time & Cost	.388**
5	Effectiveness	.398**
6	Satisfaction	.486**
7	Compatibility	.449**

Table 3 presents the results of Pearson's correlation, which shows that there is a positive relationship between all Internet characteristics and behavioral intentions. These results confirm the first hypothesis that there is a significant positive relationship between farmers' knowledge of Internet features and their behavioral intentions. This confirms that farmers recognize the potential of the Internet and consider its features beneficial for increasing farming efficiency. In particular, the results suggest that farmers perceive the Internet as offering a relative advantage, leading to increased intentions to adopt and use it.

The second hypothesis explores the strength and direction of the relationship between farmers' knowledge and intention to adopt behaviors and tries to understand how changes in farmers' attitudes can affect their likelihood of adopting the Internet. . The purpose of this research is to identify the attributes of the Internet that significantly influence adoption decisions, which can inform policy makers on which attributes to emphasize in their promotional strategies.

By identifying the most valuable features, this analysis will inform policy makers on how to effectively encourage Internet adoption among farmers. The results of the simple linear regression analysis, presented in the following table, will shed light on this significant correlation.

Table 4
Simple Linear Regression

Model	Unstandardized Coefficients		t	Sig
	B	Std. Error		
(Constant)	1.848	.212	8.709	.000
Efficiency	.916	.420	2.181	.013*
Information	1.076	.562	1.915	.007**
Management	.111	.041	2.707	.019*
Time & Cost	.086	.042	2.048	.011*
Effectiveness	.378	.190	1.989	.016*

Satisfaction	1.012	.532	1.902	.000**
Compatibility	1.747	.911	1.918	.001**

Dependent: Behavioral Intentions (Adoption) R=541 (7, 288 F) =17.042, P=.000**

Regression analysis reveals a strong model, explaining 54.1% of the variance in behavioral intention ($F(7, 288) = 17.042$, $p < 0.001$), while regression coefficients indicating that information, satisfaction, and compatibility is one of the most important attributes of the Internet affecting farmers intentions. A one-unit increase in these attributes leads to a significant increase in farmers' agreement to use the Internet in farming. In contrast, efficiency, management, time and cost, and effectiveness have minimal impact. Farmers recognize the potential benefits of the Internet but lack the skills to take advantage of it, highlighting the knowledge gap in using digital technologies to increase efficiency, streamline operations, and reduce costs. Emphasizing the need for training and capacity building initiatives.

Conclusions

The main objective of this study is to predict the adoption of Internet by farmers for agricultural purposes to shed light on the usefulness of technology adoption models. Based on models of technology adoption, variables such as performance expectancy from Unified Theory of Acceptance and Use of Technology (UTAUT), relative advantage from Innovation Diffusion Theory (IDT), and perceived usefulness from Technology Acceptance Model (TAM) have been operationalized and examined to determine whether farmers' knowledge of technology influences its workplace adoption or not. In addition, the other main objective of the study is to understand the interrelationship between internal factors such as user's pre-existing knowledge of any technology and behavioral intentions to adopt that technology. Because most studies have examined the role of external factors in technology acceptance and use. Therefore, the objective of this study is to examine the argument that internal factors also play an important role in this context. Farmer's knowledge about some characteristics of internet such as efficiency, information, management, time & cost, effectiveness, satisfaction, and compatibility were included in order to examine the effect of all these on the behavioral intentions of adoption. The use of the Internet in agriculture is technologically very important because it allows farmers to exchange information, transact business, and search for diverse customers. The use of internet has increased a lot in the last few years in the rural areas of Pakistan, but the data points to the fact that the usage of the internet is still very low and this is the fact that this study was conducted. The utility of the Internet in agricultural affairs is an undisputed fact and is also indispensable for agricultural development. The results revealed that all these variables have a relative relationship with adaptability, but some of them have a very high intensity and some have a very small effect. Hence the implications that emerge from the present study highlight that relevant pre-existing knowledge of potential adopters must be taken into account while implementing any technology. This also creates a challenge for extension professionals who first have to adapt themselves to any new technology and later they have to enable their respective customers to use this technology. Therefore, it is very important to demonstrate the benefits of using the Internet by extension professionals so that farmers can also reap the desired benefits by using this technique. Examining prior knowledge about the technology also highlights the importance of other variables in adoption models, as the regression results in the present study clearly show that the attributes of a technology in question that require skill to use the technology does not have a significant effect on behavioral intentions to adopt such as how time and cost can be reduced by using the Internet, how administrative matters can be managed, etc., all these have no significant effect on behavioral intentions. Another very important implication of the findings of the present study is that pre-existing attitude has no significant effect on technology adoption. But almost all models of technology adoption emphasize on attitude who actually influence adoption. While the

results of the present study show that prior knowledge can also directly influence usage intentions. From consideration it is revealed that the farmers agree that the use of internet is very beneficial for their agricultural affairs but due to lack of internet usage skills, they are unable to understand how to get these benefits like time and cost reduction, access to relevant agricultural information when needed, and timely resolution of their problems. The implications of these results are that, firstly, there is no special need to fully apply the models of technology adoption and secondly, that generally the adopter is aware of the usefulness of technology, but he is not aware of the use of this technology.

Recomendations

Lack of skills becomes the biggest barrier to its adoption. It is therefore important that extension programs train farmers to use such technology for specific purposes. Policy makers should set up programs to capture the practical benefits of the technology. This study makes a necessary addition to the current body of knowledge and highlights that theories play a different role in different regions due to different social structures and some parts of it are applicable in some places but some are partially applicable due to their technical nature. In the future, there is an urgent need to broaden the scope of this study and examine the variables used in it along with some other social variables such as social class, culture and land distribution system to examine the adoption in more depth.

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