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Impact of Modern ICTs' usage on Agricultural Productivity: An Application of Modified TAM

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Abstract:
Available academic literature liberally appreciates the capability of modern Information and Communication Technology (ICT) for its significant contribution towards social and economic development. However, very few studies have extended the technological domain to the agricultural sector. Given the natural resource constraints on agricultural productivity in India, use of ICT could be a sustainable and inclusive solution. This paper attempts to understand the impact of ICTs on agricultural performance and income of the farmers. A descriptive study was conducted in Karnal and Sonepat districts of Haryana state in India and data was collected from 300 farmers. Structural Equation Modeling was used to assess the impact and test the hypotheses. Modified Technology Acceptance Model (TAM) given by Davis has been used to understand the technology acceptance behaviour of farmers in their farm related activities. The study revealed that farmers were using the modern ICTs. Usage of modern communication channels for knowledge dissemination among the farmers has resulted in creating both forward and backward linkages and positive externalities. Farmers accepted that usage of ICTs in agriculture led towards increased agricultural productivity in terms of increase in yield, quality of produce, number of crops sown as they are more aware. The study implies that India needs to emphasize on using modern ICT technologies for improving agricultural performance and scale the existing initiatives and create more awareness among the farmers for adoption of new technologies in farming.

Keywords: *Information and Communication Technology, Agricultural Productivity, Indian Farmers, Technology Acceptance Model, Income disparities.*

I. INTRODUCTION

Agriculture and its allied activities contribute 17% to the GDP and employs more than 56% of Indian working population, thereby making it the sector essential for overall economic development [1]. However, Indian agricultural landscape has continued to witness a substantial decline in agricultural productivity across states for more than two decades especially after liberalisation which has led to severe distress among the farmers. The sector registered a miser growth of around 1.6 per cent during 12th five year plan [2]. Several factors like increasing loan burden on farmers, poor irrigation facilities, stern dependence upon weather adversaries, usage of unproductive conventional farming methods, inefficient use of agricultural inputs, lack of product diversification, dependence upon middlemen and inadequate financial support are chiefly contributing towards low productivity in agricultural sector [3]. The demonetization of currency in 2016 by the Indian government has further adversely affected the agriculture sector as it is solely dependent on cash transactions.

Less than average landholding size for cultivation coupled with negative returns from crop production further aggravate the conditions of Indian framers. In India, 85% of agricultural landholdings are less than five acres in size and 67% farming households are still struggling to earn their livelihood on less than one acre landholding [4]. In spite of several initiatives like building irrigation facilities, extension services, land reforms, loan waivers, hike in minimum support price, extending credit and marketing support taken by both the central and state governments to revive the agriculture sector, it only grew at 3.7 per cent during the 11th Five Year Plan [2]. Such, concerted efforts by the government to revive the agricultural productivity in

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India deem to be insufficient and unsustainable agenda in long run and offer no permanent solution to the problem.

Indian farmers face multiple challenges like erratic monsoons, high cost of agricultural inputs, low prices of produce, inadequate market access and many localized problems [5]. There remains a strong need of bringing holistic changes in technological, infrastructural and market mechanisms to offer value enhancement in agriculture ultimately leading towards enhanced productivity of small farmers. Given the natural resource constraints on agricultural productivity, use of Information and Communication Technology, hereafter referred as ICT, could be a sustainable and more inclusive solution which has the potential to improve farm productivity and rural incomes [6]. The World Bank Group defines ICT as a set of hardware, software, networks, and media for the collection, storage, processing, transmission, and presentation of information in the form of voice, data, text, and images [7]. Contemporary devices and platforms like computers, mobile phones and internet are at the core of ICT framework, which have significantly transformed the ways of communication, sharing and searching information resulting in significant learning and improvement of processes for people at large. Knowledge and information sharing for rural people are significant elements for accelerating agricultural development. It can benefit the farmers by reducing the information asymmetry existing in agricultural sector and help in improving farm productivity and profitability. Availability of quick, relevant and reliable information can improve the decision making capability of the farmer and also increase their bargaining power in the market. Use of ICT also makes a meaningful contribution by minimizing distances and cost of interaction among various stakeholders. It has the potential to help farmers in the entire cycle of production, i.e. from production to sales [8]. Efforts are being made to make ICT technologies available to rural farmers and focus is on improving the availability and quality of information by extension workers or by ICT technologies like radio information services, tele-centres, and mobile messaging service. Use of ICT to promote Indian agricultural development can be a strategic move to improve its current position in terms of productivity, income and consumption of those engaged in this sector.

Available academic literature liberally appreciates the capability of modern ICT for its significant contribution towards social and economic development. However, very few studies have extended the technological domain to the agricultural sector. This study genuinely appreciates the existing research gap and aims to fulfill the same by conducting an academic study that would help understanding the various aspects of ICT usage ultimately affecting the farmers. The rapid penetration of low cost mobile devices, reducing data prices and government's thrust for digitalization offer exceptional opportunity to revive the highly distressed Indian agricultural sector. This study attempts to understand the impact of ICTs on agricultural performance and income of the farmers collectively referred as agricultural productivity.

II. REVIEW OF LITERATURE

Information and Communication technologies, the culmination of human's centuries old knowledge and experience are now taking the centre stage and playing pivotal role in economic growth and development. Innovations in the field of ICT are not only renewing traditional sciences like agriculture, but also focus on issues like poverty alleviation, environmental protection, climatic deterioration and the future of planet as a whole which have been neglected in the past years. According to World Bank [7], ICT can successfully deal with poverty alleviation by increasing efficiency and global competitiveness of the economy, enabling better delivery of public services and generating new sources of income and employment for poor populations. ICT owing to its unique characteristics namely being pervasive, easily affordable, compatible and progressive, has the potential to empower the rural masses majorly engaged in agriculture and can change the face of rural India.Farmers in rural villages are using voice and data services through their mobile phones to get agriculture related information. Community Based Information System started by Grameen phone in Bangladesh provided information to rural farmers [9]. Richardson [10] classified information technology usage in agriculture and rural context under five categories; economic development of farmers, community development programs, research and education, development of SME and media networks. This study would concentrate on the first aspect of classification provided by Richardson that is how usage of ICT can lead to economic development of farmers in rural market who represent a major chunk of consumer segment in Indian market today.

Simon [11] stressed that adoption of improved agricultural technologies has a positive and significant affect on crop income and consumption of farmers leading to increase in welfare and reduction in poverty. Rise in agricultural productivity will be achieved when farmers have access to information [12]. Majority of the farmers depend on intermediaries for market information and sale of their produce. They travel to market for getting updated information on price. Use of ICT technologies can facilitate better information exchange and lower transaction and

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transportation costs of farmer thereby increasing their incomes [13]. Efficient deployment of ICTs in agriculture sector leads towards unification of the varied information related to quality of produce, disease control and marketing of crops and makes it easily accessible to the farmers ultimately manifesting in the form of improved agricultural productivity [14]. Ninan [15] analyzed the positive association between increase in income of people and good agricultural output which was also corroborated by the study of Aggarwal and Kumar [16] who also emphasized that enhanced agricultural productivity and production leads to increase in income of rural poor and decline in poverty during mid-1970s to early 1990s. Deloitte Study [17] emphasized that a mere increase of 1% broadband penetration in India can lead to an increase of Rs 162 billion in gross GDP which was equivalent to 0.11% contribution to GDP of our country in 2015. This led to the hypothesis Ha1.

Ha1: Usage of Information and Communication Technologies positively affects the agricultural productivity of Indian farmers.

Rural areas are often described as 'information-poor' and dissemination of information is one of the most important objectives of various development efforts [18]. Farmers need to have comprehensive information, related not only to the best practices and technologies for crop production and weather, but also the information regarding marketing, storage, and handling of produce [19]. ICTs especially the mobile phones offer quick, reliable, real time, cost effective information to the poor marginalised farmers in developing economies and are definitely superior to traditional communication alternative [8]. Dissemination of real time information to the farmers can enable effective use of agricultural inputs and selling the products in the markets at better prices. Singh and Kameswari [20] stressed that improvement in technology and its usage has led to increase in income and fall in incidence of poverty in Indian context. Prasad and Pradhan [21] revealed that ICT technologies are cost-effective and enables quick information delivery and hassle free knowledge sharing among farmers. Zhang et al. [22] revealed that there is a direct relationship between perceived usefulness of ICTs and its usage in agricultural sector. It can be apprehended from the above discussion that ICTs are creating contemporary communication channels for farmers leading to enhancement of their agricultural productivity. This led to the formulation of hypothesis Ha2 of the study.

Ha2: Perceived usefulness of ICTs leads farmers towards the intentions to use them in agriculture.

User friendliness of a technology is one of the most important factors affecting its adoption by the masses [23]. User friendliness represents the ease of understanding, usage and less complex nature [24]. Narine, Harder and Roberts [25] assert that ease of use is one of the essential determinants of ICTs adoption by the farmers. Perceived usefulness and perceived ease of use are the two basic constituents of Technology Adoption Model proposed by Davis [26] which also suggests that perceived ease of use not only affects the perceived usefulness but also the adoption of technology. Ease of use is defined as the extent to which a user believes that using a particular technology would be free of effort. Amin and Li [27] proposed a farmer technology acceptance model based on TAM where Perceived ease of use and Perceived usefulness had a direct impact on adoption and intention to use technology by the rural farmers of Bangladesh and China. Some studies have tried to explore the relationship between perceived ease of use and intention to use ICT in agriculture and believe that if technologies are of low cost and gathers large information in shortest time, they are more likely to be used by the farmers [20]; {21]. Subsequently hypotheses Ha3 and Ha4 were formulated for the study

Ha3: Perceived ease of use positively and significantly affects the perceived usefulness of ICTs.
Ha4: Perceived ease of use leads to the intentions to adopt ICTs by Indian farmers.

Effort expectancy is considered as the ease of using a particular have a significant roles in predicting the intention to accept using a system and significantly one of the factor that explain the behavioural intention to accept to use a technology. Effort expectancy significantly correlated with the behavioural intention, has direct effect on actual usage of technology [28]. TAM and other prominent technology adoption models like Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB) and Decomposed Theory of Planned Behaviour (DTPB) unanimously agree over the relationship that actual usage of a technology is always preceded by usage intentions. TAM states that perceived usefulness and perceived ease of use explains the difference in users' intention for technology adoption [26].This study also hypothesized that:

Ha5: *Intentions to use ICTs lead towards actual usage of ICTs by Indian farmers.*

Based upon the hypothesized proposition, conceptual model given in Figure 1 was used in the study. Basically, the model is a modified version of commonly used Technology Acceptance Model given by Davis [26]. The

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mode has been modified by removing the attitude context and tailoring the key constructs like Usage Intentions and Actual Usage agricultural context. The model has been further extended by adding one more construct namely the Agricultural Productivity.

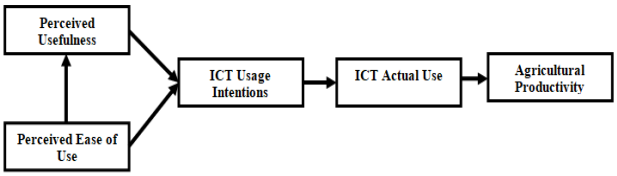

Figure 1: Conceptual Model

The model states that perceived usefulness and perceived ease of use of modern ICTs lead towards the intentions to use the latter by the farmers. Perceived ease of use also affects the perceived usefulness of ICTs for the farmers. The relationship among these three constructs was also envisaged in the similar fashion as per original TAM. Usage Intentions lead towards actual usage which in-turn leads towards enhanced agricultural productivity.

III. OBJECTIVES OF THE STUDY

The following objectives were envisioned for the study:
1. To study the impact of perceived usefulness (PU) and perceived ease of use (PEOU) of modern ICTs on usage intentions of farmers in Haryana.
2. To assess the impact of modern ICTs on agricultural productivity of farmers in Haryana.

IV. RESEARCH METHODOLOGY

The study was descriptive in nature that aimed to assess the impact of modern ICTs (Mobile and Internet) on agricultural productivity. An individual farmer was considered as sampling unit for the study. Farmers were contacted once, which made the study cross-sectional in nature. The study was conducted in the one of the most progressive state of the country, Haryana. Though, it is geographically a very small State, its contribution to the country's development has been very significant. Agriculture remains the mainstay of Haryana's economy. Haryana is a leading State in wheat, mustard and rice production and productivity. A list of farmers, obtained from 'Krishi Vigyan Kendra' using its mobile services was used as sampling frame. Two districts namely Sonepat and Karnal were chosen for the study to reduce the selection bias and ensuring adequate variability in the sample. Karnal, the biggest rice exporters in the country with more than 200 rice mills is a developed district in the field of agriculture in comparison to Sonepat. Ten villages, within the maximum radius of 30 kilometres from the district headquarters were conveniently selected. A total of 300 farmers from the list, were contacted and 'schedule' i.e. the tool of data collection was self-administered by the researcher especially to overcome the language constraints keeping the rural context in mind to obtain the primary data. 288 farmers accepted to be a part of the study. Structural Equation Modeling was used to assess the impact and test the hypotheses.

V. CONSTRUCTION OF THE SCALE

The study hypothesized that PU and PEOU are the major determinants leading towards the usage intention thereby leading of ICTs in agriculture which is in conformance with the basics of Technology Adoption Model (TAM), the most popular model in understanding adoption of technology among individuals. TAM has been accredited as a robust and parsimonious model especially in the case of Internet and mobile technologies in diverse contexts [29]; [30]. TAM has also been applied in the field of agriculture and rural market in different studies [22]; [31]. So, scale items for factors like PU, PEOU and usage were adapted from TAM and modified for the current study. Table 1 gives the details of scale constructed for the study.

Table 1: Construction of the Scale

Constructs and Measuring Statements	**Reference Studies**
Perceived Ease of Use (PEOU) • ICTs are easy to use. (PEOU1) • Easy to get desired information. (PEOU2) • Interaction with ICTs is understandable (PEOU3) • Interaction with ICTs is flexible. (PEOU4)	[20]; [22]; [23]; [24]; [25]; [26]; [32].
Perceived Usefulness (PU) • Using ICTs helps accomplishing farm operations quickly. (PU1) • Using ICTs makes the farm operations easy.(PU2) • Using ICTs enhances the effectiveness. (PU3) • Usage of ICTs is useful in farm. (PU4)	[9]; [18]; [19]: [21]; [22]; [26]: [32]; [33]
Usage Intentions (UI) • Always try to use ICTs in agricultural tasks wherever it might help. (UI 1) • Try to use ICTs in as many cases as possible for managing the farm. (UI 2) • Plan to use ICTs in future for farm management. (UI 3) • Expect usage of ICTs in farm management to increase in the future. (UI	[20];[21]; [25]; [26]:[27];[28]; [31]; [32]; [34]

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4).	
Actual Usage (AU) • Use ICTs to get information about farm inputs. (AU1) • Use ICTs to get information about crop types. (AU2) • Use ICTs to get information about weather conditions. (AU3) • Use ICTs to get information about market rates (AU4) • Use ICTs to get information about seeds variety (AU5) • Use ICTs to get information about pesticides and insecticides.(AU6)	[9]; [22]; [26]:[27]; [28]; [31]; [32]; [35]
Agricultural Productivity (AP) • There is an increase in yield because of using ICTs. (AP1) • There is an increase in income because of using ICTs.(AP2) • There is an increase in quality of produce because of using ICTs. (AP3) • There is increase in number of crops sown in field in a year because of using ICTs. (AP4) • There is better disease control for the crops because of using ICTs. (AP5)	[8]; [12]; [15]; [16]; [22]; [31]; [32]; [36]

VI. RESPONDENTS' PROFILE

This can be seen from Table 2 that 34% of the farmers were in 31-40 years age group whereas 30% were laying in 41-50 years age group. 92% respondents were male farmers whereas 8% of the sample was represented by female farmers. 90% of the respondents were single and 10% were married. Highest number of representation was observed in monthly income class Rs. 11,000- Rs. 20,000 (44%); followed by income up to Rs. 10,000 (25%) then followed by Rs. 21,000- Rs. 40,000 (21%) and respondents were thinly distributed in income class Rs. 40,000 and above (10%). 27% of respondents only had primary education, 30% had high school education, 24% of the respondents had studied till higher secondary and 19% were possessing graduate degree and above. Farmers made adequate use of ICTs and mobile phone emerged as the most used channel of communication used by 75% of the respondents. Television was used by 70% of the respondents and internet was used by 25% of the respondents. Radio was the least used channel, used merely by 14% of the respondents.

Table 2: Respondents' Profile

Variable	Categories	Number (%) of Respondents
District	Sonepat	150 (52%)
	Karnal	138 (48%)
Age	21-30	52 (18%)
	31-40	97 (34%)
	41-50	85 (30%)
	50 and above	54 (18%)
Gender	Male	265 (92%)
	Female	23 (8%)
Marital Status	Married	259 (90%)
	Unmarried	29 (10%)
Income	Up to 10,000	72 (25%)
	11,000-20,000	127 (44%)
	21,000-40,000	60 (21%)
	41,000 and above	29 (10%)
Education	Primary Education	79 (27%)
	High School	86 (30%)
	Higher Secondary	68 (24%)
	Graduate &Above	55 (19%)
ICT Used	Internet	71 (25%)
	Mobile Phone	217 (75%)
	Television	201 (70%)
	Radio	39 (14%)

Reliability of the scale was checked with the help of Cronbach's Alpha and for each construct value was found more than .7, thereby indicating an internal consistency of the scale. Validity of the scale was checked with the help of factor loading wherein each item loaded more the cut off value of .6. Average Variance Extracted (AVE) value was also found more than the recommended values of .5 for each construct [37]. Discriminant validity was checked with the help of Fornell-Larcker [38] wherein square root of AVE of each construct was found greater than their inter-construct correlations.

VII. DATA ANALYSIS AND FINDINGS

This can be seen from the table Table 3 that for all the constructs, respondents assigned more than the average value (more than 3), which was also found significant. T-test was applied as test of significance at 5% level of significance.

Table 3: Descriptive Statistics and Hypothesis Test Summary

Construct	Mean Value	Std Deviation	Test Statistic	Sig.
Perceived Ease of Use (PEOU)	4.30	1.080	One Sample	.005
Perceived Usefulness (PU)	4.25	.090		.003

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Usage Intentions (UI)	4.01	.710	t-test	.000
Actual Usage (AU)	3.46	.457		.000
Agricultural Productivity (AP)	3.44	.876		

The significant results indicated that farmers in both the districts considered ICT channels easy to use where they considered ICTs as easily understandable and flexible enough to offer the desired information effortlessly. They assigned the highest mean value (4.30) to the perceived ease of use. They also considered ICTs significantly contributing towards quick accomplishment of farm operations thereby augmenting farm operations and enhancing effectiveness. They exhibited intentions to use ICTs in future as well in maximum farm operations possible. Farmers also agreed to use ICTs for taking information about farm inputs, crop types, weather conditions, market rates, seed variety and pesticides. Farmers also expressed that usage of ICTs in farming has led to an increase in yield and income, number of crops sown and quality of produce. Farmers also agreed to the fact that usage of ICTs has also resulted in disease control.

Proposed model for the study was checked for its fit using structural equation modeling. Table 4 gives the fit indices of structural model. The proposed model was found fit with a CMIN/DF value of 2.286, which was less than the recommended value of 3 [39]. Root mean square error of approximation (RMSEA) value was found as .038 indicating the good fit of the proposed model [40]. Other fitness indices were also found exceeding value of .9.

Table 4: Model Fit Indices

Index	Model Value	Recommended Value
CMIN/DF	2.286	≤ 3
NFI	.906	≥.80
RFI	.923	≥.90
IFI	.957	≥.90
TLI	.964	≥.90
CFI	.932	≥.90
RMSEA	.038	≤.10

All the constructs of the study were found in relationship as predicted in the proposed model. This led to the acceptance of all the hypotheses of the study. Figure 2 displays the results of path analysis.

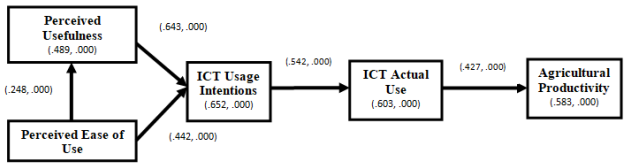

Figure 2: Results of Proposed Model

Significant relationship was ascertained between PU and usage of ICTs (.643, .000) and between PEOU and Usage of ICT (.442, .000). Significant relationship was also obtained between PEOU and PU (.489, .000). PU and PEOU explained 65% variation in the usage intentions. Usage intentions positively affected the actual usage as a significant relationship was observed between UI and AU wherein former explained 60% (.603, .000) variation in the latter. Farmers accepted that usage of ICTs in agriculture led towards increased agricultural productivity in terms of increase in yield, quality of produce, number of crops sown and increased income. The relationship was found significant whereby usage of ICTs explained 58% of the variation in agricultural productivity. The results of the study resulted in acceptance of all the hypotheses.

VIII. DISCUSSION AND IMPLICATIONS

Existing research works have touched upon different dimensions of information and communication technology in different time and place settings especially in foreign contexts. Is it wise to replicate the interventions that succeeded in other countries in India? Will those interventions work in India? Very few studies were found in the field of agriculture in Indian rural context, that too mainly focusing upon the determinants and barriers**.** Moreover Indian studies have been conducted in southern states of the country and hardly any study has been done in Northern India. Available literature highlighted that ICTs have the capability to affect the overall agricultural productivity. The literature also revealed that farmers use ICTs in agriculture due to the perceived benefits and ease of use associated with these technologies which ultimately lead towards improved agricultural productivity. However, one can observe the dearth of studies especially in Indian context dealing with such observations. So, this study is developed as an interventionist solution (attempted in the past and ongoing) to apply in Information and communication technology in agriculture in Indian context and explore different dimensions of ICT usage on farmer's income and productivity.

The evolution of ICT in developing countries offers a new platform for accessing information. It could be

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complementary to agricultural extension, which has long suffered with challenges related to scale, sustainability, relevance and responsiveness. There are various ICT projects in India, Bangladesh and sub-Sahara implemented in the agriculture sector. But like traditional agricultural extension, ICT-based agricultural extension risks becoming unsustainable, a "fad" and with limited impact on knowledge, application of technology and prosperity of poor households.Last decade has seen many ICT projects being implemented by Government and private organizations but these are too few in relation to the ever growing need of the growing population. For this reason, projects need to be evaluated and monitored rigorously. It is important to assess their potential sustainability as well as cost effectiveness in the long run.

The Haryana government have a created a Web Portal "Digital Kisan" which has a collection of relevant web sites to disseminate information for the benefit of farmers. They have also introduced Voice-Based Service – information dissemination through telephone as well as SMS based service has been initiated by Krishivigyan Kendra .'KisanSuvidha' a mobile app has been launched by hon'ble PM at the centre level for dissemination of certain basic information like weather, market prices, advisories and Pests/diseases etc. National e marketing platform NAM has been initiated which has led to integration of 585 wholesale mandis to enable e trading across the country with an objective of removing the intermediaries and ensuring a larger share for the farmer with higher transparency. Video Conferencing facilities to facilitate information service have also been started in district centres and panchayats to disseminate relevant and timely information for farmers.

The number of people dependent on agriculture is huge and if India is striving to achieve a higher level of economic growth, it needs to emphasize on using modern ICT technologies for improving agricultural performance. India can speed up developmental projects in rural market so that the country experiences an improved income growth as it provides food for domestic consumption as well as produce surplus for generation of additional earnings.

There are multiple government bodies which are operational in the state of Haryana like department of Rural Development, Department of Land Resources, Haryana Kisan Aayog and many others which work for Rural Development of the state. Gagging the influence of modern technologies, such as the internet and mobile telephony, on agriculture is crucial in the pursuit for sustainable development in the rural market of a developing economy. So bodies like Krishi Vigyan Kendra have been established for facilitating a linkage between these modern technologies and farmers.These technologies have the potential to assist farmers on sharing relevant agricultural information that will boost their productivity and incomes. This study will provide economic and social planners, decison makers, and implementers for implementing effective policies on sustainable agricultural development. The study will also guide policy-makers, researchers, and practitioners on methods and approaches that can be used to promote the development of the use of ICT in agricultural operation.

ICT is an instrument and not a resolution to the socioeconomic problems of India. The information services must be tailored according to the requirements of rural consumers and be development focused. Adoption and Appropriation of ICTs in rural market is a long and gradual process which will enable farmers in rural market to explore new dimensions and benefits of ICT use in their lives. Even if new ICTs like Internet and mobile is quite beneficial but it has to be customer centric. Target customers need to integrate these technologies in their lifestyle. Presently there are innovators and early adopters of these technologies in rural market. But with innovation in Telecom and Broadband Industry very soon diffusion of these technologies is going to reach greater heights.

IX. CONCLUSION

The study revealed that farmers were using the modern ICTs and intended to do so in near future also. The most contemporary communication channel 'mobile phone' was used by 73% of the farmers. Farmers were getting SMS messages from Krishi Vigyan Kendra about the optimal quantity of manures, pesticides and fertilizers to be used for different crops in the farm of standard size. This reduces the use of excess fertilizer and economizes the cost and results in savings for the farmers. 26% of the farmers were using internet along with mobile phones. Usages of contemporary communication channels resulted in creating both forward and backward linkages and positive externalities which are helping them to reap double advantages. ICT help farmers with limited resources by assisting them in growing by apprising them about variety of seeds, pesticides and insecticides, crop type and weather updates resulting in backward linkage. ICT technologies enable framers to search for better market prices and reduce their transportation cost by taking their produce to those markets where they are able to fetch better price for their output, resulting in forward linkages. Farmers were also receiving information about the prevailing rates of agricultural crops in the neighbouring Mandis from Krishi Vigyan Kendras. Farmers considered themselves skilful in

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understanding modern ICTs and perceived these technologies easily accessible and easy to use.

X. RESEARCH LIMITATIONS AND FURTHER RESEARCH

The study is an exposition on the micro level analysis conducted in two districts of Haryana. Though the issues and solutions for measuring the impact of ICT application on agricultural productivity may not be very different from macro issues but the same has been largely ignored in this study. Therefore due caution must be taken while interpreting the results or extending the study in other parts of India and globe. The methodology design included a convenience sample due to descriptive nature of the study and time constraint. However, with additional planning and time, the inclusion of random sampling would have been able to provide strengthened regression and/or causal models. ICT adoption in rural market should not be restricted to only agriculture. Its contribution to the rural community in different forefronts like e governance and E-selling should also be considered. The "agent of change" may not be the "innovative farmer" and the target function may not be to maximize agricultural productivity/ output but the development of entire rural community.

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