INFORMATION TECHNOLOGY FACTORS THAT IMPACT ON IMPROVING PRODUCTIVITY IN RURAL INDIA

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ABSTRACT

This research study explores factors that affect information technology acceptance in rural Indian agriculture. These factors are age of participant, size of farm, annual income and number of crops per year. The methodology used a survey to obtain information about the tendency of rural Indian farmers to accept information technology solutions on their farms including data about farmer's age, education, size of farm, annual income, existing infrastructure on their farm and their willingness to accept information technology solutions to increase production. The research findings suggest that most farmers are willing to accept information technology to improve productivity.

Keywords: Rural India, Information Technology Acceptance, Indian Farmers.

INTRODUCTION

In India agriculture and related industries contribute to the overall economic growth of India and determines the standard of living for over 58% of its population (Mukunthan 2015). However, uses of conventional agriculture methods have affected productivity as these methods have not been changed for many years (Seufert, Ramankutty & Foley 2012). Many in India believe that increasing the use of all technology, including information technology in the agricultural sector, is the only way out of poverty for rural India (Sivakumar 2014).

The use of information technology in agriculture has the potential to improve farm productivity in India. For instance, soil and irrigation analysis can provide detailed information about a farm from vulnerabilities in the soil to automatic irrigation system in farms (Thakur & Kshirsagar 2015). This technology uses sensors that are placed on a farm and each sensor provides accurate information that is gathered through software to analyse different properties like soil, water and weather (Nagarajapandian, Kumar & Selvan 2015). With the implementation of this new technology in the Indian rural agriculture, there are many factors that can affect acceptance of

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information systems in farms to increase productivity (Sivakumar 2014), including the need for a basic understanding of computers and software.

The structure of this paper is as follows: first, a literature review is presented that explores the acceptance of information technology in rural India. This is followed by a description of the aims and objectives for this study, a description of the research methodology employed, analysis of the primary data gathered, a discussion of how this compares to what has been found in the literature and how this fits within the technology acceptance model. Finally, a conclusion is presented that suggests that rural Indian farmers are prepared to accept information technology and that there may be socioeconomic factors that detract from the uptake of technological solutions.

LITERATURE REVIEW

Information technology (IT) has been used in the Indian urban agriculture to improve production in recent years (Capalbo & Antle 2015; Mahendra Dev 2014; Mittal 2012). On the other hand, Indian farmers have been reluctant to adopt IT to improve productivity on their farms (Thakur & Kshirsagar 2015; Mukunthan 2015). Factors affecting the adoption of IT in rural India include: the status of the rural agriculture sector (Agrawal 2014); difficulties arising because of a lack of technology in Indian rural agriculture (Mahendra Dev 2014); and rural farmers socioeconomic status and attitudes to introducing IT on farm (Mukunthan 2015).

To implement information and communication technologies, there are some basic factors including how quickly a farmer can adopt these technologies and how fast a farmer can understand these technologies. To obtain knowledge of such factors a number of attributes, including education, age and geographical area, must be considered before implementation of information and communication technology (Goria 2012).

Factors that impact on information technology acceptance include the following:

Age of a farmer. Indian farmers tend to be in the 40 to 50 years age bracket. As this population is older, the adoptability of information technology is lower than average. Farmers who are above fifty in age could face difficulties in adopting new technology due to a huge experience of traditional agriculture methods (Aubert, Schroeder, A & Grimaudo 2012). There may be resistance to change in agriculture methods due to lack of information regarding new immerging technologies of information technology (Hernández, Jimenez & Martin 2011).

Education level. If one considers the Indian rural literacy rate, literacy rate in rural India is much lower than in urban India (Agrawal 2014). The education factor is the most important factor that influences information technology acceptance in agriculture (Chen 2011). At least a basic level of education is required to understand how to operate computing devices including the Internet, computers, and smart phones. Educated farmers are more likely to adopt information technology (Capalbo & Antle 2015).

Annual income. Farmer's income is a contributing factor when analyzing the tendency to adopt information technology (Kassie, Shiferaw & Muricho 2011). Sometimes a farmer is willing to implement the latest technology in the farm but he/she cannot afford this due to a

lack of income. Therefore, income is an important factor to be considered in information technology adoption to improve productivity (Mittal 2012).

The next category of factors is farm characteristics. This category contains the following factors that may affect information technology adoption:

Farm size. Though there is no simple and definitive relation between farm size and technology adoption, several empirical studies have shown strong positive relationship between farm size and technology adoption (Aker 2011). It would appear that the larger the farm, the more likely it is that information technology is adopted to increase productivity and hence income.

Number of crops grown. Many farmers harvest crops twice a year. Lack of technology can decrease the level of income. If farmers have adopted the latest technology on their farm, it may be possible to harvest more than one crop in a year. This eventually reflects on a higher income at the end of year (Mahendra Dev 2014). New technologies can improve the productivity and facilitate farmers to harvest more than one crop from the same farm without any difficulties.

Current available infrastructure. Availability of current infrastructure is a key factor while considering acceptability of new information technology by farmers (Kameswari, Kishore & Gupta 2011). The use of smart phones, computers and the Internet are positive indicators of technology acceptance as these farmers are already using IT devices and are familiar with the basic concepts of information technology (Clements, Haggar, Quezada & Torres 2011).

One of the main inhibitors in information technology (IT) on farms in rural India is infrastructure provision (Mahendra Dev 2014). For the uptake of information and communication technologies (ICTs) such as the Internet, smart phones, and digital televisions information and communication technology is essential. Of these technologies, mobile phone technology is very efficient and can be implemented with less financial resources (Singhal, Verma & Shukla 2011). The socio-demographic status of rural India places this sector lower than all urban areas in India for education, income, and IT infrastructure provision (Mukunthan 2015; Goria 2012).

In rural India, it has been found that older farmers are less likely to adopt IT solutions on a farm (Aubert et al., 2012) as they are more likely to adhere to traditional farming methods. This is also influenced by resistance to change in adopting IT solutions (Hernández et al., 2011; Sivakumar 2014). Education level is also a factor to be considered with the literacy rate for rural India less than urban India by 11% (Sivakumar 2014; Chen 2011). Educated farmers are more likely to adopt IT (Capalbo & Antle 2015a). Rural India is the poorest sector of India's economy (Mukunthan 2015) and for some farmers income level is a barrier to adopting IT for productivity gains (Kassie et al., 2011 & Mittal 2012). Larger farms are more likely to implement technological solutions (Aker 2011). Adopting technology can also assist farmers in harvesting crops twice a year, which in turn leads to an increase in income (Mahendra Dev 2014). Some of rural India is hampered by a lack of technological infrastructure (Kameswari et al., 2011), natural phenomena like monsoons, and insufficient irrigation systems (Subramanian & Tarafdar 2011).

So far, Indian rural agriculture has lagged behind urban India in accepting IT and modern techniques or methods that have been implemented in agriculture (Mukunthan 2015). According to the National Sample Survey Office (NSSO) in June-July 2012-2013 (Crop Period), 57.8% of rural households were involved with agriculture as shown in Table 1 below.

TABLE 1
Profile of Agricultural Households

	Number (Lac)#	% of Rural Households	%Reporting Farming*	% of Income**
Kerala	14.04	27.3	39.0	34.5
Tamil Nadu	32.44	34.7	66.1	43.2
Andhra Pradesh	35.97	41.5	65.4	51.8
West Bengal	63.62	45.0	58.7	30.3
Bihar	70.94	50.5	72.9	56.0
Punjab	14.08	51.1	55.6	69.3
Telangana	25.39	51.5	89.1	72.9
Karnataka	42.42	54.8	76.5	62.6
Maharashtra ***	70.97	56.7	74.9	59.5
Orissa	44.94	57.5	62.4	54.7
Jharkhand	22.34	59.5	73.4	56.0
Haryana	15.69	60.7	69.1	72.8
Assam	34.23	65.2	82.5	74.8
Gujarat	39.31	66.9	68.1	61.4
Chhattisgarh	25.61	68.3	81.1	64.3
Madhya Pradesh	59.95	70.8	77.9	76.5
Uttar Pradesh	180.49	74.8	68.5	69.0
Rajasthan	64.84	78.4	52.8	55.9
All India	902.01	57.8	68.3	59.8

 # 1 Lac = 100,000 Rupees = NZD2100
** % reporting farming as principal income source*
*** % income earned on farm. Farming income includes net receipts from cultivation and animal husbandry. Figures are for the period July 2012-July2013*
**** Data for this research project gathered from Maharashtra*

Maharashtra state has improved towards accepting and implementing information technology as a means of improving productivity, which is seen as a way to boosting India's economy (Maertens & Barrett 2013). Farmer characteristics studied were age, education level, farm size, number of crops annually and available infrastructure. Maharashtra is the second largest state in India, where 55% of the population is dependent on agriculture either directly or indirectly.

RESEARCH METHODOLOGY

The aims and objectives of this research project were to explore what factors impact on the acceptance of information technology in rural India. In researching these factors, the following research question (RQ) and sub questions were posed:

RQ: What are the factors that impact on farmers in rural India accepting information technology solutions to improve productivity?

1. What is the effect of the socio-demographic profile factors of age, education and annual income on Information Technology acceptance?

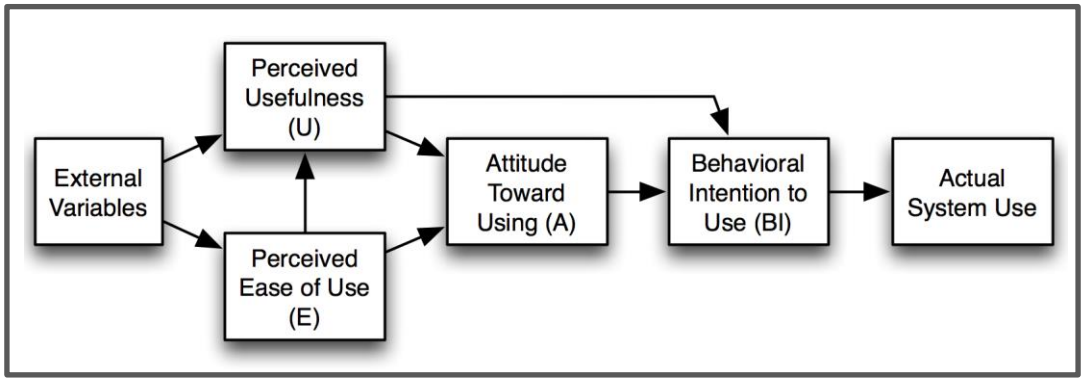
2. What is the effect of farm characteristics on information technology acceptance in rural Indian agriculture?
3. What are the views of Indian rural farmer towards information technology acceptance?

For this research project, data from 106 farmers in Maharashtra state was collected using a survey where data was gathered online and by telephone. The target population for this research project was farmers in rural India in Maharashtra state who have agriculture as their primary business. Because of time constraints for this project, a convenience sample (non-probability sample) from personal networks was used for this research project. Descriptive statistics only have been used to analyse the data as the sample collected was not statistically significant. The population or rural Maharashtra state is in excess of 61,000,000 and a statistically significant sample size at a confidence level of 95% and a confidence interval of 4 would be 600. As only 106 participants responded, descriptive statistics have been used. The usual ethics approval was obtained including no harm to participants, informed consent, non-invasion of privacy and no deception in data gathering. Limitations for this study included; difficulties in contacting sufficient farmers who are faced with limited information technology infrastructure provision including electricity provision and access to the Internet, so a variety of methods were used to gather the data including landline telephone, cellphone and computer. Participation level was lower than expected, which in part was attributed to a high illiteracy rate in rural India.

Theoretical model used (Technology Acceptance Model)

The Technology Acceptance Model (TAM) (see Figure 1 below) has been used in this study on the adoption of information technology (IT) in agriculture (Gollakota, Pick & Sathyapriya 2012). TAM proposes that perceived usefulness and perceived ease of use are primary factors that determine the attitude toward IT acceptance (Aubert et al., 2012). Since acceptance of IT is a voluntary act, an intrinsic motivation would have as much of an impact as perceived usefulness (Šumak, Hericko & Pusnik 2011). Therefore, perceived usefulness and perceived ease of use are proposed as the main factors that affect a user's beliefs. In this study, perceived usefulness and perceived ease of use are important factors for farmers in rural India, considering implementing technical solutions to improve farm productivity. For this reason, the Technology Acceptance Model (TAM) was considered to be the most appropriate theoretical model.

FIGURE 1
Technology Acceptance Model



(Davis 1989)

FINDINGS

Data gathered from rural farmers in Maharashtra state was analysed using descriptive statistics for age, education, farm-size and technology infrastructure.

Age

79% of participants within the age range 20-30 were likely to accept information technology (IT). Participants in the age range 31-50 were less willing to accept IT. From this small sample, it seems that with increase in age for the age range groups 20-30 and 31-50, IT acceptance level decreases. In contrast, participants the age group of 51 and above had more willingness to accept IT than those participants aged 31-50.

Education

70% of participants with tertiary qualifications and above were willing to accept IT, whilst participants who were educated up to 10^{th} standard were less likely to accept IT.

Farm Size

Participants having a farm of size 0-25 acres and 100 acres and above were more likely to accept IT than farmers having farm of size 26-50 acres and 51-100 acres.

Infrastructure

92% of participants were ready to accept IT for those who had a computer and the Internet at their farm.

Farm Size, Age vs IT Acceptance

Combined factors of farm-size, age and IT acceptance have been considered as shown in Table 2 below. It can be seen that participants aged between 20 and 30 were more likely to accept IT regardless of farm size. 90% of this age group whose farm size was small (0-25 acres) accepted IT. 67% of this age group with a farm size between 26 and 50 acres accepted IT. With increasing farm size, IT acceptance rate reduces. With the combination of factors of farm size between 0-25 acres, and farmers older than 50 there is less acceptance of IT (47%). On the contrary, when farm size up to 25 acres and age of farmer up to 30 are considered together it is more likely that IT is accepted (90%). Finally, when considering farm size above 100 (acres), and farmers between the age of 31-50 there is less IT acceptance (33%).

TABLE 2
Farm Size-Age vs IT Acceptance

Farm Size (acres)	Age	IT Acceptance
0-25	20-30	90%
0-25	31-50	71%
0-25	51 and above	47%
26-50	20-30	67%
26-50	31-50	60%
26-50	51 and above	78%
51-100	20-30	0%
51-100	31-50	25%
51-100	51 and above	67%
100 and above	31-50	33%
100 and above	51 and above	57%

Farm Size-Annual Income vs Information Technology Acceptance

In Table 3 below the combination of farm size and annual income was considered to establish IT acceptance in this sample. Annual income appears to have a direct relation with IT acceptance. Participants having an annual income of 1-10 lacs were more willing to accept IT (85%). Participants having an annual income between 11-20 (Lacs) had the lowest acceptance level irrespective of farm size (37%, 50% and 20%) while 50% of participants having a farm size 51-100 (acres) were more likely to accept IT. 60% of participants whose income was 1-10 Lacs accepted IT, 20% of participants who earned 11-20 Lacs accepted IT and 67% of participants who earned 21-50 Lacs accepted IT. Participants having 51-100 acres of farmland, were less willing to accept IT (60% and 20%).

TABLE 3
Farm Size-Annual Income vs Information Technology Acceptance

Farm Size (acres)	Annual income	IT Acceptance
0-25	1-10 Lacs*	85%
0-25	11-20 Lacs	37%
0-25	21-50Lacs	57%
26-50	1-10 Lacs	80%
26-50	11-20 Lacs	50%
26-50	21-50Lacs	57%
51-100	1-10 Lacs	60%
51-100	11-20 Lacs	20%
51-100	21-50 Lacs	67%
100 and above	50 Lacs and above	50%
* 1 Lac = 2100NZ$		

Crop Harvest-Weather vs Information Technology Acceptance

India has faced significant weather changes in the past few decades, such as droughts, unexpected rainfall and floods. Farmers that harvest their crop once a year face more risk due to climate conditions. These climate conditions are unexpected rain, flood and drought. 70% of farmers who harvested once a year had unexpected rainfall, 67% of farmers who harvested once a year said they experienced flood Those participants who harvest once a year indicated 100% acceptance of IT to alleviate climate related problems due to drought. 96% of Participants who harvested twice a year stated that they experienced unexpected rainfall, 70% of participants who harvested twice a year stated that they experienced flood, and 58% of this group state that they experienced drought. Farmers that harvest crops four times in a year are less likely to accept IT as shown in Table 4 below.

TABLE 4
Crop Harvest-Weather vs Information Technology Acceptance

Crop Harvest	Weather	IT Acceptance
Once a year	Unexpected Rainfall	70%
Once a year	Flood	67%
Once a year	Drought	100%
Twice a year	Unexpected Rainfall	96%
Twice a year	Flood	70%
Twice a year	Drought	58%
Four times	Unexpected Rainfall	56%
Four times	Flood	54%

Farm Size-Crop Harvest vs Information Technology Acceptance

When considering the attributes of farm size and crop harvest it can be seen in Table 5 below that participants who had small farms had information technology acceptance rates from 67% (those who harvested four times a year), 78% (those who harvested twice a year) and 77% (those who harvested once a year).

TABLE 5
Farm Size-Crop Harvest vs Information Technology Acceptance

Farm Size (acres)	Crop Harvest	IT Acceptance
0-25	Once	77%
0-25	Twice	78%
0-25	Four Times	67%
26-50	Once	0%
26-50	Twice	69%
26-50	Four Times	87%
51-100	Once	50%
51-100	Twice	40%
51-100	Four Times	78%
100 and above	Once	83%
100 and above	Twice	50%

For those participants who had a farm size between 26-50 acres, no farmers who harvested once a year accepted information technology, 69% of participants who cropped twice a year accepted information technology, and 87% off participants who cropped four times a year accepted information technology. For farmers with a farm size between 51-100 acres, 50% of participants who cropped once a year accepted information technology, 40% of farmers who cropped twice a year accepted information technology and 78% of farmers who cropped four times a year accepted information technology. Of those participants with large farms of 100 acres or more, 83% of farmers who cropped once a year accepted information technology, 40% who cropped twice a year accepted information technology, and 78% who cropped four times a year accepted information technology.

DISCUSSION

In addressing the main research question for this study: what are the factors that impact on farmers in rural India accepting information technology (IT) solutions to improve productivity, socio-demographic profile factors of age, education and annual income were considered as influencing factors, along with farm characteristics of farm size and number of crops harvested each year, and weather events. The responses gathered suggest that participants can protect themselves from adverse weather events by a combination of cropping more than once a year and adopting IT to help manage their farming. When the TAM model is considered (Figure 1) external variables that affect participants' acceptance of IT included extreme weather events like unexpected rain, drought and flooding. In some ways, TAM is outmoded because perceived usefulness and perceived ease of use have faded into the background as IT has become easier and more intuitive to use. More important are attitudes toward using IT and actual system use. Older participants indicated a reluctance to accept IT in their responses, whilst younger participants regardless of farm size were most likely to accept IT solutions on farm.

LIMITATIONS

The first limitation for this study was the limited information communication infrastructure for rural India. India is a developing country that has limited rural Internet communication infrastructure. Many rural Indians still do not have mobile phones, computers or access to the Internet. Farmers in this category were contacted by landline telephone.

The second limitation for this study was the rate of illiteracy in rural India. Because there is a low literacy rate in rural India, this made it difficult to convince farmers to participate in this research project that was conducted by a survey.

A third limitation was the lack of basic infrastructure in rural India, such as information communication technology allowing access to the Internet. Also, many people living in rural India do not have access to basic infrastructure such as electricity. To implement information technology for increase productivity, they need basic infrastructure for the implementation of new technology.

Because of these demographic, geographic and socioeconomic factors that exist in rural India, it cannot be guaranteed that the sample for this research project is representative of the

agricultural population in rural India. The small sample size is also a limiting factor, and so the results have been limited to descriptive statistics. There was also a limited time frame in which this research was carried out.

CONCLUSION

After analyzing the data gathered, it can be concluded that younger farmers are more willing to accept technology change than older farmers. So, sub-question 1 with respect to age, is likely to be supported that the age of a farmer affects information technology (IT) acceptance. According to analysis results, farmers with tertiary qualifications are 100 percent willing to accept information technology, while farmers with a lower education level have less interest in accepting IT. It has often been stated that education is a well-known route out of poverty, and it would seem that rural India is no exception. Hence, according to the education angle of sub-question 2, the education level of farmers also affects information technology acceptance, as less educated farmers have a significantly lower rate of technology acceptance. Analysis results show that IT acceptance varies with different farm sizes. Farmers with the low farm size (i.e. up to 25 acres) and farmers with the largest farm size (i.e., above 100 acres) have a higher percentage of information technology acceptance than those farmers with mid-sized farms. Farmers' views about information technology appear to be influenced by a variety of factors, so it is not clear at this stage what the outcome for sub-question 3 is. Further research is needed to ascertain what these might be. As this was a relatively small sample for this research project on IT acceptance in rural India, it would seem that this would need further research to ascertain whether or not this was a true result.

Recommendations arising form this study are:

- There is a need for information technology infrastructure in rural India, including electricty supply. Much of rural India has no basic infrastructure such as a regular. stable electricity supply
- The Indian government has provided farmer empowerment services and more farmers could benefit by taking advantage of these services. Poverty is often an inhibiting factor for the uptake of such empowerment services
- Knowledge sharing communities would benefit rural India with those farmers who have embraced what information technology acceptance can do on farm sharing with those who have not accepted information technology to improve productivity.

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