ICT Adoption and Its' Implications for Agriculture in Sri Lanka

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ABSTRACT

Agriculture is the backbone of the Sri Lankan economy and it constantly experiences with advances in technology. Because of the rapid development of Information and Communication Technology (ICT) in the world, each organization or person has to concern their products and services more towards modernized and ICT related manner. This research contribute to understand the adoption & use of ICT, identify the constraints associated with ICT use and propose recommendations with managerial implications towards the improvement of present ICT system in agriculture sector of Sri Lanka. Tea producers and poultry farmers in Kurunegala District were served for the survey. A scoring system was used to develop continuous dependent variables which were used in regression models to identify the variables most significantly influencing ICT use. Least significant difference technique was used to identify comparisons of constraints in ICT adoption and use.

There were 60.6% of the participants who used ICT related equipments or facilities for their business and 76.1% of the participants having ICT uptake problems, where telecommunication and internet reported higher impact on agriculture sector. The participants stressed the cost of technology, lack of training, trust level in the ICT system, lack of ICT proficiency and lack of technological infrastructure are thresholds for ICT adoption and use. Managers can use these results to promote ICT adoption that can lead to more efficient communication and increased demand for the firm's products and services. The usage of different ICT applications was comparatively high in tea sector and in general the usage of mobile communication was common among all participants. This survey results provide insights which suggest corrective steps to expedite ICT adoption and prioritize the necessary research.

Index Terms ICT adoption, constraints, tea, poultry, ICT

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INTRODUCTION

Today, the ICT is developing rapidly in all over the world. Recently, the use of Information and Communication Technology such as electronic mail (e-mail), mobile communication, teletext, fax, Decision Support Systems (DSS) and the World Wide Web (WWW) has become widespread. For the betterment of future, as a country whole the agriculture, industry and services sectors have to couple with this phenomenon. Information is the lifeblood of organization. It's vital to collect accurate and complete information for all market sectors and industries including agriculture. Information promotes competition and improves market performance (Thompson and Sonka, 1997). Information may also increase the level of trust on consumers in a product or firm and leading to increased demand. Information and communication technologies offer the ability to increase the amount of information provided to all participants in the agricultural sector and to decrease the cost of disseminating the information (Kurtenbach and Thompson, 2000). ICT in the agriculture sector facilitates knowledge sharing within and among a variety of agriculture networks including researchers, exporters, extension services and farmers. ICT enables vital information flows by linking rural agricultural communities to the Internet, both in terms of accessing information and providing local content.

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Agriculture is the backbone of the Sri Lankan economy and it contributes to higher Gross National Production (GNP) of Sri Lanka. In year 2002 & 2003 agriculture sector contributes Rs.287840 and Rs.297342 millions respectively to GNP (Central Bank Report, 2005). The demand for agricultural products in Sri Lanka is increasing annually with the population that grows at an average rate of 1.4% per year. Achieving this continuously increasing demand is the challenge in the agriculture sector in Sri Lanka (Chandrasiri *et al., 2002)*.

In Sri Lanka, few agriculture sector participants (organizations / individuals) use ICT in their day to day activities or agricultural production. For an example some tea sector participants use e-commerce applications and a few poultry and livestock farmers use ration formulating software to prepare feeds. But in developed countries use portals, DSS / expert system and e-commerce applications like higher ICT heavily in agriculture. For an example large scale horticulture industries use automated fertigation systems (Taragola and Gelb, 2005). A few works could be found that attempt to address the use of ICT in agriculture sector in Sri Lanka. Therefore, adoption of ICT in agriculture sector is recognized as an urgent need in present day agriculture. Hence the research on ICT adoption is very scarce in Sri Lankan agriculture sector; the need exists to understand the adoption and use of ICT, reason for some agriculture sector participants tend to use ICT faster and more readily than others. An understanding of the factors associated with ICT adoption and use in agriculture will enable the development of strategies to promote ICT adoption and increase the effectiveness and efficiency of information use in agriculture sector (Kurtenbach and Thompson, 2000). More specifically, advances in ICT have progressively reduced the costs of managing information, enabling individuals and organizations to undertake information-related tasks much more efficiently, and to introduce innovations in products, processes and organizational structures in agriculture sector in Sri Lanka.

LITERATURE REVIEW

ICT Adoption

Adoption is usually not spontaneous, the technology has to be taught and learned - adopted to existing experiences and integrated into production. In several countries where ICT adoption researches were done it focused mainly on computer adoption for general agricultural production. Batte *et al.,* (1990), & Warren *et al.,* (2000), clearly demonstrated that, the adoption of ICT is strongly associated with the education level of the farmer and farm size and negative effect of age of the farmers. It is suggested that there is disparity in adoption between different sizes and types of farm (Warren, 2002). Several studies supported the argument that, the ICT adoption devoted much time and effort (Rosskopf, 1999; Kurtenbach and Thompson, 2000; Gibbon and Warren, 1992). Gelb & Bonati (1998) revealed that presence of the internet is very useful for present day agriculture.

Factors Affecting the Use of ICT

It's clearly demonstrated that the complexity of farm, degree of external support, age, time, experiences, network, availability of information, personality and approach to learning enhanced or diminished a framers computer use (Iddings and Apps, 1990). And also factors like lack of ICT proficiency, lack of ICT benefit awareness, too hard to use, lack of technological infrastructure, cost of technology, trust level in the ICT system, lack of training, system integration and software availability limit the use of ICT by farmers (Taragola and Gelb, 2005). The numerous factors that influence IT adoption and use in agricultural organizations can be grouped into five categories such as access to IT, demographic, IT training/education, trust, and time (Kurtenbach and Thompson,

2000). It is possible for adoption factors to fit into more than one category (Gelb and Parker, 2005). The most important limiting factors in developing countries in terms of infrastructure and cost of technology are no longer a threshold for ICT adoption in developed countries (Kurtenbach and Thompson, 2000).

Use of ICT in the World Agriculture Sector

Several good examples for ICT adoptions and implications of agriculture sectors are found. Kenya Agricultural Commodity Exchange (KACE) is harnessing this ICT technology to disseminate market information and intelligence. In Philippine there are lots of portals, e-commerce applications and innovative technologies use to provide relevant agricultural information in country specifying the rural areas. Specially, e-AGRIKultura, e-Consortia, e-Farm & K-AgriNet place a major role among them. In Thailand a multi-lingual Internet portal, Agricultural Information Network (AIN) enabling Thai farmers, field officers, policy-makers and government to communicate and access relevant and useful agricultural information. Farmers in India use e-Choupal one of the portals to setting up a kiosk network that provides mediated access to them. E-Choupal has already become the largest initiative among all Internet-based interventions in rural India (Anon., 2006). And also members of the Primary Agricultural Credit Societies (PACS) in South India can access both procurement prices and markets on a click of the mouse.

Farmers can gain access to the best of advice across the globe using DSS / Expert System. Some of the expert systems that have been developed for uses in agriculture are given as: COMAX - provides information on integrated crop management in cotton, POMME-provides information about pest and orchard management of apples, SOYEX- soybean oil extraction expert system and FINDS -a Farm level Intelligent DSS to assist in determining optimal machinery

management practices for farm-level system (Anon, 2006).

In Sri Lanka the Ministry of Rural Economy in partnership with the Information and Communication Technology Agency of Sri Lanka (ICTA) has opened the "Govi Gnana Centre" & "Rural Knowlegde Centre" which empowered villages including farmers by linking up with the WWW (ICTA Monthly Newsletter, 2005). So farmers can collect the market information in all major markets in the country. "Nenasala" project is implemented to meet the infrastructure requirements in order to address the information and communication needs of rural areas in all parts of the country (Anon., 2007).

METHODOLOGY

Source of Data

Sri Lankan Tea producers and Kurunegala district poultry farmers served as the observation groups. At the beginning a preliminary interviews of selected employees of both observation group were done to identify important user and organizational characteristics and current applications of ICT in both groups. The results from the interviews which could include input from the technical and managerial staff of tea producers and various farmers were used as the basis for structuring the final survey (detailed questionnaire). The final survey was conducted using randomly selected participant of the above two groups and included detailed information of WWW use, e-mail use, DSS use, other ICT related practices and user comfort level with these technologies.

Basically Bingiriya, Udubaddawa, Pannala, Kuliyapitiya, Paduwasnuwara, Nikaweratiya, Allawwa, Giribawa, Wariyapola and Kurunegala A.G.A Divisions were selected for the survey areas of the poultry sector and Badulla, Nuwara-Eliya, Kandy, Kegall, Galle and Ratnapura districts were selected for the survey areas for tea producers in Sri Lanka. As the highest poultry population

and production was reported in Kurunegala District, it was selected for poultry sector area in this survey (Central Bank Report, 2005).

Statistical Analysis

The data obtained from the survey were analysed with proper statistical methods with the aid of Statistical Analysis System (SAS), MINITAB and MS Excel software. Least significant difference (LSD) technique and general linear models (GLM) procedure were used to identify the comparison of the limiting factors. A scoring system was applied to a selection of the survey questions to create WINDEX, EINDEX and MINDEX to represent WWW, e-mail and mobile communication use respectively. Kurtenbach and Thompson, (2000), & Fredrickson, (1984), clearly demonstrated the method of creating a scored index from categorical data. WINDEX, EINDEX and MINDEX were computed by applying scores to the responses for each of the questions which were included in questionnaire.

Variables Formed for the Scored Indices

It is hypothesized that, the following variables were affected by the adoption and use of WWW, e-mail and mobile communication. These variables were categorized into four groups such as (a) access to ICT (receive/send email attachments, percentage work related to email) (b) ICT training and knowledge (days of training, knowledge of HTML), (c) trust (solve ICT related problem myself or with help, using the Internet is easy, e-mail is helpful for day today business, using the mobile phone is easy) and (d) time. Basically, each scored indices was represented as a function of the related variables being formed. Therefore, WINDEX, EINDEX and MINDEX were analysed as a combined data set (Kurtenbach and Thompson, 2000). Regressions were run using these three use indices as dependant variables to determine which factors from the survey

had the greatest impact on WWW, e-mail and mobile communication adoption and use.

RESULTS AND DISCUSSIONS

Table 1 shows the summarized details of the participant in ICT adoption survey. There were 218 participants involved in the ICT adoption survey and out of them 135 participants from poultry industry and the rest from tea sectors. The results shows that 60.6% of the total participants use at least one of the ICT related equipments or facilities. But in general, this result does not 100% implies that whole 60.6% of the participant use ICT related equipments for their business or farm operations because of some farmers who own the computers use it for watching films and playing games only.

Table 1. Participants of the ICT adoption survey

	Use of ICT	Not use of ICT	Total Surveyed
	60	23	83
Poultry	72	63	135
Sub total	132	86	218

Fig.1 gives some indication of the use of ICT related equipments by tea & poultry sector participants. When only the tea industry is considered 72.3% of the participants use ICT related equipments/facilities for their business. Statistically, it is a very clear significant difference between the use of ICT and not use of ICT in tea sector participant (p=0.0053, α=0.05). Therefore we can say that, 72.3% of the tea sector participants in Sri Lanka use ICT for their business. Specially, the tea industry participants more incorporates with export market and Colombo tea auction. To cope up with the global market they have to use more sophisticated technologies. Therefore, they used ICT related equipments or facilities for their business heavily. In poultry sector, 53.3% of the participants use ICT

related equipments or facilities for their business. But the use of ICT and not use of ICT values are not statistically significant (p=0.1379, α=0.05). We can say that, 53.3% of the poultry sector participants in Kurunegala district use ICT for their business. Specially, the 95% of the poultry industry involved in local market and they used comparatively less ICT related facilities for their business.
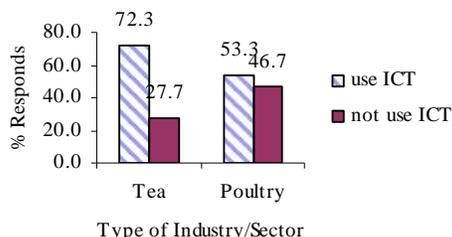

Fig. 1 Percentage use of ICT related equipments by tea & poultry sector participants

Table 2 shows the summary statistics of the entire survey. There are 83.1% of the tea industry participants and 71.8% of the poultry industry participants in Kurunegala district indicated that they have problems with the uptake of ICT in their business or farm operations in agriculture. In an average, 76.1% of the farmers reply that they have ICT uptake problems in agriculture sector. Comparing our results with the ISHS[1] 2004 survey, we could find that, 94% of the ISHS participants' having problems with the uptake of ICT in agriculture and the process control, DSS and production models like modern technologies resulted the higher ICT uptake problems. Because of more than 90% of the participants in developed countries used ICT for their business and the people more incorporate with modern technology, they have to face lots of problems, challenges and afterwards they gained lot of experiences. But in Sri Lankan situation, people do not engage in modern technologies like process control in glass house production, precision farming and production models applying in

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[1] ISHS : International Society for Horticultural Science

poly-tunnels etc. The most important ICT uptake problems indicated by the participants were, use of telecommunication and Internet. Considering the tea sector 69.8% for the Internet and 60.2% for the telecommunication were reported as ICT uptake problems. In the poultry sector 63.7% for the telecommunication and 54.1% for the Internet were reported. The marginal ICT uptake problems were resulted due to the use of sophisticated ICT facilities such as e-commerce, DSS and precision farming because most of the farmers are unaware of these new technologies and the inability of using it. Therefore it is important to identify the possible reasons which limit the use of ICT in agriculture sector.

Table 2. Summery statistics of the survey

	Tea sector %	Poultry sector %	Total %
ICT usage for their business	72.3	53.3	60.6
ICT uptake problems	83.1	71.8	76.1
Limiting factor to use of ICT	62.6	42.9	50.5
1. cost of technology	56.6	32.6	41.7
2. inability of farmers to use ICT	45.7	34.8	39.0
3. lack of training	32.0	28.9	30.1
4. level of trust in ICT	30.1	29.6	29.8
5. lack of technological infrastructure	31.3	23.7	26.6
6. Lack of ICT proficiency			
E-mail use [a]	90.0	70.8	79.5
WWW use [a]	85.0	65.3	74.2
Mobile communication us [a]	96.7	90.3	93.2
DSS use [a]	28.3	16.7	22.0

[a] % of the all who use ICT (n=132)

Table 2 also summarised some of the limiting factors for use of ICT in agriculture sector. If we take the tea sector participants alone, the cost of technology

(62.6%), inability of farmers to use ICT (56.6%) and lack of training (45.7%) like limiting factors gave the highest impact on ICT use. And also considering the poultry sector, cost of technology (42.9%), lack of training (34.8%) and inability of farmers to use ICT (32.6%) gave the highest impact on ICT use. Therefore, cost of technology has overall the highest impact and its 50.5% of the total farmers surveyed. The result implies that if a farmer is willing to adopt the new technology the main barriers to adapt to ICT is cost of technology. Taragola & Gelb, (2005) said that obviously, the developing countries faced this type of challenge. Secondly, the inability of farmers to use ICT (41.7%) and lack of training (39.0%) have highest impact. According to the mean separation of each and every limiting factor inability of farmers to use ICT and lack of training are not significantly different. That means, statistically these factors affect in similar capacity for the ICT adoption and use. And also, the lack of technological infrastructure (29.8%), trust level in the ICT system (30.1%) and lack of ICT proficiency (26.6%) has third largest impact on ICT use. It is noted that mean separation of all these 3 factors were not significantly different. Therefore, statistically these factors affect in similar capacity for the ICT adoption and use in the survey group.

By considering the farmer's percentage use of different ICT applications based on all who use ICT, the tea sector participants use 85% Internet, 90% email, 96.7% of the mobile communication and 28.3% of the DSS while poultry sector participants used 65.3% of the Internet, 70.8% of the email, 90.3% of the mobile communication and 16.7% of the DSS. It is noted that, the usage of ICT applications by tea sector participants was always higher than poultry sector participants. As the tea sector farm size is comparatively larger than the poultry sector farm size it supports the argument that adoption of ICT is strongly associated with farm size (Batte *et al.,* 1990). Figure 2 shows the total

percentage usage of ICT applications by tea and poultry sector participants in Sri Lanka. It is noted that 56.4% of the farmers used mobile communications in their business or farm related operations. While 45.0% of the farmers use Internet and 48.2% of the farmers use email facility. Only the mobile communication usage is more than 50% and each other ICT application usage is less than 50%. Comparatively the use of web and email are similar in capacity and the use of DSS is very low. Some of the possible reasons were the cost of technology, inability of farmers to use ICT and poor infrastructure development.
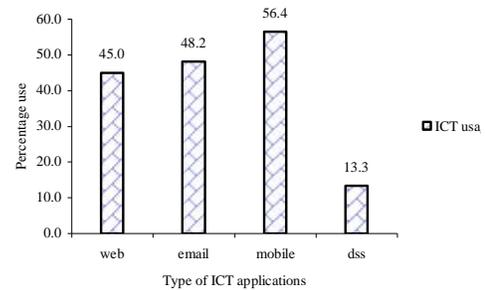

Fig. 2 Percentage use of ICT applications by farmers in Sri Lanka

Using the theory and stepwise regression results in the WINDEX, EINDEX and MINDEX models, the following variables were identified as providers of greatest explanatory power with respect to WWW, e-mail and mobile communication use. Variables like "Days of training (trdays)" and "knowledge of HTML (knhtml)" related to the ICT training and knowledge category were positively significant implying that farmers with more days of training and html knowledge use ICT more. These results indicated that ICT training and the literacy promotes the adoptions of ICT. (In that scenario, the people with higher ICT literacy will adopt and use ICT more). In the trust category, variables like "e-mail is helpful for day today business (emhelp)", "solve ICT related problem myself or with help (prbslv)", "using the Internet is easy

Table 3. Parameter values in Regression for Scored Indices

Variable	WINDEX		EINDEX		MINDEX	
	coefficient	prob	coefficient	prob	coefficient	prob
trdays	7.81	0.031				
knhtml	3.47	0.047				
prbslv	13.61	0.023	15.78	0.047	18.31	0.001
intezy	8.53	0.036				
sattach			7.21	0.032		
emhelp			12.67	0.022		
wkhrse			4.23	0.061		
mphelp					9.87	0.043
mphezy					8.03	0.025
freump					6.37	0.068
R^2	0.721		0.790		0.663	
Adj.R^2	0.694		0.734		0.622	
F	10,75	0.001	11,82	0.001	18,16	0.000

(intezy)" and "using the Mobile is easy (mphezy)" were found to be significant in influencing ICT usage. All these variables resulted significant, positive coefficient indicating more trust individual in the ICT system, use more ICT. In the access to ICT category, "Percentage work related to email (wkhrse)" and "Frequency of mobile phone usage (freump)" variables were not significant though they have positive coefficient. In the time category, there were no any variable formed because, this survey doesn't have data in several years.

The R-square (R^2) value indicates the amount of variability in the data explained by the given model. Therefore statistically, the WINDEX described 69.7%, EINDEX described 73.4% and MINDEX described 62.2% of the variables used for final regression model. These results suggest an arbitrary rule that R^2 should be above 0.60 to observe a probability value just below 0.05 to declare the significance of each variables for the above three indices.

CONCLUSIONS

There were 60.6% of total participants (72.3% of the tea sector in whole island and 53.3% of the poultry sector in Kurunegala district) uses at least one of the ICT related equipments or facilities for their business. The survey shows 76.1% of respondents having ICT uptake problems in agriculture sector. The telecommunication and Internet result higher uptake problems whereas DSS, precision farming and production model like new technologies result lower uptake problems because of their limited use due to lack of awareness of these technologies. The results suggested that the most important limiting factor which affects the use of ICT in agriculture is cost of technology. It shows 62.6% of tea sector and 42.9% of poultry sector ICT use is affected by cost of technology. Lack of training and inability of farmers to use ICT is the second factor that affects. The factors namely trust level in the ICT system, lack of technological infrastructure and lack of ICT proficiency are the third level category that affects the use of ICT in agriculture. It appears that the usage of mobile phone is very common among the tea and poultry sector. The use of mobile phone is high compared to other ICT application such as Internet, WWW, e-mail and DSS. It is noted that, usage of ICT applications by tea sector is always higher than the poultry sector. Statistically, the WINDEX, EINDEX and MINDEX described that the variable used represents 69.7%, 73.4% and 62.2% in the regression model respectively. Variable related to the ICT training and knowledge category

which consist of "days of training" and "knowledge of HTML" were positively significant. In trust category, variables like "e-mail is helpful for day to day business", "solve ICT related problem myself or with help", "using the Internet is easy" and "using the Mobile phone is easy" are also positively significant.

Determining the factors that influence ICT adoption can assist companies in deciding the ICT use profile of their customers based on the significant adoption factors identified in this study. The knowledge of ICT adoption and use will help in understanding the potential of customers and product and services of the firm / company. The company / farm can then focus marketing and advertising campaigns on attracting these individuals to their business. A customer's comfort and trust level with a company may increase as they are able to gain more information about a company via ICT. For example, a customer's trust level with a company will increase if he is able to track his shipment order via the Internet. Some individuals and organizations within society have a fear or mistrust of ICT. At the same time, agriculture constantly experiences advances in technology and the use of information and communication technologies is becoming more common place each day. Therefore, it is essential for firms and managers to understand the reasons for ICT adoption to remain competitive and to best serve their industry and customers.

RECOMMENDATIONS

Agricultural production efficiency needs to be enhanced by improving use of ICT in collaboration with management skills of the producers. Identifying the constraints of ICT adoption and use will help industry participants to increase information flow and increase the level of trust in the firm and the demand for the firm's products or services. Managers can gain lots of benefits if they use DSS or Expert System in agriculture. Because of these systems provide knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solution and have the potential to help farmers run their business more economically. The critical barrier for the use of ICT, cost of technology needs to be reduced. If the public or private sector enhance / facilitate some funding scheme for ICT service will results to reduce the cost of technology barriers to some extent. Public funding would be justified under the assumption that the public in large would benefit from "cheaper and better" agricultural products. Farmer training needs to be further improved. Farmer training increases ICT adoption and use (Batte *et al.,* 1990). Public sector attention regarding this issue would be useful in urban areas. Specially conducting farmer training programs and demonstrations on ICT usage would beneficial. Therefore, firms may benefit from providing training on information and communication technologies for both employees as well as customers.

Managers should proactively use ICT to promote the trust in their employees and customers who associated in ICT. This will increase the overall use of ICT and promote the use of ICT in all aspects of employees and customers personal lives and work. Increasingly, individuals will turn to ICT when they need information or to communicate with the firm for personal or work-related reasons. If we can build trust in ICT systems among farmers it's very easy to implement good ICT enable environment and it will facilitate efficient and reliable ICT outcome. This survey should be continued in future to get clear justification of ICT adoption and use with time in agriculture sector of Sri Lanka.

ACKNOWLEDGMENT

farmers of the Kurunegala District and tea producers in Sri Lanka for providing necessary information.

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