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Full Length Research Paper

Diffusion and adoption of e-extension technology (computers and the internet) among extension agents in extension work in Sohag Governorate, Egypt

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A survey was conducted during 2010 among two targeted segments of Sohag governorate agriculture producers to evaluate questions about the effect of e-extension (computer and internet) technology on extensional business activities and agriculture decision making in Sohag governorate, Egypt. The study was conducted on a sample of 200 extension agents from the agricultural extension centers in Sohag governorate. A questionnaire form was prepared to collect data. The diffusion-adoption model was employed to characterize agricultural extension agents by stage in the technology adoption process. The agricultural extension agents who use the internet were examined for their frequency and nature of internet use when making business decisions.

Key words: Diffusion, adoption, e-extension technology, computers, internet.

INTRODUCTION AND RESEARCH PROBLEM

Extension workers constantly encounter and are well aware of the impacts that technological innovations have on individuals, agricultural extension agents, and communities across rural Egypt. A major technology invading the clientele of extension professionals today is the personal computer and the Internet (WWW, World Wide Web). Egyptian agricultural extension agents have been besieged by a wave of innovations associated with these technologies. Major shifts are underway in the way information is accessed by agricultural extension agents, including a diversification of channels through which they receive information (Abdel-wahed, 2007). Rosenberg (2010) predicted that 25 million Egyptians would have access to the internet by 2009. However, many rural areas will experience a "digital divide" caused by the lack of facilitating infrastructure such as high-speed communication lines. Whereas 48% of all households in Egypt were making use of the internet in 2007, only about 8 governorates in rural areas had gained internet access by the end of the decade (Center for Information and Decision Support Egyptian, 2011). Although internet and information technologies are becoming more accessible to rural households, still there is a considerable gap between rural and urban areas (Saleh, 2006).

Information transfer through evolving computer and internet technologies is enhancing agricultural marketing strategies and improving possibilities for farm profitability (Lasley, Padgitt, & Hanson, 2001). Information technology was already playing a significant and expanding role in agricultural commerce. One estimate suggests that the internet generated more, with E-commerce accounting for 2 million of this amount (Saleh, 2006).

The computer and internet are pressing farmers into the Third Wave era (Toffler, 1989) of the technology revolution in agriculture. Expanded application and use of internet technology by agricultural extension agents provides valuable information to assist with making business decisions (Ferreira, 1999). Internet technology is a tool that can be applied in different ways and for different purposes and is part of a dynamic internet technology that actually

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embodies a number of technologies--e-mail, databases, chat rooms, and information and education resources, among others. Additionally, the internet exhibits many elements that constitute a culture or community language, symbols, rituals, interaction, and other elements of communication. It thus essentially becomes an environment into which users enter in order to diffuse and adopt e-agricultural extension knowledge (computer and internet) in rural areas between agricultural extension agents and farmers (Saleh, 2006).

The application of communications and information technology (computer and Internet) in agricultural extension programs, and delivery of agricultural information to users, and on the internet network has led to the emergence of the Electronic Agricultural Extension (E-Agricultural extension). E-agricultural extension is an extension system which depends on new communications and information technology represented in computer technology and the internet (e-mail, Web services, and services on-line discussions, and digital technology independently or loaded on the Internet, such as digital TV and digital radio and mobile phone, and also multimedia such as CD-Rom, DVD for diffusion of agricultural information and knowledge, and available to all users without being attached to the place, and is delivered timely, flexibly and easily (Thomas & Daney, 2002).

E-agricultural extension is an extension system that allows the use and application of information and communications technology (ICTS) to access and obtain information related to agricultural production, agricultural marketing, distribution, and agricultural prices, and the results of agricultural research, agricultural innovations, to raise the level of agricultural production (Engalhard, 2003). It is these definitions of observing that electronic agricultural extension depends on the computer and Internet technology, which requires the training of agricultural extension agents on the use of these technologies, and diffusion of training programs in rural areas as well as adoption of these technologies (computer and internet) among agricultural extension agents and their application in agricultural extension (Elbert and Antonie, 2005).

Characteristics of Adopters

Rogers (1995) recently presented four additional adoption/diffusion theories. Through five stages in the diffusion process, first, they must learn about the Innovation Decision Process. Potential adopters of a technology progress over time innovation (knowledge); second, they must be persuaded of the value of the innovation (persuasion); they then must decide to adopt it (decision); the innovation must then be implemented (implementation); and finally, the decision must be reaffirmed or rejected An adoption analysis approach considers the process from the broader perspective of both user-perception and organization attributes, resulting in a plan for carrying out the adoption of technology that is rooted in an organizational context and addresses issues of concern to the intended user. Product and application design and development are also significantly influenced by this approach.

No single approach or process may be sufficient to ensure successful innovation adoption. But clearly, internet and web-based technology is individual-user based in application, and the adoption/diffusion process should start at that level. It should focus on the potential adopters and address their characteristics in the context of the environment in which they will be using the technology. Diffusion is the process by which an innovation is communicated through certain channels over time among members of a social system" (Rogers, 1962).

Researchers have often assigned titles to individuals based on their adoption behavior. The best-known scheme is from Rogers (1958). Since the adoption of an agricultural innovation followed a normal curve, he developed classifications of adopters by calculating the mean for the curve and then, by adding or subtracting the standard deviation, divided the curve into five segments. The segments were assigned these categories: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards (Figure 1).

The literature describes farmers who adopt an innovation early as being different from other farmers. Innovators are younger (Lionberger, 1960), more cosmopolitan (Coleman, 1957), have higher incomes than later adopters and have the largest operations of all adopter categories (Coleman, 1957). In addition, adopter categories differ in their source of information on innovations, with innovators relying on primary sources and later adopters relying on word of mouth (Ryan & Gross, 1943).

Characteristics of Innovations

A key part of the adoption process is identifying the criteria used in decision making. To begin with, the new innovation has to have a relative advantage over the old practice and it has to be consistent with existing cultural practice. In addition, researchers identified a number of other characteristics of innovations that relate to their adoption. Innovations that are less complex, are divisible, readily observable, low cost, and profitable are adopted quickly (Bohlen, 1961). Innovations that are congruent with previous innovations are also adopted quickly. For instance, hybrid sorghum was adopted at a dramatic rate where hybrid corn was already in general use (Brandner & Straus, 1959).

Stages of the Adoption Process

Beal, Rogers, and Bohlen (1957) developed a sequence of

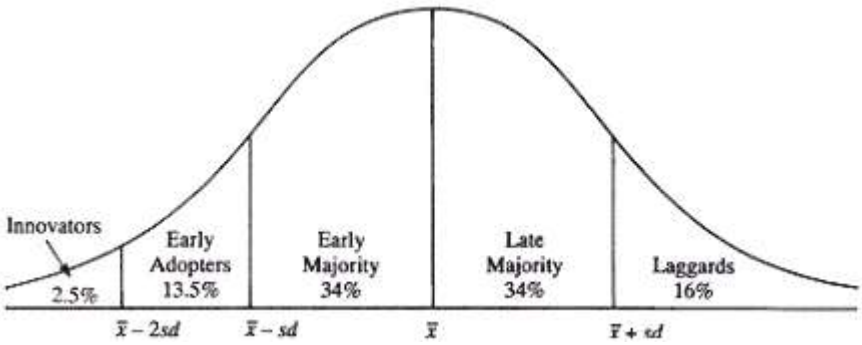

Figure 1. The classic adoption curve indicating a small number of individuals adopting the innovation early (left tail), followed by the majority of adopters. Those adopting last form the right tail of the curve (after Rogers, 1958).

stages to describe the adoption process:

- Awareness-The farmer knows of the existence of the innovation but lacks details.
- Information-The farmer becomes interested in the innovation and seeks further information.
- Evaluation-The farmer takes the information about the innovation and weighs the alternatives regarding resources of land, labor, capital, and management ability.
- Trial-The farmer uses the innovation on a small-scale basis.

Adoption- The farmer uses the innovation on a full-scale basis patterns (Barnett, 1953). Goss (1979) observed that the application of innovation diffusion theory in developing countries had undesirable consequences. These problems stemmed from the following.

- It is assumed that benefits resulting from the adoption of innovations spread and become homogeneous. But experience from Latin America showed the gap in inequities actually widened.
- Aggregate statistics for development projects may show improvement in elements like production, but commonly the farmers most in need of help received little benefit.
- Non-adopters are affected by the diffusion of innovations process because larger farmers increase production as a result of adopting an innovation, resulting in a decrease in prices received by all farmers.

Today a growing number of agricultural operators are adopting the Computer for its extensional business applications, as well as for researching product markets and obtaining marketing services. The Computer Age has lowered the cost of obtaining, producing, and delivering information while increasing the quantity and rate at which information flows (Paarlberg & Paarlberg, 2000).

The purpose of the analysis discussed here is to apply the diffusion-adoption model to the use of computer and internet technologies by agricultural extension agents and to determine the extent of their integration into extensional works decision-making. The diffusion-adoption model offers a logical progression of five sequential stages for the adoption of the computer and internet by agricultural extension agents. Relevant criteria for progressing from one stage to another with this information technology are sought. Once the stages are identified, they are applied to the actual adoption experience of extensional operators in order to classify them by current adoption stage. Subsequent analysis attempts to identify relevant extensional business and operator characteristics associated with agricultural extension agents at each adoption stage.

Vercon in Egypt

Appropriate participation of the agricultural extension service in the adoption-diffusion process for the computer and internet by agricultural extensional agents is a debated issue (Risdon, 1994). Traditionally, extension has provided agricultural operators with timely information about a wide variety of management and business technologies to assist them in maintaining profitable and sustainable production. A primary goal of extension is the dissemination of research information produced by research centers to potential users, particularly farmers.

Egypt appeared in the application of computer technology and the internet since 2003 from computer applications in the agricultural extension system. Expert Systems Agricultural, a computer program similar to the work of the agricultural expert, human in his field, who are consulted to resolve a specific problem, which one can use to get recommendations and agricultural information is a necessary technical aspect of the crop, and diagnosis of plant diseases and treatment, do any computer work of an agricultural human expert/specialist to provide recommendations for guidance for agricultural crops, and expert system asks questions that inquire about the agricultural expert specialist. Put Central Laboratory for Agricultural Expert Systems five systems expert in Egypt,

Table 1. Placement of extensional agents the Diffusion-Adoption

		Extensional agents	
Stages of Adoption Diffusion	Computer Usage	Number	Percent
Non-adopters	Do not have computer access	56	28
Late majority	Have computer access only	49	24.5
Early majority	Use computer for Internet access	12	6
Early adopters	Use the computer for Internet access in their extensional business	60	30
Innovators	Use the Internet for conducting extensional business	23	11.5
Total		**200**	**100.0**

expert system for the orange and lemon, and expert system for cotton, and expert system for wheat, and expert system for the option and the tomatoes were distributed in ten regions of the Republic in order to guide the farmers to the agricultural operations that lead to increased agricultural production quality and quantity (Richardson, 1997). The Central Laboratory for expert systems currently, the development and production of agricultural expert systems in various fields of agricultural download expert systems available on the Internet directly, so the user can access it, and use of the site www.cleas.sci.eg.

Been employed as information and communication technology (ICT), represented in the Internet, to establish links between these systems, the establishment of a network Virtual Extension Research communication Network (Vercon) the web Site www.vercon.sci.es

To provide communication between research, extension and farmers, where network availability needs of customers of new information, and to achieve coherence between research and extension, and cooperation between all bodies involved, and agricultural producers at all organizational levels, and especially small-scale farmers to improve agricultural production and food in rural areas (FAO, 2001). This network aims to strengthen the links between agricultural research, extension and farmers, to provide extension services to farmer's audience: View extensional publications. Ask the expert system development. Economic data base introduce problems of farmers. Agriculture News to improve methods of extensional communication for the benefit of this work in agricultural extension and development of the rural sector.

Agricultural Extension Service and Diffusion-Adoption of Information Technology (Computer and Internet)

The adoption-diffusion process for the computer and Internet by Agricultural Extension agents is a debated issue (Risdon, 1994). Traditionally, Agricultural Extension has provided agricultural operators with timely information about a wide variety of agricultural management and business technologies to assist them in maintaining profitable and sustainable production. A primary goal of agricultural extension is the dissemination of research information produced by universities and Research Centers to potential users, through agricultural extension.

O'Neil (1999) contends that extension has a professional duty to develop in-house PC and internet expertise and to offer agricultural awareness of how this technology can be used by its agricultural extension agents. This is somewhat in flux and clouded by uncertainty about agricultural extension through extension agents.

In actual sense, extension needs to teach agricultural extension agents how internet technologies can be used as an on-line information resource. Moreover, they have an important role in assisting extensional agents to interpret information retrieved from the internet and to apply that information to their agricultural extension operations (Lesley, Padgitt, & Hanson, 2001). However, Samson (1998) cautions that extension personnel must recognize the barriers that exist in many rural areas which are hindering the agricultural extensional agents' use of internet information technology in their areas, thus hindering extensional business and diffusion of information to farmers.

Currently, the role of agricultural extension is somewhat in flux and clouded by uncertainty as to how to meet the challenges of this new wave of information technology. Commercial entrepreneurs have entered the communication technology arena and raised questions about the kinds and amounts of the technology assistance appropriate to the extension mission. The extension service is in the process of realigning its programs related to this technology.

For information technology, as with most new ideas and procedures, there is a decision process that potential adopters undergo. This change process includes a progression consisting of five stages from first awareness

Table 2. Diffusion-Adoption Stages and Use of Information Technology by Selected extension agents Characteristics

Character-	Diffusion-Adoption Stages (Percents)						
	Non-Adopters	Late Majority	Early Majority	Early Adopters	Innovators	Total	c^2
Age							
30-40	21.0	11.1	8.6	34.0	13.9	88.6	
41-50	19.0	29.3	2.4	21.3	7.1	79.1	
51 and Over	16.0	8.6	1.0	4.7	2.0	32.3	
							43.2**
education years							
9-12	35.5	19.2	7.4	7.3	9.7	17.4	
12-16	17.7	17.3	40.7	21.7	19.4	21.6	
16-overe	46.8	63.5	51.9	71.0	71.0	61.0	
							28.1*
Length of service in agricultural extension							
2-11	51.8	51.1	54.2	31.2	46.7	21.6	
12-21	14.3	12.8	16.7	39.3	16.7	45.4	
22- over	33.9	36.2	29.2	29.5	36.7	33.0	
							17.2*

of something new to its acceptance and regular use (Rogers, 1983). These stages are characterized as:

- Knowledge,
- Persuasion,
- Decision,
- Implementation, and
- Confirmation.

Potential adopters must pass through a mental and behavioral process of gaining knowledge and implementing change as they proceed along the path to assimilation of a new technology into their everyday practice. For the computer and internet, the process involves working out how this technology can be applied to agricultural business management and diffusion of agricultural extension magazine and extensional publications.

Extension, both at the state and county levels, has been and remains one of the most notable and successful agents for assisting the agricultural extensional agents with knowledge and technology adoption (Fliegel, 2001; Eveland, 1986). Extension agents have an educational mandate to assist farmers through the entire adoption process. However, the extension role is particularly acute among extensional agents "left behind" in a rapidly changing communication technology environment (Ryan & Gross, 1943; Beale & Rogers, 1960). To realize this responsibility, current diffusion-adoption progress in computer and internet use by extension clientele must be determined.

For this task Rogers (1995) assigned descriptive names to the five stages of the diffusion-adoption continuum. From least to most advanced these are:

- Non-adopter,
- Late majority,
- Early majority,
- Early adopter,
- Innovator.

This article attempts to classify extension agents into their current stage in the information technology adoption process and to describe the farm extension agents characteristics associated with each adoption stage.

Procedures

In the research on current computer and internet use in the extension works reported here, a target population of local agricultural extension agents in agricultural extension centers in Sohag governorate- Egypt is presented.

Egypt appeared in the application of computer technology and the internet since 2003, can contribute to the improve-

ment and development of agricultural extension work, activation of the E- agricultural extension, which provides environmental communication most appropriate for rural development, and provide new information by providing communication channels and a wide variety of service-sector agricultural extension, and delivery of information and knowledge of agricultural technology at the right time and place, and dissemination of new ideas and innovations to all rural areas, through extension centers.

Each extension centers has an independent population. Because the computer and internet are rather recent technologies, we assumed that extension agents are most likely to be aware of and knowledgeable about these technologies and their potentials for their extensional business than other extension agents. Sohag governorate has 240 extension agents. Almost all the extension centers were chosen through random sample selected from about 200 of them to find how much the internet technology and PCs are affecting the extension work.

For the second objective, we described the characteristics of extensional operators at each adoption stage. Descriptive variables selected for this analysis included age and education years, agricultural extension work size, length of service in agricultural extension.

Non-adopters are agricultural extension agents without access to a computer who have access to and use a computer but do not have access to the internet comprised the late majority. The early majority adopters are those extension agents who have access to a computer and to the internet but do not use the internet in their extensional business. Operators currently using the Internet to search for extensional information are early adopters, while innovators are operators who use the internet for extensional business applications such as purchasing supplies and marketing farm products.

Finding

The completed and returned questionnaires from our sample of extension agents revealed that 28% were non-adopters who had no access to a computer at home or work (Table 1).

Another 24.5% were at the late majority stage with access to and use of a computer but no internet connection. The smallest percentage of extension agents (6%) were in the early majority stage, where they had internet capability available but did not use this technology for their extensional business.

Early adopters are the more progressive extension workers who use the internet for accessing agricultural information to aid in managing their extensional business. These operators represented 30% of these extension agents and the largest segment in the diffusion-adoption chain. Because the study focused on extension workers, this proportion seems consistent with the progressive but cautious demeanors typical of early adopters. Innovators, who act more independently of their peers in their agricultural activities, account for only 11.5% of extension workers.

Next we analyzed selected extension workers characteristics associated with placement in each of the five adoption stages. Frequency distributions for each descriptive characteristic were tested for significant variation across the five adoption stages using chi-square test. Because only nominal categorical data were available for the descriptive characteristics, a nonparametric test was appropriate. It was observed that only age, education, and farm production type vary significantly across diffusion-adoption stages (Table 2).

Age was examined using three categories: 30-40, 41-50, and 51 years and above. These categories were chosen from the proportional distribution for our sample. Older extensional agents dominated the first three stages of non-adopters, late majority, and early majority extensional agents. Conversely, 52 and 58% of those using the internet for their extensional business were younger than 45 years of age (early adopters and innovators). These data suggest that age is a key factor in the adoption of the computer and internet for extensional business, as might be hypothesized.

Three levels of education years, high education graduate, were examined next. The education years of these extensional agents were rather high, with 61% having high education. Early adopters and innovators were most likely to have a middle education. The proportion was 71% compared to 46% for non-adopters who lack access to a PC. The education contrast between internet users and non-users is clear. However, there is a larger proportion of high education graduates in the late majority than expected if education is the sole determinant of adoption behavior with the most education are believed to adopt new ideas and technologies more rapidly than those with less education (Rogers, 1995). This least-to-most education progression across the five-stages was expected, but not observed in a consistent pattern; possible explanation for this inconsistency could be due to an age-education interaction. This possibility is addressed later.

Length of service in agricultural extension was the only extension agents characteristic found to differ significantly across adoption stages among the selected farm factors considered. It was expected that information technology would involve distinct production needs and agricultural extension management practices that would distinguish among stages. Such a difference was found in the adoption of information technology by extension agents, but there was no pattern to the differences across diffusion-adoption stages. Other extension agent's characteristics, including length of service in agricultural extension, defined in terms of acres owned, extension agents no significant differences at the various adoption stages.

Because age appears highly related to education, we then controlled on age to obtain a more accurate understanding of the relationship between our other descriptive characteristics and stage in the adoption process. With age controlled at three levels, education no longer differed significantly across diffusion-adoption stages, while extension agents are significant only among middle-age. There are extension agents of about 45 to 55 years of age in whom information technologies are represented more in the extreme stages of either non-adopters or innovators.

For this sample of extension agents, age appears as the dominant factor in PC and internet adoption for the extensional business. One explanation for the primacy of age might be the perceptions older individuals, including extension agents have of this technology. We speculate that because both the PC and internet require learning new skills and changing behavioral practices, many older persons may perceive this technology as threatening and perhaps mysterious.

Also, education among extension agents are closely associated with age. As such it plays only a supporting role in determining PC and internet adoption. When we controlled for age, education is no longer significant, and the link with age becomes clear. PC and internet adoption is not directly related to extension agent's education but more linked to having younger extension agents in the extension work who provide exposure to the technology and some of its uses.

The types of information sought by extension agents on the internet focused only on that associated with the extensional business and the amount of time associated with this extensional business related use. We found that a majority of extension agents use the internet from 1 to 5 hours a week to obtain extensional weather information was cited most by all agricultural extension agents. Agricultural extension workers search on-line for information pertaining to agricultural products, and farm news is sought more often than economic or political news. In contrast, peanut producers indicated farm news is the primary internet topic they search for on-line. The Internet is seldom used by either group for seeking information.

Although age is the primary factor in determining adoption of the PC and internet by extension agents, once the technology is adopted, age seems to play a minor role in determining the amount of usage or the type of information sought on-line. The only topics that age significantly affects are the search for information. Extension agents make more use of the internet to search for non-farm and farm products than do operators 45 years and older.

CONCLUSION

Current technology estimates suggest that more Agricultural extension agents are connecting to the Internet and searching for extensional-related business and farm information. Our findings confirm that PC and internet usage has become a component of many extension agents' extensional business management tools. Certainly, farm business information retrieval is used by a sizable number of extension agents with a benchmark for PC and internet adoption established, future research can proceed to examine whether the information gained on-line is proving to be an asset in agribusiness decision-making. Further research and extension efforts must define the benefits from information technology and how the technology can be enhanced to assist farmers in making decisions for their farm business. For extension programming, the task is to adjust and tailor activities and programs to articulate with these external information networks. In many ways, the role of Extension agents is becoming a more difficult one to navigate.

It should be remembered that the extension agents surveyed in this study are recognized extension agents in their commodity production area. They are not representative of the many operators of small farms who make up a sizeable proportion of Egyptian farms. There is a large segment of the farm population that has not yet adopted the PC and an even larger segment that is not connected to the internet. One reason is a lack of infrastructure availability in many rural areas that prohibits internet access. Because such limitations remain for many extension agents, the use of the internet for retrieving extension business information has not replaced the need for traditional sources of information.

For now and the immediate future, agricultural extension must maintain traditional communication channels to extension agents in order to ensure that internet non-adopters and late majority adopters continue to have access to emerging agricultural information. Simultaneously, extension should encourage and direct agricultural operators to explore the potential advantages of the PC and internet for obtaining agricultural information and for managing their extensional agricultural business.

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