An Investigation on the Effect of Prior Knowledge on Farmers' Decisions to Use Computers in Agriculture: Empirical Evidence from Rural Punjab, Pakistan

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Abstract

This study deeply analyzes the complex relationship between internal factors, such as farmers' existing computer knowledge, and adoption within the context of Pakistan's agricultural sector. To collect the data from a random sample of 416 farmers drawn from Punjab Province's five agro-ecological zones, surveys were conducted on computer knowledge and adoption intentions. The results would then reveal that although farmers still enjoy the benefits associated with computers, they actually require better skills on some specified hardware and related services in order to conduct prime activities such as assessing e-portals, online market search, and keeping financial, livestock, business planning, and payroll records. Specifically, the study outcomes go beyond those of the conventional adoption models since it shows that behavioral intentions could directly formed by a influence of prior knowledge. The study points to targeted interventions by extension professionals and policymakers towards preparing the farmers with all the computer skills required in their work, promoting digital inclusion towards the eventual development of agriculture.

Keywords: Computers, Behavioral Intentions, Agricultural Technology, ICT’s

Introduction

Unlike the mainframe computers that were bulky, historically out of reach and prohibitively expensive, the arrival of microcomputers drastically changed the face of agriculture practices by rendering high tech accessible and operable for the individual farmer (Colussi et al. 2024). The uninterrupted advances in computer hardware and software have expanded farm management decision-making tools to empower farmers with efficient and informed solutions (Adereti et al. 2024). However, Zulfikhar et al. (2024) stated that computer adoption among commercial farmers in Pakistan has been lower than envisaged and inconsistent with the broader projections of widespread adoption by 2021. As such, there is no prior study on computer ownership and factors of adoption at any level in rural Punjab; thus this research fills an important knowledge gap and informs the challenges and opportunities associated with the computer use context of local farmers.

Wang et al. (2023) claimed that judiciously deployed computer-based technologies can bring great changes in the field of agricultural practices and create avenues for optimized information sharing, more efficient customer engagement, and the unfolding of a more comprehensive virtual market channel. Subsequently, it develops a stronger and sustainable agro-ecosystem.

Similarly, Barakabitze et al. (2015) discussed that computer technology has replaced conventional methodologies and brought in a new paradigm of digital interaction, communication, and information interchange. In this regard, the outcome and effectiveness of

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this technology integration depend on users' awareness, receptiveness, and ability to exploit its use.

The adoption of technology is a function of several issues, including its inherent characteristics, perceived benefits, efficiency gains, and its ease of use (Rolandi et al., 2021). The value proposition itself is crucial because the user balances the possible benefits against the resources allocated for implementation. Value realization requires effective resource allocation and management-to be smoothened and maximized for an optimal impact. The technology is accepted and applied or becomes a success only when it is placed suitably within the organizational objectives and improves task accomplishment (Zulfikhar et al., 2024).

Therefore, the diffusion of innovative agricultural technologies would depend on the individual variation in cognitive awareness, knowledge, and receptivity. Daberkow and McBride (2003) highlighted that the adopter categorization framework that encompasses innovators all the way to laggards also depicts how varying levels of comprehension and acceptance influence the rate of technological diffusion. The first step therefore would be to investigate perceptions as well as awareness of farmers towards computer-based technologies, from where knowledge gaps-informing initiatives would be derived, thus demonstrating the benefits of integrating these technologies with existing ICTs in enhanced agricultural development.

Meijer et al. (2015) pointed that an understanding of the diversity level of the knowledge among farmers is a major problem facing adoption in agriculture. According to Colussi et al. (2024) core features that appeal to the knowledge of farmers would have to be identified since it varies widely among different segments. This complexity in the nature of things has been a problem in developing targeted marketing and communicating its value proposition to computer-based programs in agriculture. An exploratory research study will examine the impact of the current knowledge level of farmers regarding computer applications in agriculture on acceptance and adoption, as well as usage of this technology. The research question for this purpose is whether farmers holding different levels of knowledge about innovative products and technologies differ in their rate of adoption or not. In addition, it will check the nexus between knowledge and propensity for adoption.

Understanding the knowledge and expectation of innovative farmers is extremely crucial in developing responsive strategies that cater to their needs, maximizing adoption, and usage of ICT innovations in agriculture (Adereti et al., 2024; Dibbern et al., 2024; Mendes et al., 2024). Expected differences in knowledge levels vary the expectations of farmers, and, therefore, the information will aid stakeholders in engaging and helping them improve agricultural productivity and innovation. Ultimately, findings of this research will guide stakeholders on suitable targeting and support for farmers to ensure strategic uptake and proper application of computer-based technologies in agriculture. In that way, the stakeholders will reap maximum benefits in terms of productivity through agriculture and innovation to help the agricultural sector at large.

Literature Review

Farmer's Knowledge about Usefulness of Computer in Farming

The primary objective of the study is to find out the farmers intentions of computer adoption. Therefore, conventional wisdom holds that technology adoption decisions are essentially made based on forces and events that lie outside of a person's control. However, a recent study comes up to put these external factors in balance with internal factors by suggesting a positive relationship between personal characteristics and beliefs with adoption decision. As Lillestrøm et al. (2024) stated, many studies confirmed that individual attributes and beliefs could be as potent in the influence as the external conditions of farm size, type, or operator characteristics on interest in new technologies. This new perspective also is not in line with the traditional theories but instead emphasizes the evaluation of the personal attributes in analyzing the technology adoption behavior.

Interesting are recent studies such as Granado-Díaz et al. (2024), reminding us of the importance of internal factors-that is, knowledge, attitude, and skills-to technology adoption decisions when combined with external factors. This is in accordance with another objective of the study that emphasize on ascertaining and analyzing the association of intrinsic factors such as adopter knowledge with their adoption decision. Such internal constructs open windows for appreciating consumer decision-making processes and how likely it may or may not be to adopt new technologies. Therefore, understanding such interplay as both ends-in-between factors, researchers and practitioners are in a better position to predict technology adoption probability, thus informing targeted strategies aimed at streamlining integration and maximizing uptake (Gemtou et al., 2024).

Technology acceptance research declares that knowledge is the users' understanding about any technology and its features, advantages, and disadvantages (Gabriel & Gandorfer, 2023; Kolady et al., 2021; Wang et al., 2023). On the other hand, Montes de Oca Munguia et al. (2021) also provide a different perspective as provided by the rational choice approach, which combines sociological and rationalistic views. According to this framework, knowledge and attitudes of people are relatively invariant but situational as well as context-dependent, and vary from one area of interest to another. Additionally, this perspective asserts that people weigh up the costs against the benefits of an innovation before adopting them; those situations and circumstances will also influence their action. In conclusion, individuals consider the merits and demerits of a technology in deciding to adopt it, thus decisions are made based on the value perceived (Githinji et al., 2023).

In past research, different scales have been used to measure the knowledge of adopters (Lazar et al., 2020; Ratchford & Barnhart, 2012; Richardson, 2011). For example, one of the large reports that documented the developed economies of the world used a detailed 10-item scale to measure different cognitive aspects. The factor analysis in this research analyzed and extracted seven necessary dimensions while gaining a deep understanding of the knowledge aspect of adopters. These seven key dimensions include: process efficiency, informative value, administrative coherence, operational effectiveness, outcome quality, user satisfaction, and contextual suitability. According to Pandey and Rai (2020), such dimensions provide a foundational framework in understanding consumer knowledge and the influence of such knowledge towards technology adoption, providing valuable implications to stakeholders.

The literature review, on the other hand, would justify the emphasis on economic benefits instead of efficiency improvement as a driver for technology adoption. Three relevant dimensions emerged: productivity, access to information, and financial benefits. We created a customized survey questionnaire focusing on know-how on the part of the farmer, with seven questions that capture the subtleties of these dimensions.

Further research also suggests that the innovative consumers approach technology from a different standpoint as a tool for streamlining and upgrading their activities and workflows (Pandey & Rai, 2020). Successful identification of such knowledge therefore holds the key for marketers in terms of focused marketing strategies and potent messages besides chances of influencing the uptake and growth of technology (AlHogail, 2018). According to Frank et al. (2023), whereas there is an attempt to standardize consumer knowledge, the dispersed views among the researchers have fragmented our understanding of how the technology features shape and interconnect with consumer knowledge.

The connection between consumer knowledge and behavioral intentions is vague, and the empirical studies available have led to inconsistent and often conflicting findings (Chuang et al., 2020). This vagueness demands further study of the underlying dynamics and drivers of consumer behavior. Besides, Landmann et al. (2021) found that although several studies do report high correlations between consumer demographics and behavior, many studies showed

no significant correlation, thus confirming the complex nature of the relationship.
Considering the extensive prevalence of inconsistencies and gaps in literature, the knowledge-behavioral intention nexus of Punjab farmers in Pakistan becomes a prime area of research. In the particular context, this tries to unfold the nature of relationships between knowledge and behavioral intentions among farmers by identifying major correlates that might lead towards better comprehending what factors drive the intentions and behavior of farmers.

Computer for Enhanced Agricultural Productivity and Farmer Support

It is already at a crossroads when the agricultural sector is in its very troubled phases of insecurity and productiveness. However, the digital revolution has unchained tremendous amounts of data from modern farms, including yield performance, soil health, seasonal trends, crop growth, pest management, and field-level operations. Computers now retrieve and process the data for an ultimate transformation into a life-enhancing package of precision, productivity, and profitability with sound environmental responsibility (Hou et al., 2019). Data turns into a highly valuable resource in the data-driven decision-making process triggered through computers, leading to better yields and waste reduction through continual measures (Gao et al., 2018). Computers modernize farming into an efficient, more eco-friendly activity by fostering precision farming and automation of resources. As pointed out by Khan et al. (2022), computerizing farming is timely and much-needed to update agricultural innovation and sustainability.

Hence, Walton et al. (2010) posits that computers have turned agriculture for Southeast Asian farmers into vital sources of news and educational material as well as e-commerce. However, despite such prospective efficiency, low usage levels persist, meaning that only targeted initiatives towards overcoming this kind of digital divide can empower farming communities. At the ultimate end of such initiatives, farmers will be better off in terms of both welfare and productivity in order to become more self-sufficient and resilient agricultural producers.

The agricultural sector has seen an uptake of computers by the farming producers, which indicates that 27% of the respondents use their computers on a daily basis thereby changing the nature of digital engagement (Carrer et al., 2017). Computer application at wide levels enable farmers to utilize information efficiently, enhance productivity, and promote environmentally friendly practices as well, thus leading to the ultimate development of a sustainable and food-secure future. However, Paraforos et al. (2016) note that application of computers is generally utilized by farmers for non-agricultural purposes. In response to this mismatch, scholars have developed prescriptive recommendations and framework models to exploit computer technology for agricultural productivity, process streamlining, and growth. This opportunity allows farmers to capitalize on unparalleled prospects for innovation, competition, and resilience-an unmatched revolution for agriculture.

Computers have had an incredibly transformative approach over the last two decades from very simple means of communication devices to multifunctional tools that have been profoundly and deeply affecting society. Today, they enable billions of people around the world to connect, access vast information, and exchange ideas and innovations that shape our world. Computers, social media, and the internet have merged into a collaborative and revolutionary force for modern communication, accelerating the transfer of information and cultivating international relationships and much more engagement, collaboration, and social interaction. This dynamic has altered the very stratum of modern life-the way we communicate, access information, and share our perspectives, according to (Liu et al., 2024). The presence of computers and social media, generally, has overhauled human expression in that most have given up exchanging information and communicating socially, consequently revolutionizing the landscape of modern society.

Theoretical Framework

Since the 1980s, there have been various theoretical models to guide consumer perception and intended adoption of new technologies. Some of these models include TAM, IDT, and UTAUT as the most-well-known models (Dissanayake et al., 2022). Davis's Theory of Reasoned Action forms the basis of the TAM, stating that PU and PE are determinant factors in technology adoption. In detail, PU studies the worth or value likely to result from adoption, while PE evaluates how easy or tough it is to learn and how an individual can effortlessly use a technology. Empirical studies have shown that PU and PE play a great role in affecting the attitude and intention a consumer holds toward adopting technology .

Rogers' seminal innovation diffusion theory (1962) identifies five crucial features that empower innovation adoption by the consumer concerning relative advantage, compatibility, complexity, trialability, and observability. Having studied the factors in detail allows researchers to explain what drives adoption, ascertain what is probable about levels and timing of diffusion, and construct efficacious strategies for efficiently diffusing innovation. Venkatesh's UTAUT model extends this concept to a more complete framework of user acceptance of information technologies. UTAUT model articulates four key factors; performance expectancy, effort expectancy, social influence, and facilitating conditions that affect behavioral intention, usage behavior, and performance expectations influencing the adoption of technology and behavior of information (Namirembe et al., 2024).

This study investigated the relationship between knowledge and adoption intention of computer-based solutions among farmers and the degree to which knowledge might influence their adoption behavior. Knowledge here is defined as the perception of benefits derived from applying technology in agriculture, whereas usage intentions represent the probability of adopting and using such an application in agricultural practice. It aims to identify key adoption drivers and its impact on acceptance and use based on prior knowledge of the technology. The base of this research is in Musa. (2006) assertion that agricultural growth depends on embracing new technology; this study recognizes the critical role of continuing knowledge and education of speeding innovation adoption. Assessment of the level of knowledge among computer users has been identified as an important step toward the adoption and integration of technology into agriculture.

The Technology Acceptance Models include TAM, UTAUT, and IDT, which have defined three key constructs for influencing adopters' knowledge and attitudes toward technology: Perceived Usefulness (PU) with a pertinence of how technology is going to enhance productivity in the workplace; Performance Expectancy (PE), that pertains to the expected positive change in job performance and, by consequence, the resultant outcomes; and Relative Advantage (RA), that pertains to the perceived advantage of the new technology compared to the old one. These constructs considerably influence Behavioral Intentions toward the use of the technology. Relative advantage refers to the extent to which technology is better than any solution already in existence and, therefore, makes it a more preferable choice for adopters.

Following hypotheses regarding the examination of this relationship is as under:

H1: farmer’s knowledge does not influence their computer usage behavior.

H2: Knowledge of computer positively predicts usage intentions.

Materials 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 study used correlational design with 5% level of significance. This research study was based on 416 random samples drawn from five distinctive agro ecological 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' behavioral 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 on their knowledge concerning computer characteristics. The results from the table revealed a high level of consensus among respondents towards the relevance of computers to agriculture, further illustrating farmer appreciation of the potential value that computers can bring into the farming sector. Data analysis shows that the knowledge level among farmers is different: it shows notably significant variations with respect to process efficiency and contextual suitability. More precisely, it shows that farmers have a more elaborate knowledge of process efficiency than contextual suitability. Since this variation reflects subjective bias, meaning that farmers tend to prefer gains in productivity over practicality when it comes to appraising the adoption of computer technology

Table 1: Knowledge of the Computer Characteristics

No	Question	Response Categories	Count	Percent %
1	**Process Efficiency** Processing efficiency of your daily work would increase by using computer	Strongly Disagree	48	11.5
		Disagree	68	16.3
		Neutral	80	19.2
		Agree	101	24.3
		Strongly Agree	55	13.2
		No Response	64	15.4
2	**Informative Value** Computer could allow you to access relevant agricultural information	Strongly Disagree	45	10.8
		Disagree	71	17.1
		Neutral	91	21.9
		Agree	83	20.0
		Strongly Agree	47	11.3
		No Response	79	19.0
3	**Administrative Coherence** Computer would make it very easy to monitor all the administrative activities in the farm	Strongly Disagree	47	11.3
		Disagree	75	18.0
		Neutral	93	22.4
		Agree	79	19.0
		Strongly Agree	53	12.7
		No Response	69	16.6
4	**Operational Effectiveness** With the help of computers you would schedule your time and cost	Strongly Disagree	49	11.8
		Disagree	70	16.8
		Neutral	83	20.0
		Agree	94	22.6
		Strongly Agree	51	12.3
		No Response	69	16.6

5	**Outcome Quality** The use of the computer brings you a sense of all job done effectively	Strongly Disagree	57	13.7
		Disagree	62	14.9
		Neutral	72	17.3
		Agree	82	19.7
		Strongly Agree	59	14.2
		No Response	84	20.2
6	**User Satisfaction** It is a good idea to use a computer in farming	Strongly Disagree	38	9.1
		Disagree	65	15.6
		Neutral	76	18.3
		Agree	103	24.8
		Strongly Agree	60	14.4
		No Response	74	17.8
7	**Contextual Suitability** As a farmers you may find the computer compatible with farming system	Strongly Disagree	50	12.0
		Disagree	64	15.4
		Neutral	73	17.5
		Agree	93	22.4
		Strongly Agree	63	15.1
		No Response	73	17.5

From the responses of the farmers, descriptive statistics was employed in computing the arithmetic means for each of the seven questions. This helped the categorization of the level of knowledge of the farmers regarding the selected attributes. The results indicate that user satisfaction stood out with the highest ranking score at (M = 3.24), followed closely by contextual suitability at (M = 3.16), which means that farmers realize that computers can apply to their farming systems and meet their needs. Process efficiency also attained highly ranked scores of (M = 3.13), as did outcome quality (M = 3.09), showing appreciation from the farmers for the usefulness of computers in aiding agricultural activities. While informative value and administrative coherence scored relatively lower at (M = 3.05), scores of operational effectiveness stood at (M= 3.08). Hence the findings point to areas where guidance is needed in proper use of the computer by farmers in resource allocation. While finding direct implications in the need for targeted support and education for the better use of computer technology among farmers, the overall tendencies found there generally sway toward subjective experiences rather than practical applications.

Table 2: Actual Usage Intentions for Computer

No	Question	Response Categories	Count	Percent %
1	**Present** Supposing you have access to the computer then you are going to use it.	Strongly Disagree	29	7.0
		Disagree	57	13.7
		Neutral	82	19.7
		Agree	119	28.6
		Strongly Agree	75	18.0
		No Response	54	13.0
2	**Future** Assumed that you have access to the computer, you predict that you would use it.	Strongly Disagree	37	8.9
		Disagree	48	11.5
		Neutral	95	22.8
		Agree	105	25.2
		Strongly Agree	69	16.6
		No Response	62	14.9

The data shown in table 2 represent the behavioral intention of farmers toward using computers for agricultural purposes. A two-stage question elicited from the respondents their intended use of computers if available and how they would intend to use computers if provided. Results show that there is a high intention of using computers by farmers since 52 percent of the sample intends to use them. Such results underscore the catalytic role of access to computers in rural areas in leaps toward agricultural development, diversification, and ICT adoption among farmers.

Table 3: Pearson's Correlation Coefficient

No	Knowledge	Coefficients
1	Process efficiency	.531**
2	Informative Value	.613**
3	Administrative Coherence	.557**
4	Operational Effectiveness	.469**
5	Outcome Quality	.526**
6	User Satisfaction	.685**
7	Contextual Suitability	.497**

Table 3 illustrates the Pearson correlation analysis, which is positive to show that the characteristics of computers have a positive relationship with farmers' behavioral intentions. Hence, the first hypothesis of this research is accepted, and knowledge does not restrict the farmers from engaging in computer usage behavior. Instead, the potential benefits accrued by the farmers and the features of the computer are considered as positives to enhance the effectiveness of farming activities. Data further shows that computers are seen to provide a relative advantage, which will increase the farmers' intentions to adopt and use it.
The second hypothesis of the study, which claims a positive relationship between computer knowledge and utilization intentions, is also supported. This research attempted to determine what aspects of computers were most pivotal in driving its adoption, thus enabling policymakers in their promotion efforts. Policymakers can devise ideal programs to stimulate the adoption of computers by farmers once they identify the most important attributes. The following table summarizes the simple linear regression analysis, with the most critical factors characterizing this relationship.

Table 4: Simple Linear Regression

Model	Unstandardized Coefficients		t	Sig
	B	Std. Error		
(Constant)	2.954	.375	7.878	.000
Process efficiency	1.362	.459	2.967	.002**
Informative value	.968	.325	2.978	.011**
Administrative coherence	1.975	.412	4.793	.005*
Operational effectiveness	.864	.359	2.406	.000*
Outcome quality	.764	.249	3.068	.019**
User satisfaction	1.857	.548	3.388	.000*
Contextual suitability	1.761	.416	4.233	.016*

Dependent: Behavioral Intentions (Adoption) R=.547; F(7, 267) =16.321, P=.000**

The regression analysis yielded a fairly strong model, accounting for 54.7% of the variance in farmer's behavioral intention to use computers ($F(7, 267) = 16.321$, $p < 0.001$). The model hinted process efficiency, administrative coherence, user satisfaction, and contextual suitability as such critical attributes that oriented farmers' intentions. Each rise by one unit for any of the above variables directly translated into a significant increase in farmers' intent to use computers in farming activities. In fact, the important predictors were not informative value, operational effectiveness, and outcome quality. The main finding is an awareness gap: farmers might be aware of potential benefits that computers could bring in terms of efficiency and time saving, but lack the required skills to make them work optimally, thus preventing those gains and operational streamlining that would eventually lead to possible cost reductions. Therefore, targeted capacity building and training programs are called for to bridge that gap.

Conclusion

This paper explores how farmers have adopted computer technology for agricultural production in relation to what is desired in the outcomes of technology adoption models. A group of explicatory frameworks to be applied here involves the UTAUT, IDT, and TAM and will center on main performance expectancy, relative advantage, and perceived usefulness. The purpose of this research is to study how knowledge about computer technology of farmers influences the intensity of its adoption for agricultural purposes.

The study validates how the interplay of internal factors and earlier technology knowledge and behavioral intent to adopt affects adoption. Unlike other studies that focused on some external factors, the present research would consider what role internal factors play in the decision to adopt. Knowledge about computer attributes such as process efficiency, informative value, administrative coherence, operational effectiveness, outcome quality, user satisfaction, and contextual suitability for farmers is assessed to measure their influence over adoption intentions.

It enables information sharing and access to business transactions and customers, which all boost both agricultural practices and livelihoods. Despite its increasing usage in rural Pakistan, the adoption rates remain terribly low; it is therefore a really important piece of work. Computer technology is unavoidable for agricultural development.

Results indicate that there are varied influences of the adaptation factors, which underscore the need for prior knowledge in the diffusion of technology. The agents face double battles-from exposure to new technology and on the role of helping clients who use them. This paper advocates for farmers' realizing the benefits of computer technology, but this is well supported after proving the need for it.

Regression analysis depicts that attributes which require savvy use of technology are non-significant in predicting behavioral intention. Contrary to conventional wisdom, preexisting attitudes are not the primary push behind technology adoption. As a matter of fact, prior knowledge affects intention to use directly.

Results indicate that the farmers are aware of some of the benefits of computer technology-time and cost savings, quick access to information, and timely problem solving-but lack the skills in the necessary areas. Implications: (1) A more simple adoption model would be sufficient; (2) the adopters need direction on practical use of technology.

Recommendations

This study found the major barrier to adopting technology among farmers is a wide skills gap. Consequently, targeted extension programs are crucial to inform farmers on appropriate ways of using technology. Policymakers are called upon to fashion targeted initiatives unlocking the practical benefits of this technology, thereby reducing the knowledge gap that exists.

This research meaningfully adds to the existing literature as it indicates the limitations of such theoretical frameworks in the context where regional differences characterize social structure. The findings have underlined the importance of and the need for placing models of technology adoption in a relevant regional context in order to account for regional nuances.

The future studies must extend the concepts developed in the paper with further social factors that enable the establishing of complexities in the adoption dynamics. Accordingly, research targeting understanding and determining how social status, norms, values, or tenure hold forth in the adoption of the technology will provide some unprecedented insights. Doing this will allow researchers to proceed to develop frameworks and inform effective policy interventions that are more comprehensive as well as region-specific.

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