Qualitative Technology Transfer Model for Predicting Adoption of Information Delivered Through Information and Communication Technology: A Case of Experimental Research

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Abstract: Everett M. Rogers' Diffusion of innovation model is still ruling the field of agricultural extension research with respect to technology adoption due to the validity and relevance of the model even in different contexts. However, the changes in the communication strategy used by the agricultural extension system in the recent past would have created changes in the stages of adoption of scientific information by farmers. Hence, the present paper deals with an ICT based technology transfer model proposed to predict the adoption of agricultural technological information disseminated through smartphones. In the proposed model, adoption of technological information obtained through ICT tool based agro advisories consisted of six stages such as awareness, need, knowledge, evaluation, decision, and gratification. The traditional categorization of adopters is not relevant to this context as ICT based extension services especially in the form of agro advisories deliver information that has time utility and demands immediate response from the farmer. In such cases, only innovators who adopt the advisory were considered in the model. This model would be helpful for bureaucrats and R & D proponents to anticipate the likely rate of adoption of agricultural technologies by farmers and visualize the impact of ICT based agricultural extension projects.

1 INTRODUCTION

Since decades, several models on adoption of technologies by farmers have been evolved as an outcome of research works of eminent scientists in the field of sociology, psychology, communication, etc. However, the techniques to estimate the extent of adoption of new agricultural technologies and improved practices by farmers are still based on the principles of Everett M. Rogers (2003) diffusion of innovations theory which is still ruling the field of agricultural extension research with respect to technology adoption due to the validity and relevance of the model even in different contexts. However, the changes in the communication strategy used by the agricultural extension system in the recent past would have created changes in the stages of adoption of scientific information by farmers.

Since its inception, the focus of agricultural extension is to change the knowledge, skill, and attitude of farmers by educating them with the information relevant to the agricultural innovations developed through scientific research. During the course of time, different extension communication methods ranging from individual methods to ICT enabled mass communication methods have been evolved so as to better suit the broad spectrum of contexts brought about by changes in the demographic, socio, economic and environmental factors. With the advanced and dynamic growth of ICTs, how quick are the farmers accepting the information disseminated through these technologies depends on several factors. This emphasizes the importance of studying those factors, re-evaluate the stages of adoption of technological information by farmers in the era of information technology revolution and to reconstruct the orientation of agricultural extension accordingly.

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The research evidence on cyber extension is bountiful on modelling the factors that leverage farmers' adoption of ICT tools for accessing the details pertaining to the emerging agricultural technologies and improved practices in the face of dynamic agriculture (Islam *et al*,2011; Mittal *et al,* 2016; Rathod, 2016). Yet, the likely extent of adoption of information disseminated through ICTs and the potential benefits upon adoption of improved agricultural practices cannot be ascertained from these models. In addition to this, there is a vast body of scientific literature on the ex-post facto analyses of adoption and impact of information delivered through several ICT projects (Ninsiima, 2015; Harmandeep,2016; Murugan and Karthikeyan, 2017). However, attempts to synthesize this empirical evidence on the extent of adoption of technologies into a model to predict the adoption of information delivered through ICTs by farmers is negligible. There has been a huge demand for adoption prediction models among the policy makers and agencies involved in designing ICT based extension projects to estimate the likely benefit of the projects through making assumptions about adoption. Despite the increasing need, an ex-ante model predicting farmers' innovation adoption like the models on the spread and acceptance of new consumer products (Bass, 2004) has not been developed for wider use. A unique model for predicting adoption has not been developed for a specific context which may be attributed to the influence of complex social and agro-ecological factors on adoption outcome variables (Llewellyn and Brown, 2020).

Hence, the present paper deals with an ICT based technology transfer model proposed to predict the adoption of agricultural innovation disseminated through Information and communication technology. The proposed model is based on the well-established diffusion of innovation model with minor modifications, and it focuses majorly upon the adoption process and adopter categories.

2 METHODOLOGY

Several factors or constructs that could influence the acceptance of an innovation, either be an object or information have been proposed in the models and theories over the years to explain the user's adoption of new technologies. Hence, using the theoretical framework of different technology adoption models proposed by various scientists and based on the survey experiences & cross verified cases through triangulation, a qualitative model has been proposed to predict the adoption of information delivered through Information and communication technologies. The present research study uses the data from experimental research where weather based agro advisories were delivered to the farmers' smartphones. Medium range weather forecasts have high accuracy, high to very high usefulness which influence the decisions of cultivators pertaining to the routine farm operations (World Meteorological Organization, 2012) and relevant agro advisory information is chosen for dissemination through smartphones to farmers.

The research study was conducted in the Erode district of Western zone of Tamil Nadu state in India. A sample of 90 farmers who had access to smartphones with internet facility, who don't have subscription to any other agro advisories being offered by government and private entities and who expressed their willingness to receive the advisories for the ensuing crop season were selected as subjects for experimentation. Weather based agro advisories from field preparation to harvest accounting to sixteen numbers has been disseminated through WhatsApp for the whole crop season on a weekly basis to the farmers. The findings on the adoption of a particular advisory which was found to be new to the farmers were considered to arrive implications about the adopter categories for the proposed model.

3 FINDINGS AND DISCUSSION

As it was recognized by the early researchers, adoption of information consisted of stages. It is not the result of a single decision to act but series of actions and thought decisions (Wilkening, 1953). In the proposed model, adoption of technological information obtained through ICT consisted of six stages viz., (i) awareness, (ii) need, (iii) knowledge, (iv) evaluation, (v) decision and (vi) gratification.

The ICT based technology transfer model is depicted in Figure 1.

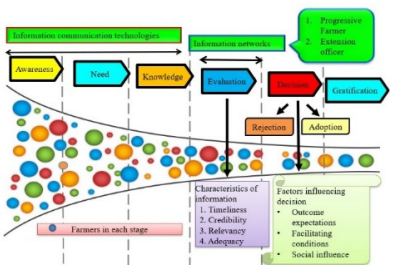

Figure 1: ICT based technology transfer model.

3.1 Awareness Stage

Awareness is the key to adoption, which is decided through acquaintances of the farmers with the technological information. Adoption of information related to innovation requires farmers to be aware of the existence of innovation. According to the model of diffusion of innovations, we cannot potentially expect the farmers to accept an innovation until they know about it. Awareness and positive attitude toward innovation come from information about innovation (Napier *et al.,* 2000).

Specific to the present context, a farmer becomes aware of the technological information by acquaintances with their access to ICT tools. Now-a-days, several ICT based technology transfer projects have been implemented by the change agency system (Public extension departments, private and corporate sector) to create awareness among farmers to motivate them to adopt the information. Though an individual is aware of the existence of innovation from the ICT tools, they consider the innovation for adoption only when they recognize the need for application of the obtained information. This states that awareness is followed by the need to make decisions on utilization of the information. Hence, awareness is a passive activity. The decision to use the information stops with the awareness stage when the need for it is not felt. Hence, it is proposed that awareness precedes need. However, this is contradictory to Singh (1965) who argued that need precedes awareness. But an individual develops a need when he or she learns that an innovation exists. This is in coherence with (Rogers, 2003), who indicated that awareness about innovations can lead to needs and vice versa. So far, research has not provided an accurate answer to the question "Does awareness precedes need or need precedes awareness?" This has been addressed in the proposed model stating that awareness precedes need.

Hence, awareness is proposed as the first stage of adoption of information delivered through mobile enabled extension services.

3.2 Need Stage

From the observations of the study, it was found that farmers seldom develop interests to seek further details of the delivered information, unless they feel the need for the information. Rogers (2003) reported that awareness knowledge about the existence of innovation may motivate an individual to seek further information i.e., "how to" knowledge to proceed with the innovation decision process. He further added that felt needs/problems as the prior conditions for knowledge. In the present context, it was observed that farmers receiving mobile based agro advisories gave significant attention to information that is in high demand for them. For instance, it was evident from several research that farmers accord more value to the information on market price, weather forecasts, forecasts on pest and diseases outbreak and schemes/ subsidies as they felt the need for such information and the information being considerably new to their level of knowledge. All the other information on crop cultivation practices has not gained considerable attention from the farmers as its need has not been felt by most farmers. Hence, it is proposed that farmers give attention to the advisories only when they feel the need. This is in congruence with Hassinger (1959) who argued that even if individuals are exposed to innovation messages, such exposure will have little effect unless the innovation is perceived as relevant to the individuals' needs. Hence, need has been proposed as the second stage of adoption of information disseminated through information and communication technologies with special reference to mobile enabled agro advisories.

3.3 Knowledge Stage

Knowledge is proposed to be the third stage of adoption of information disseminated through ICT tools. Knowledge here refers to the understanding i.e., constructing meaning from the instructional messages. It includes interpretation of the information by farmers. Knowledge is regarded as the initial stage of cognitive process that corresponds to transfer of information from understanding to application in the field to solve the problems. At this stage, the disseminated information will become the knowledge. Rogers (2003) represented three levels of knowledge viz., awareness-knowledge about the existence of the innovation, "how-to" knowledge about the information necessary to use the innovation properly and principles-knowledge about the information dealing with the functioning principles underlying how an innovation works. He stated that behaviour of individuals seeking information on "how-to" knowledge and principles-knowledge is concentrated at the knowledge stage of the innovation decision process, though it may also be found to occur at the persuasion and decision stages. The proposed model derives correspondence from Rogers' (2003) diffusion of innovation model.

3.4 Mental Evaluation Stage

At this mental evaluation stage of adoption of information delivered through ICTs, the individuals make subjective judgments on the appropriateness of information delivered regarding the characteristics of the message such as timeliness, credibility, relevance, and adequacy based on their experience in farming. These attributes of the information are important at this stage to motivate the individuals to evaluate the usefulness of the information delivered through ICTs.

However, based on the observations from the study, credibility and relevance of the messages were found to have a crucial influence on the individuals' decision to adopt the delivered information. This was due to the anonymity of the source of information delivered through ICT's. As in the present scenario, different stakeholders of agricultural extension service delivery are involved in dissemination of agro advisories to the farmers, it increases the degree of uncertainty about the technological information for the farmers who were typically not certain about the utility of the information.

Here comes the need of interpersonal communication networks to reinforce the delivered information. This was reported based on the observation that farmers in the study area discussed the information obtained through ICTs with their fellow farmers and agricultural extension officers to consider the information for adoption. Information networks have a major influence in the evaluation stage to motivate farmers to pass on to the decision stage, though it might influence the farmers' decision at the decision stage.

It is proposed that ICTs play an important role only upto the stage of mental evaluation. To motivate individuals to decide to adopt the information, their information communication networks play a distinctive and prominent role.

It is proposed that the stages of adoption of information delivered through information and communication technology ends at the mental evaluation stage itself for adopter categories as proposed by Rogers (2003) with the only exception to the innovators who adopt the information.

3.5 Decision Stage

Farmers who perceive the information disseminated through ICTs to be appropriate for their field conditions will make decisions on adoption based on factors such as outcome expectations, facilitating conditions and social influence.

In the proposed model, outcome expectation refers to the belief about the likelihood that a particular behaviour would lead to a specific outcome. If the farmer believes to obtain more yield upon adoption of information, he will go for adoption. The proposed model is congruent with the Social Cognitive Theory model as proposed by Bandura (1986) in which the construct 'outcome expectations' have been used to predict the information technology usage.

Facilitating conditions is operationalized as the availability of resources such as farm inputs, labour and capital to make use of the information disseminated through agro advisories. This is in congruence with the Theory of Planned Behaviour as proposed by Ajzen (1985) which indicated that planned behavioural control is determined by the availability of resources, opportunities, and skills, as well as the perceived significance of those resources, opportunities, and skills to achieve outcomes. In addition to this, the proposed model derives support from the economic constraint model which assumes adoption as the ability to use innovation. According to this model, adopters lack the ability to accept new technologies due to the paucity of funds to use. The model stated the access to land and capital as the most important factors limiting the adoption of innovations (Napier *et al.,* 2000). Social influence is operationalized as the change in behaviour of an individual as expected by the other individual. A farmer's adoption of information is influenced by another farmer's decision due to many factors such as convenience of carrying out agronomic practices, market availability etc. This is because the present study is concerned with paddy crops where topographic factors have a major influence because of the slope of land. For instance, if farmers choose to cultivate a particular variety of paddy, he must seek the decision of the neighbour farmer to carry out the farm operations in a convenient way. Hence, farmers must depend upon other farmers to perform crop management practices. This derives correspondence from the Unified Theory of Acceptance and Use of Technology according to which the constructs 'social influence' and 'facilitating conditions' were found to have significant influence on the user acceptance of a technology. If the above mentioned three factors are favourable, then the farmer goes for adoption of information or else he will not utilize the information besides being appropriate to them and the same is validated through the data from experimental research.

3.6 Evidence from Research

The research results indicated that there was a significant difference in adoption of information between the farmers exposed to weather based agro advisories and the farmers who were not exposed to such advisories. Although most of the information disseminated was not new to the farmers, they continued to adopt the information when it was reinforced by the advisories disseminated through smartphones. This could be attributed to two reasons such as the delivered information being compatible to their past experiences and the credibility accorded to the source of information as farmers were informed about it prior to the dissemination of weather based agro advisories. However, among the advisories disseminated, the technological information related to the use of Biocontrol agents to manage leaf folder and stem borer attacks in Paddy was entirely new to farmers and this also had contributed to the differential adoption rates between the farmers exposed to advisories and those devoid of advisories. So, this technological information was considered to find out the rate of adoption of information disseminated through smartphones because of the newness of the information being delivered to the farmers. The finding on adoption of technological information related to the use of Biocontrol agents is given in Table1.

Table 1. Distribution of respondents based on the adoption of technological information on Biocontrol agent.

S.No.	Category	Number	Per cent
1.	Adopters	5	5.56
2.	Non adopters	85	94.44
	Total	90	100.00

It was found from Table 1 that 5.56 per cent of the farmers who received weather based agro advisories had adopted the information within a short period of time. These farmers are considered as the innovators as they have adopted the innovation immediately when it comes to their knowledge. Hence, the study indicated that the percent of innovators is 5.56 per cent which is contradictory to the findings of Rogers (2003) who declared the percent of innovators to be 2.5 %. It was during 1962 that Rogers proved the innovators to be 2.5 % and by the time now, the finding has become obsolete. The study inferred that the adoption of technological information disseminated through information communication technology especially smartphones, is only confined to the innovators and the categorization of adopters such as early adopters, early majority, late majority and laggards who adopt the advisory, only after getting convinced of the consequences faced by innovators over a period of time were not appropriate to the context since the advisory delivered was based on medium range weather forecast which requires immediate adoption within a week time else the advisory would become obsolete. Information delivery through smartphones works on the concept of avoiding repetition and delivers something new as and when the farmers gain access to it. This demands immediate response to the information delivered, making innovators as the only category to adopt it. All other categories naturally tend to become non-adopters in this case.

3.7 Characteristics of Innovators

Based on the observations from the study, it was found that Innovators were usually educated, large landholding farmers getting considerable income, and they were keenly interested in attempting new things for self-satisfaction.

Hence, use of information is the fifth stage of adoption of information delivered through ICTs. However, this stage is not the end. It is followed by the stage of gratification.

3.8 Gratification Stage

Use of information is not the final stage of adoption. This is followed by the gratification stage because an individual continues to access and use the information delivered through ICTs only if he or she derives satisfaction out of utilizing it or else, an individual may revert to the conventional information sources to cater to their needs. Hence, gratification has been proposed to be important for persistent adoption of information delivered through ICTs. This is in coherence with Ruggiero (2000) who argued that any attempt to speculate on the future direction of mass communication theory must seriously include the uses and gratification theory which intended to explore why people become involved in one particular type of mediated communication or another and what gratifications do they receive from it? Hence, it is important to study the gratification that holds the farmers in the use of ICTs and the content that satisfies their needs. In the present study, gratification was measured in terms of farmers' perception on the effectiveness of content, treatment

of the advisories and the channel used for the dissemination of weather based agro advisories. The study revealed that farmers are satisfied with the weather based agro advisories which was reflected in their willingness to receive weather based agro advisories for the following crop seasons.

4 CONCLUSIONS

To sum up, the stages of adoption of information delivered through Information and Communication technologies (Smartphone), starts with the awareness stage and ends with the evaluation stage. Hence it is proposed that the role of ICTs in influencing the adoption- decision of farmers terminates in the evaluation stage. The traditional categorization of adopters is not relevant to this context as ICT based extension services especially in the form of agro advisories deliver information that has time utility. Such kind of information requires immediate response from the farmer as it might become obsolete in future course of time. Hence, only innovators can adopt the technical advisories delivered through ICTs. 5.56 per cent of the farmers come under the innovator category, contradictory to Rogers (2003) who stated that 2.5 per cent constitute the innovator category.

The implications of the proposed model for the policy makers and those engaged in research and development of ICT based extension strategies are as follows:

- The proposed model will provide insights into the adoption and diffusion of information among farmers in the context of ICT enabled extension.
- The model will create a greater understanding of the adoption process for those involved in designing ICT based agricultural extension projects which may be employed to expand the use of innovative agricultural information delivered through ICTs.
- Policy makers and R & D proponents may rely on this model to anticipate the likely rate of adoption of agricultural technologies by farmers and visualize the impact of ICT based agricultural extension projects.
- This model would help the extension officials to modify their extension strategy based on the socio economic and agro-ecological context to achieve the estimated rate of adoption of agricultural innovations disseminated through cyberspace by the farming community.
- Based on the observations and findings from the research, a qualitative model for predicting the adoption of information delivered through ICTs has been proposed. Future studies may be undertaken by the extension researchers to test the validity of the proposed model.
- As the study was conducted at micro level, further studies can be taken up at macro level by taking some other technologies to reconfirm the proposed model.

CONFLICT OF INTEREST

There is no conflict of interest.

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