Impact of information and communication technology on marketing of rice

A study of Uttar Pradesh

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Abstract

Purpose – The lack of proper dissemination of market information is observed as the main reason of poor marketing of the agricultural produce in India. Application of information and communication technology (ICT) can bridge this information gap by means of dissemination of required marketing information specifically targeted at the farmers. The purpose of this paper is to study the impact of ICT on marketing of rice in Uttar Pradesh, one of the biggest northern states of India.

Design/methodology/approach – As rice is the dominant crop of Uttar Pradesh, the impact of ICT on net price received (NP_f) by rice producers of the state is studied. An attempt is also made to identify the factors that influence the use of ICT. Primary data are collected through a multistage sampling technique. Single, multiple dummy and binary logistic regression models are used in the present work.

Findings – A significant difference is observed in the NP_f of the farmers using ICT than that of non-users. Education and land holding type also have a positive and significant impact on ICT use.

Originality/value – In the existing literature, the study related to the impact of ICT on agricultural marketing is almost absent for India in general, and Uttar Pradesh in particular. ICT has created impact in almost all directions of life. It is expected that the implementation of ICT will create a notable impact on the income level of the farmers. The present study will give a direction in this regard. The study is based on primary data and original work of the authors.

Keywords ICT, Logistic regression, Agricultural marketing, Dummy regression, Net price received

Paper type Research paper

1. Introduction

1.1 Market information and marketing

Agricultural marketing is a group of activities starting with production plan, harvesting, growing, packaging, transport, storage, agro processing, distribution and finally selling (Murugesan and Rajarajan, 2016; Vadivelu and Kiran, 2013). Specifically, agricultural marketing consists of two concepts, namely "agriculture" and "marketing" (Kiruthiga *et al.* 2015). Efficient marketing is necessary if the country wants to develop its agricultural sector. Failure to develop efficient agricultural marketing system negates the efforts to increase agricultural production to a great extent (Mandal *et al.*, 2011; Rit, 2014; Swaminathan *et al.*, 2015). Improvement in the condition of farmers and agriculture depends to a large extent on successful agricultural marketing (Vadivelu and Kiran, 2013). Several challenges are involved in marketing of agricultural produce in India: there is limited access to market information, the literacy level among the farmers is lower than the national average, and there are multiple channels of distribution that eat from the pockets of both farmers and consumers (Nidhi *et al.*, 2017). The lack of proper dissemination of appropriate market information is the main reason of poor marketing of the agricultural produce from the farmer's perspective (Bhal, 2008; Partovifar, 2010; Ameru, 2018). Internet-enabled solutions could enable farmers to grow their performance as they become more effective and

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efficient, thus increasing the scale of their operations (Dalberg, 2013). Appropriate timely received market information is an influential device in the empowerment of farmers in the present liberalized marketing system (Tollens, 2006; Das, 2014; Goutam, 2014). A well-organized network of agricultural markets helps to overcome the difficulty that the agricultural sector faces because of the fixed locations of the farms (Rit, 2014). Farmers need easy access to relevant, up-to-date and adequate agricultural marketing information. Agricultural marketing information systems play a vital role in farmers' decision-making process in production and marketing of farm produce (Amer *et al.*, 2018).

1.2 Information and communication technology and marketing

Information and communication technology (ICT) has made its presence felt in each and every walk of life. ICT, sometimes referred to as "Information Technology" (IT), has remarkable potential to increase the flow of information, thereby creating a potential tool for empowering agricultural markets (Chapman and Slaymaker, 2002; Meera *et al.*, 2004; Lio and Liu, 2006; Shalendra *et al.*, 2011; Gandhi, 2011; Ali, 2011; Mittal *et al.*, 2010). Some of the activities that can be addressed scientifically by ICT are pricing, virtual trading floors, holistic trading services, etc. Improved communication system of agricultural information can help poor farmers to remain informed about the opportunities and challenges associated with the agricultural development strategies (FAO, 1998). The role of ICT in agriculture was identified as a key action line during the World Summit on the Information Society held in 2003 and 2005. Government, co-operative sectors, private entities and NGOs have already started working in this field with different objectives toward the idea of modernization of agriculture sector in India. National Commission on Farmers viewed that Indian farmers are facing the problem of knowledge deficiency, which can only be addressed with proper implementation of ICT tools specially devised for this sector. One of the most important factors for agricultural development is the marketing of agricultural products. Information, as the most important facilitator and main core of the marketing system, has an effective role in increasing the marketing efficiency. Today, farmers need access to updated and exact information in order to improve the quality and quantity of the agricultural marketing (Lashgarara *et al.*, 2011a, b, c). The use of ICT results in fast and efficient accessibility to the market, increasing selection power, improving communication, identifying markets, saving time and energy, improving marketing and reducing business costs (King *et al.*, 2003). The potential of ICTs to support the farmers to access reliable information about agricultural technologies and markets is enormous (Zijp, 1994; Okuseinde, 2014). Most of the developing countries using ICT in agricultural marketing face problems such as developing infrastructures, inadequacy of experts, lack of information about government policies, illiteracy of people in rural areas, high cost of hardware, and lack of sufficient support from private sector for more participation in agricultural marketing (Aftab, 2003). Along with the existing technology, the future agricultural technology will also be information intensive, mostly (Tripp, 2001). Thus, technology adoption is urgent in all sectors of life in general and agriculture in particular. The Government's digital initiatives for improving agricultural marketing in India include launching of Agrisnet, Agris, Agmarknet, Dacnet, Vistarnet, Aphnet, Fishnet, Hortnet Seednet, Ppin, Coopnet, Fertnet, Arisnet, Afpinet, Arinet, Ndmnet, etc., with their independent websites.

The problem of Indian agriculture is not the lack of technology, but it is the inadequacy and inefficiencies in the dissemination of relevant information to the farming sector (Bhal, 2008). Despite several policy initiatives to promote rural ICT penetration, growth in tele-density continues to be skewed heavily in favor of urban India (TRAI, 2012).

1.3 About the state of Uttar Pradesh

Uttar Pradesh, located in North India, is India's second largest state according to economy and the fifth largest according to area. Uttar Pradesh is primarily an agrarian economy with more than 60 percent of the population dependent on agriculture for its livelihood. Also, one-fifth of the farmers of the country live in Uttar Pradesh (Singh, 2013). The state is the largest producer of food grain in India and offers a diverse agro climatic condition that is conducive for agricultural production. However, there is limited access to the market information, the literacy level among the farmers is low and there are multiple channels of distribution that eat away from the pockets of both farmers and consumers in the state.

NSSO 59th Unit Level data show that the farmers of Uttar Pradesh are mainly using ICT devices like television, radio and newspapers for getting production-related information. These ICT devices are used, 1.9, 1.2 and 8 percent, respectively, for getting the market information by the state farmers. The national averages are higher than Uttar Pradesh. Punjab is shown, according to the same data, as the highest user of ICT for market information in India.

The present study tries to analyze the impact of ICT on the farmers' income of Uttar Pradesh. Rice, being the dominant food crop of the state (Dwivedi, 2017), is considered for the present work.

The remaining part of the paper is organized as follows. Some of the existing literature works are highlighted in Section 2. Research methodology is presented in Section 3. Section 4 describes the results and discussion of the present work. Conclusion is presented in Section 5.

2. Existing literature

In this section, the existing literature works on the ICT are discussed under four different subsections, namely different modes of ICT initiations, benefits of ICT initiation, factors influencing use of ICT and challenges of ICT initiation.

2.1 Different modes of ICT initiations

Anonymous (2007) reported that the National Horticulture Board had launched a scheme for the development of marketing of horticulture produce realizing that a sound system of marketing with the latest and accurate information on prices and arrivals on the internet was important for effective disposal of highly perishable horticultural crops.

Annamalai and Rao (2003) focused on the evaluation of e-Choupal – a pioneering Indian initiative that makes use of ICT to connect farmers into the agricultural supply chains of ITC – a large Indian agro-business. In this case, farmers benefited from more accurate weighing, faster processing time, and prompt payment, and from access to a wide range of information, including accurate market price knowledge, and market trends, which help them decide when, where, and at what price to sell.

Dhankar (2003) studied the Agril Marketing information system network (Agmarknet) in India and found that almost all the states and union territories were providing market information in one form or the other for the benefit of market users like producers, traders and consumers. However, the information was collected and disseminated by conventional methods, which caused inordinate delay in communicating the information to different target groups, thus adversely affecting their economic interest.

Meera *et al.* (2004), in their study to evaluate the performance of ICT projects in India, reported that irrespective of origins and purposes, all the ICT projects are concerned with improving the delivery of information to farmers and other rural dwellers.

Sood (2006) found that mobile phones helped in various ways including accessing market information, coordinating travel and transport, increasing paying work days and managing remote activities.

Veeraraghavan *et al.* (2009) showed how Indian farmers benefited from a move away from PC internet data-based systems located in rural kiosks (which showed a high failure rate) to a mobile network voice-based system that was found to be less vulnerable, easier to maintain, user friendly, more accessible to farmers in remote areas and delivering more up-to-date provision of information and notification of prices.

Okello *et al.* (2010) found that 79 percent of rural market traders used mobile phones in their trading activities, with 77 percent choosing to use voice rather than SMS, which was preferred by only 2 percent. This was because traders preferred a system that allowed interaction with the broad range of participants in any given produce value chain including agents, brokers, assemblers, wholesalers and final purchasers – and "voice" best facilitates this.

Yan and Bu (2003) revealed that major information sources of Chinese farmers were other farmers as well as television broadcasts in Chinese agricultural marketing system. The Chinese farmers were not sensitive to the price changes in future market and international market.

Anonymous (2003) studied the information system and its uses in Chinese agriculture. He observed that the Ministry of Agriculture (MOA) initiated research on computer application in agriculture during the Seventh Five Year Plan for the first time, and the first professional journal entitled "Computer Application in Agriculture" started to appear in 1986. In order to achieve industrialization and market orientation of agriculture through internet, MOA developed the website known as China Agricultural Information Network.

Agwu *et al.* (2008) observed that the major source of information on improved agricultural technologies to farmers was co-farmers followed by radio programs. A greater proportion (96.3 percent) accepted radio as a useful source of information on improved agricultural technologies.

2.2 Benefits of ICT initiation

Rai *et al.* (2001), in their study on application of IT in agricultural marketing, explained the necessity for developing a Farmers Agriculture Information System that could be operated at Zonal Agricultural Research Stations, Krishi Vigyan Kendras, Agricultural Marketing Corporations (Mandis) and Extension centers of SAUs where farmers normally assemble for various reasons.

Overå (2006) found that both producers and traders benefited considerably from the use of mobile phones. The speed of communication allowed for more efficient information flows within the network of value chain actors, which, in turn, saved time and reduced transportation costs. This led to better matching of supply and demand, and improved monitoring of compliance within the terms of trading contracts.

Kapoor *et al.* (2015) stated that rural market of India is showing an impressive growth largely due to better communication network and rapidly changing demand structure of consumers of rural area.

Egyir *et al.* (2011) identified mobile phones as the pre-dominant communication technology among farmers in Ghana, measuring an increased speed of price transmission in maize markets. Although 80 percent of the surveyed traders and 48 percent of the surveyed farmers used mobile phones to access information, traditional means of collecting and exchanging information had not changed (such as traveling to the market), but the use of phones speeded up pre-existing processes. For mobile users, this resulted in trading of larger volumes, better prices and slightly larger margins.

Dalberg (2013) pointed out that ICTs increase the impact of young entrepreneurship and facilitate new avenues of addressing systemic barriers, such as skills acquisition, financing, marketing and business networks.

Iboma (2014) observed that ICTs are also used to find the best locations and prices of inputs such as seed and fertilizers. In Nigeria, the government's e-wallet program, which leverages farmers' access to mobile phones, enables farmers to obtain subsidized inputs that raise their productivity.

Rengarajan *et al.* (2018) studied the working pattern of technological services to the agricultural marketing. The study observed that the proper and timely implementation of

ICT projects can bring revolutionary change in the Indian agricultural sector of our country. Due to the unavailability of records in the farms studied, the cost and return particulars were collected verbally from the farmers in the study.

2.3 Factors influencing use of ICT

Several studies have analyzed factors that affect the adoption of IT by farmers.

Ramirez and Shultz (2000) through the Poisson Count model proved that participation in community activities is positively related to technology adoption. Besides, access to credit, labor availability, education, farm size and type of cropping system can also be important determinants of the adoption of technology. The authors added that farmer's age and experience have a non-linear effect on technology adoption means, increasing in the initial stage and then a gradual deterioration in the technology adoption rates.

Batte (2005) found that the computer adoption increased with increase in farm size and higher education, and it diminished with age.

Alvarez and Nuthall (2006) observed that farmers with small farms, aged 50 years or more, less formal education, are less likely to use software. But large farms, with young and educated farmers, without properly developed information system may not constitute a condition where software use is likely to occur successfully. They finally opined that a well-developed information system may be able to take advantage of the benefits offered by computerization, irrespective of farm size, age, experience or farmer's education level.

Agwu *et al.* (2008) observed that age, farming experience and membership of farmers' organization have a significant influence on the adoption of improved agricultural technologies disseminated through the radio.

Lashgarara *et al.* (2011a, b, c) aimed to identify ICT capabilities in marketing the agricultural products of Garmsar city. The study observed that delivering information about selling products is the most important role of ICT for this sector.

Das (2014) made an effort to comprehend how ICTs facilitate the dissemination of agricultural information. The study indicated that "education" and "training" factors have a positive bearing on the adoption of ICTs as a source of information, highlighting the relevance of capacity building initiatives for enhancing the use of ICTs in Indian agriculture. Not much discussion regarding the market information through ICT is observed in the study.

FAO (2017) pointed out that to use market information for long-term decisions, farmers should be aware of storage costs, to decide whether to store or not; in addition, they should have an understanding of production costs, so that they can use MIS to plan whether to grow new crops or to move to off-season production.

2.4 Challenges of ICT initiation

Kashyap and Raut (2006) suggested that marketers need to design creative solutions like e-marketing to overcome challenges typical of the rural environment such as physical distribution, channel management promotion and communication. He also added that the "anytime-anywhere" advantage of e-marketing leads to efficient price discovery and offers economy of transaction for trading and more transparent and competitive setting.

Amrutha (2009) conducted a study in Karnataka state on the importance of the market information for agriculture product. He concluded that awareness on market information in general was found to be relatively poor in case of farmers as compared to traders, since the accessibility of market information in terms of communication systems is very poor in case of farmers.

Ramaraju *et al.* (2011) observed that ICT initiatives lead to increase in crop yield, profit and access to information, and decrease in the use of pesticides, fertilizers, input cost and consumer price.

Shreshtha (2003) identified duplication of efforts, lack of standardization, inadequate network for information flow and lack of coordination and integration among various agencies as some of the limitations of market information system in Nepal.

Gunatilke (2003) reported that private sector played a major role in production and marketing in Sri Lanka, whereas the State sector played a supportive role in facilitating them, for improvement of the living standards of the farmers. The market information system was completely based on the private sector participation.

3. Research methodology

3.1 Variables considered

Net price received (NP_f) by the farmer and ICT are considered as dependent variables.

Defining NP_f. So far as agricultural marketing is concerned, net price received (NP_f) by the producer is the income item of the farmers. The net price received (NP_f) by the producer is estimated by deducting marketing costs and value loss from the gross price received for the output, whether sold or self-consumed:

$$NP_f = GP_f - \{C_f + (L_f \times GP_f)\},$$

where NP_f is the net price received by the farmers per qtl; GP_f is the gross price received by the farmers per qtl; C_f is the cost incurred by the farmers per qtl, which includes items like cost of ploughing, wages paid for hired labor, cost of machinery, irrigation, fertilisers, seeds, etc.; L_f is the physical loss in produce from harvest till it reaches assembly market per qtl.

Defining ICT. Based on the existing literature works (Korsching and Hoban, 1990; Longo, 1990; McBride and Daberkow, 2003; Bolarinwa *et al.* 2014; Lashgarara *et al.*, 2011a, b, c; Ali, 2011; Das, 2014), the mode of ICT use is bifurcated into three categories: very old, old and new, as shown in Table I.

New ICT group consists of ATM, e-banking, e-commerce, cash credit card, mobile and internet. The second group, old ICT, includes radio and television. Newspaper, books, poster, drama are incorporated in the very old category of ICT.

Defining factors. To study the factors that influence the use of ICT, two socio-demographic factors, namely age and education, and two farm characteristics, namely land holding size and land holding type (Ramirez and Shultz, 2000; Batte, 2005; Alvarez and Nuthall, 2006; Agwu *et al.*, 2008; Das, 2014), are considered in the present analysis.

The unit of age is considered in year.

Education is quantified as:

- $=1$ for primary level education.

Classification	Component
Very old ICT	Newspaper
	Book
	Poster
	Drama
Old ICT	Radio
	Television
New ICT	ATM
	E-banking
	E-commerce
	Cash credit card
	Mobile
	Internet

Table I.
Classification of ICT use

- = 2 for secondary level education.
- = 3 for degree and above education.

Ownership type is quantified as:

- = 1 for own land.
- = 0 for lease land.

Land holdings is taken in hectares.

3.2 Objective of the study

The specific objectives of the present study are as follows:

O_1: to study the impact of ICT on the net price received by the farmers (NP_f) of Uttar Pradesh.

O_2: to study the factors that influence the use of ICT.

3.3 Hypothesis

Against the above-mentioned objectives, the following hypotheses are developed:

Hypotheses against objective 1

H1. ICT has a significant positive impact on the net price received by the farmers of Uttar Pradesh.

H2. Net price received is significantly higher for the farmers using new ICT, compared to the farmers using either old or very old mode of ICT.

Hypotheses against objective 2

H3. ICT use is significantly dependent on the age of the farmers.

H4. ICT use is significantly dependent on the education of the farmers.

H5. ICT use is significantly dependent on the land holding type of the farmers.

H6. ICT use is significantly dependent on the land ownership type of the farmers.

3.4 Sampling technique

The present research is an attempt to study the impact of ICT initiation in agricultural marketing of rice producers of Uttar Pradesh. The data have been collected through a well-structured questionnaire during the year 2016–2017. Multi-stage sampling technique is used for the data collection of the present study. There are four agricultural zones in the state of Uttar Pradesh, Western Region, Central Region, Bundelkhand Region and Eastern Region (State Planning Commission, 2003), consisting of 75 districts. Out of 75 districts, top 4 rice producing districts from each region are identified in the first stage. From each district, five villages are selected through a simple random sampling method in the second stage. From each of the selected villages, the farmers are interviewed following convenient sampling technique. A total of 400 farmers are interviewed. As shown in Table II, in the process of multi-stage sampling, ultimately, 80 villages are selected, and from each village, only five farmers are interviewed.

3.5 Model used

Model 1: single dummy regression model

$$NP_{fi} = \alpha + \beta D_1 + u_i, \tag{1}$$

where NP_{fi} is the net price received by the farmers (‘/qtl); D_i the dummy variable; α, β the parameters; u_i the disturbance term. $D_1 = 1$ for ICT user and $D_1 = 0$ otherwise. The mean

Table II.
Multi-stage sampling

Stages	Unit selected	Total selection
Stage 1	Four regions of Uttar Pradesh	The state of Uttar Pradesh is sub-divided into four regions: 1. Eastern Region 2. Western Region 3. Central Region 4. Bundelkhand Region (Ref: Statistical Abstract of UP, 2013)
Stage 2	4 (regions)×4 (district) = 16 district	Top 4 rice producing districts from each region of UP
Stage 3	5 (villages)×16 (districts) = 80 (villages)	Five villages from each selected districts by simple random sampling method
Stage 4	80 (villages)×5 (farmers) = 400 (farmers)	5 farmers for each village

NP_{fi} of the farmers using ICT is (α+β), and the mean NP_{fi} of the farmers not using ICT is (α). (β) is the difference in NP_{fi} of the farmers using and not using ICT

Model 2: multiple dummy regression model

$$NP_{fi} = a + bD_1 + cD_2 + u_i, \tag{2}$$

where D_1 and D_2 are the dummy variables; a, b and c the parameters; and v is the disturbance term. $D_1 = 1$ for new ICT user and $D_1 =$ 0 otherwise; $D_2 = 1$ for old ICT user and $D_2 =$ 0 otherwise. The mean NP_{fi} of the farmers using new ICT is (a+b), and the mean NP_{fi} of the farmers using old ICT is (a+c). a is the mean NP_{fi} of the farmers using very old ICT.

Model 3: binary logistic regression model. To study the factors that influence the use of ICT, two socio-demographic factors, namely age and education, and two farm characteristics, namely land holding size and land holding type (Ramirez and Shultz, 2000; Batte, 2005; Alvarez and Nuthall, 2006; Agwu *et al.*, 2008; Das, 2014), are considered in the present analysis. A logistic regression model is developed as follows:

$$\text{ICT} = a + b_1.X_{1i} + b_2X_{2i} + b_3X_{3i} + b_4X_{4i} + u_i. \tag{3}$$

ICT user and non-users, two categories, are considered as dependent in this binary model. ICT = 1 for ICT user and ICT = 0 for ICT non-user.

The specifications of the predictors are as mentioned as follows: X_{1i} is the age in year. X_{2i} is the education. The three categories of education are considered here (Table I) and quantified as follows: $X_{2i} = 1$ for the primary level education, $X_{2i} = 2$ for the secondary level education and $X_{2i} = 3$ for degree and above education. X_{3i} is the ownership type. $X_3 = 1$ for own land and $X_3 = 0$ for lease land. X_{4i} is for land holdings in hectares.

Model 4. To study the factors that influence the use of different modes of ICT, two socio-demographic factors, namely age and education, and two farm characteristics, namely land holding size and land holding type, are considered in the present analysis. The following multinomial logit model is developed for the study.

Multinomial logit model:

$$\text{ICT} = a + b_1.X_{1i} + b_2X_{2i} + b_3X_{3i} + b_4X_{4i} + u_i. \tag{4}$$

For ICT user, different types of categories are considered as dependent in this model. ICT = 1 for ICT new, ICT = 2 for ICT old and ICT = 3 for ICT very old. X_{1i} is the age in year. X_{2i} is the education. Here, three categories of education are considered, and they are quantified as follows: $X_{2i} = 1$ for primary level education, $X_{2i} = 2$ for secondary level education, $X_{2i} = 3$ for degree and above education. X_{3i} is the ownership type. $X_{3i} = 1$ for own land, 0 for lease land. X_{4i} is for land holdings in hectares. a, b_1, b_2, b_3, b_4 are the parameters; z_i is the disturbance term.

3.6 Software used

SPSS, Eviews and STRATA software are used for estimating the parameters of the model.

4. Results and discussion

4.1 General description of the variables under study

As shown in Table III, net price received (NP_f), in respect of Uttar Pradesh, ranges from 878 to 1,024.59 per quintal. Varanasi, one of the eastern regions of Uttar Pradesh, shows highest NP_f. Among 16 states of four agricultural regions of Uttar Pradesh under study, the lowest NP_f is observed in Jhansi district, for the year 2016–2017.

The percentage share of marketing loss, marketing cost and net price received by the farmers in gross price received are presented in Figure 1.

The district-wise ICT users and non-users are presented in Table IV. The bifurcation is made based on the criteria of Table I.

Region	Districts	Gross PF (per qtl)	Marketing Cost/qtl of farmer (Cf)	LF (per qtl)	NP_f (per qtl)
Eastern	Varanasi	1,470.36	298.74	147.04	1024.59
	Ambedkar Nagar	1,434.60	363.26	143.46	927.88
	Allahabad	1,466.72	359.27	146.67	960.78
	Gonda	1,444.40	374.99	144.44	924.97
Western	Agra	1,471.52	312.80	147.15	1011.56
	Meerut	1,464.00	362.77	146.40	954.83
	Muzaffarnagar	1,474.00	315.07	147.40	1011.53
	Saharanpur	1,424.40	340.20	142.44	941.76
Bundelkhand	Jahansi	1,441.76	419.47	144.18	878.11
	Banda	1,475.00	415.86	147.50	911.64
	Chitrakoot	1,475.60	378.38	147.56	949.66
	Jalaun	1,453.76	384.52	145.38	923.86
Central	Kanpur Dehat	1,449.16	370.39	144.92	933.86
	Etawah	1,428.96	399.12	142.90	886.94
	Kheri	1,444.16	406.09	144.42	893.65
	Sitapur	1,485.80	359.64	148.58	977.58

Source: Calculated by the author

Table III. Region and district wise average NP_f and its determinants

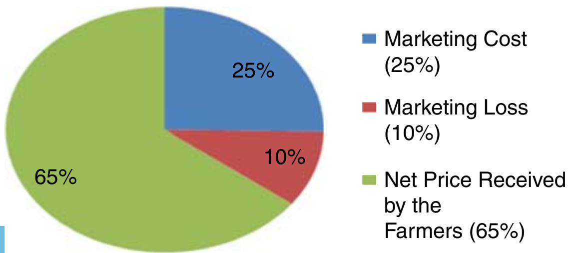

Figure 1. Bifurcation of gross price received by the farmers

Region	Districts	No. of farmers	ICT users	ICT non-users
Eastern	Varanasi	25 (100)	21 (84)	4 (16)
	Ambedkar Nagar	25 (100)	17 (68)	8 (32)
	Allahabad	25 (100)	18 (72)	7 (28)
	Gonda	25 (100)	15 (60)	10 (40)
Western	Agra	25 (100)	19 (76)	6 (24)
	Meerut	25 (100)	18 (72)	7 (28)
	Muzaffarnagar	25 (100)	22 (88)	3 (12)
	Saharanpur	25 (100)	16 (64)	9 (36)
Bundelkhand	Jahansi	25 (100)	12 (48)	13 (52)
	Banda	25 (100)	15 (60)	10 (40)
	Chitrakoot	25 (100)	19 (76)	6 (24)
	Jalaun	25 (100)	17 (68)	8 (32)
Central	Kanpur Dehat	25 (100)	16 (64)	9 (36)
	Etawah	25 (100)	12 (48)	13 (52)
	Kheri	25 (100)	15 (60)	10 (40)
	Sitapur	25 (100)	19 (76)	6 (24)
	Total	400 (100)	271 (68)	129 (32)

Note: Figures in the parentheses are the percentages
Source: Calculated by the author

Table IV.
Region and district wise ICT Users

Again, the number of different subsections of ICT users, that is new ICT user, old ICT user and very old ICT users, as described in Table I, is calculated from the sample and presented in Table V.

Now, the demographic nature of the samples is presented in the following tables.

Table VI represents the age distribution of the sample under study. Most of the farmers are aged between 40 and 60 years. The age group below 30 years is less involved in agriculture. More than 50 percent sample possesses graduate degree (Table VII).

Region	Districts	New ICT	Old ICT	Very Old ICT	Total
Eastern	Varanasi	15 (71)	6 (29)	0 (0)	21 (100)
	Ambedkar Nagar	10 (59)	6 (35)	1 (6)	17 (100)
	Allahabad	13 (72)	5 (28)	0 (0)	18 (100)
	Gonda	13 (87)	1 (7)	1 (7)	15 (100)
Western	Agra	12 (63)	6 (32)	1 (5)	19 (100)
	Meerut	13 (72)	4 (22)	1 (6)	18 (100)
	Muzaffarnagar	14 (64)	8 (36)	0 (0)	22 (100)
	Saharanpur	10 (63)	6 (38)	0 (0)	16 (100)
Bundelkhand	Jahansi	8 (67)	2 (17)	2 (17)	12 (100)
	Banda	12 (80)	3 (20)	0 (0)	15 (100)
	Chitrakoot	14 (74)	5 (26)	0 (0)	19 (100)
	Jalaun	11 (65)	6 (35)	0 (0)	17 (100)
Central	Kanpur Dehat	9 (56)	6 (38)	1 (6)	16 (100)
	Etawah	9 (75)	3 (25)	0 (0)	12 (100)
	Kheri	6 (40)	7 (47)	2 (13)	15 (100)
	Sitapur	13 (68)	6 (32)	0 (0)	19 (100)
	Total	182 (67)	80 (30)	9 (3)	271 (100)

Note: Figures in the parentheses are the percentages
Source: Calculated by the author

Table V.
Region and district wise pattern of ICT Users

Studies have shown dominance of small and medium farmers in most of the states of India. The percentage of large farmers observed is 30 percent (Table VIII). Most of the land is own cultivation, only 5.25 percent is cultivation on lease land (Table IX).

4.2 Impact of ICT on NP_f

The effectiveness of any new technology depends on whether that satisfies the requirement of its users (Freeman, 1987). Now, the present study tries to find out whether ICT is useful for the farmers to enhance their income. Dummy regression model (Equation (1)) is used to study the impact of ICT on net price received by the farmers (NP_f) of Uttar Pradesh. The OLS estimates ensured goodness of fit of the data set ($R^2 = 0.52$). Also, a significant difference is observed in the NP_f of the farmers using ICT than that of non-users. The dummy coefficient (β) of Equation (1), which indicates the difference in NP_f of the farmers using and not using ICT, is observed as statistically significant. The mean NP_f of the farmers not using ICT was observed at Rs 790.27 per quintal and that of ICT users, Rs 1,018.02 per quintal. However, the Breusch–Pagan test shows the presence of heteroskedasticity in the model. The Breusch–Pagan test, developed in 1979 by Trevor Breusch and Adrian Pagan, is used to test for heteroskedasticity in a linear regression model. It tests whether the variance of the errors from a regression is dependent on the values of the independent variables. In that case, heteroskedasticity is present. estat hettest

Age (year)	Number of farmers
21–30	6
31–40	77
41–50	141
51–60	138
61–70	38

Table VI. Age distribution of the farmers under study

Level of education	No. of farmers
Primary	77
Secondary	91
Degree and above	231
Total	400

Table VII. Education level of the farmers under study

Farmer category	No. of farmers	%
Small	159	39.75
Medium	121	30.25
Large	120	30
Total	400	

Table VIII. Land holding type of the farmers under study

Ownership type	No. of farmers
Own	371
Lease	21
	400

Table IX. Ownership type of the farmers under study command of STATA performs Breusch-Pagan's (1979) and Cook-Weisberg's (1983) test for heteroskedasticity. It is a χ^2 test. It tests the null hypothesis of homoskedasticity. If the χ^2 value is significant with *p*-value below an appropriate threshold (e.g. $p < 0.05$), then the null hypothesis of homoscedasticity is rejected and heteroskedasticity is assumed. Therefore, the above results show that the χ^2 value is insignificant with *p*-value above an appropriate threshold (e.g. $p < 0.05$); thus, the null hypothesis of homoscedasticity is accepted and heteroskedasticity is rejected (Table X).

In the presence of heteroskedasticity, "Robust" standard errors method is used to find out the impact of ICT on NP_f. "Robust" standard errors is a technique to obtain unbiased standard errors of OLS coefficients under heteroscedasticity. The presence of heteroscedasticity violates the Gauss–Markov assumptions that are necessary to render OLS as the best linear unbiased estimator. "Robust" standard errors have many labels that essentially refer all the same thing, namely standard errors that are computed with the sandwich estimator of variance. Typical terms for "robust" standard errors include White's standard errors, Huber–White standard errors, Eicker–White or even Eicker–Huber–White standard errors. "Robust" standard errors are usually larger than conventional standard errors. However, this is not always the case. The result of "Robust" standard errors analysis is shown in Table XI.

Table X.
Breusch–Pagan test of Model 1

regress NP_f D

Source	ss	df	MS	Number of obs.	=	400
				F(1, 398)	=	419.50
Model	4,533,478.56	1	4,533,478.56	Prob. > F	=	0.0000
Residual	4,301,084.14	398	10,806.7441	R^2	=	0.5132
				Adj R^2	=	0.5119
Total	8,834,562.7	399	22,141.7611	Root MSE	=	103.96

NP_f	Coef.	SE	*t*	*p*. > |*t*|	[95% Conf.	interval]
D	227.7541	11.11982	20.48	0.000	205.8932	249.6151
_cons	790.2717	9.152771	86.34	0.000	772.2779	808.2655

Notes: estat hottest; Breusch–Pagan/Cook–Weisberg test for heteroskedasticity; H_0: constant variance; variables: fitted values of NP_f; χ^2 (1) = 52.23; Prob. χ^2 = 0.0000

Table XI.
"Robust" Standard error Analysis

regress NP_f D

Source	ss	df	MS	Number of obs.	=	400
				F(1, 398)	=	419.50
Model	4,533,478.56	1	4,533,478.56	Prob. > F	=	0.0000
Residual	4,301,084.14	398	10,806.7441	R^2	=	0.5132
				Adj R^2	=	0.5119
Total	8,834,562.7	399	22,141.7611	Root MSE	=	103.96

NP_f	Coef.	SE	*t*	*p* > |*t*|	[95% Conf.	interval]
D	227.7541	11.11982	20.48	0.000	205.8932	249.6151
_cons	790.2717	9.152771	86.34	0.000	772.2779	808.2655

regress NP_f D, robust
Linear regression

				Number of obs.	=	400
				F(1, 398)	=	302.21
				Prob. > F	=	0.0000
				R^2	=	0.5132
				Root MSE	=	103.96

NP_f	Coef.	Robust SE	*t*	*p* > |*t*|	[95% Conf.	interval]
D	227.7541	13.10118	17.38	0.000	201,998	253.5103
_cons	790.2717	12.07575	65.44	0.000	766.5315	814.0119

Note: estat hottest; hottest not appropriate after robust cluster ( )

As the results show, White's heteroscedasticity – corrected standard errors (Robust standard errors) – are considerably larger than OLS standard errors, and therefore the estimated *t*-values are much smaller than those obtained by OLS. On the basis of the latter, both the regressors are statistically significant.

4.3 Impact of different kinds of ICT on NP_f

A multiple dummy regression model (Equation 2) is used to study the difference in the NP_f among farmers using ICT of different kinds: very old, old and new (Table I). To avoid the dummy trap, two dummies are considered, for measuring the three categories of ICT utilization.

Breusch–Pagan test shows the presence of homoskedasticity in the model (Table XII). Regression through OLS method is used to find out the impact of different kinds ICT on NP_f (Table XIII).

Even if the R^2 is low at 0.17, it is observed as statistically significant (Table IX) in OLS estimation. The possible reasons may be the data are cross-section and ICT is an added factor over the main variables that influence the NP_f predominantly.

As shown is Table XIV, both the dummy coefficients are observed as statistically significant. The mean NP_f of the farmers using new ICT is calculated to be Rs 1,038.09 per qtl., the mean NP_f of the farmers using old ICT is calculated to be Rs 984.74 per qtl and the mean NP_f of the farmers using very old ICT is observed Rs 881.54.

regress NP_f D_1 D_2

Source	ss	df	MS			
				Number of obs.	=	271
				F(2, 268)	=	26.79
Model	314,307.59	2	157,153.795	Prob. > F	=	0.0000
Residual	1,572,256.65	268	5,866.62929	R^2	=	0.1666
				Adj R^2	=	0.1604
Total	1,886,564.24	270	6,987.27496	Root MSE	=	76.594

NP_f	Coef.	SE	t	$p > \|t\|$	[95% Conf.	interval]
D_1	156.5538	26.15496	5.99	0.000	105.0585	208.0491
D_2	106.2046	26.92918	3.94	0.000	53.18491	159.2242
_cons	881.5345	25.53131	34.53	0.000	831.267	931.8019

Notes: estat hottest, Breusch–Pagan/Cook–Weisberg test for heteroskedasticity; H_0: constant variance; variables: fitted values of NP_f; χ^2 (1) = 0.58; Prob. χ^2 = 0.4463

Table XII. Breusch–Pagan test of Model 2

R	R^2	Adjusted R^2	SE of the estimate	F
0.41	0.17	0.16	76.59	26.79*

Notes: Calculated by the author. *Significant at 1 percent level

Table XIII. Model fit of Equation (2)

	Unstandardized coefficients		Standardized coefficients	
	B	SE	β	t
a (Constant)	881.54	25.53		34.53*
b (Coefficient of D_1)	156.55	26.16	0.88	5.99*
c (Coefficient of D_2)	106.20	26.93	0.58	3.94*

Notes: Calculated by the author. $D_1 = 1$ for new ICT use, = 0 otherwise; $D_2 = 1$for old ICT use, = 0 otherwise. *Significant at 1 percent level

Table XIV. OLS estimates of Equation (2)

From the above analysis, it can be concluded that ICT has a significant positive impact on the net price received by the farmers of Uttar Pradesh. Again, as the coefficients *b* and *c* are significant, it implies the significant *t* difference of NP_{fi} of very old and new and very old and old ICT users.

Now, the next step is to study the possible factors that lead to the use of ICT among the farmers.

4.4 Factors affecting the use of ICT

As already discussed, a binary logistic model (Equation (3)) is used to study the factors that influence the use of ICT among the rice producers of Uttar Pradesh. Two socio-demographic factors, namely age and education, and two farm characteristics, namely land holding size and land holding type, are considered as independent variables in the the present analysis. ICT users and non-users are the binary inputs of the dependent variable. The result of binary logistic regression is shown in Table XV. The overall accuracy of the model is observed at 67.8 percent (Table XV). Figure 2 is the graphical representation of Table XV.

The χ^2 test shows a significant result (Table XVI), indicating that this predictor model is preferable for present study than the normal model. The predictors in the model are explained as 24–34 (Table XVII) percent of the variation as indicated by Cox & Snell R^2 and Nagelkerke R^2.

As shown in Table XVIII, out of four variables, two variables, education and land holding type, have a positive and significant impact on the ICT use. Age and land ownership type have a positive, but insignificant, impact on the use of ICT.

Table XV.
Overall accuracy

	Predicted ICT		
Observed	ICT non-user	ICT user	Percentage correct
ICT			
ICT non-user	0	129	
ICT user	0	271	
Overall percentage			67.8

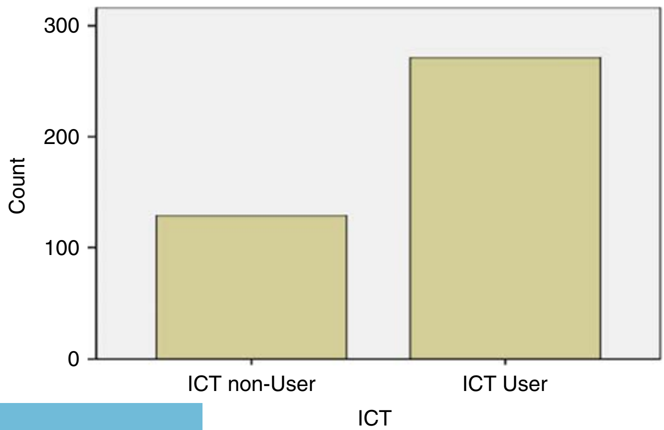

Figure 2.
Bar graph of ICT user and non-user

A comparison can be made in this regard with other existing studies of similar kind. Farmer's age is observed to have a negative impact on the technology adoption in the study of Goodwin and Kastens (1996) and Taragola and Van Lierde (2010). Agwu *et al.* (2008) depicted that educated farmers are more likely to adopt ICTs. A significant positive relationship between farm size and adoption of farm technologies is also observed in the studies of Batte and Arnholt (2003), Rahelizatovo and Gillespie (2004), Isgin *et al.* (2008), etc. Both insignificant (Soule *et al.*, 2000) and significant (Feder and Feeny, 1993) impacts are observed between ICT adoption and land holding type.

4.5 Factor effecting the different kinds of ICT use

As mentioned in Section 3.5, multinomial logit model is used to study the factors affecting the different kinds of ICT use. The results are represented in Tables XIX and XX.

The χ^2 test shows a significant result (Table XIX), indicating that this predictor model is preferable for the present study than the normal model.

As shown in Table XX, education is the most important factor regarding the uses of different modes of ICT.

	χ^2	df	Sig.
Step	110.699	5	0.000
Block	110.699	5	0.000
Model	110.699	5	0.000

Table XVI. χ^2 test

−2 Log likelihood	Cox and Snell R^2	Nagelkerke R^2
392.293	0.24	0.34

Table XVII. R^2 test

	B	SE	Wald	df	Sig.	Exp (*B*)	95.0% CI for EXP (*B*) Lower	Upper
Age	0.012	0.014	0.760	1	0.383	1.012	0.985	1.041
Education			22.678	2	0.000			
Education (1)	−1.072	0.295	13.178	1	0.000	0.342	0.192	0.611
Education (2)	0.784	0.364	4.649	1	0.031	2.191	1.074	4.470
Land holding type	0.407	0.524	0.604	1	0.437	1.502	0.538	4.194
Land ownership type	0.457	0.077	35.103	1	0.000	1.579	1.357	1.836
Constant	−1.564	0.927	2.844	1	0.092	0.209		

Notes: Education 1 represent primary level education, 2 for secondary level education, 3 for segree and above education

Table XVIII. Significance of the individual variables

Model	Model fitting criteria −2 Log Likelihood	Likelihood Ratio Tests χ^2	df	Sig.
Intercept only	379.810			
Final	342.448	37.362	10	0.000

Table XIX. Model fitting information

Table XX.
Likelihood ratio tests

Effect	Model fitting criteria −2 log likelihood of reduced model	Likelihood ratio tests χ^2	df	Sig.
Intercept	3.424E2[a]	0.000	0	
Age	344.338	1.890	2	0.389
Land size	347.876	5.428	2	0.066
Education	362.608	20.160	4	0.000
Landownership	344.638	2.190	2	0.335

Notes: The χ^2 statistic is the difference in −2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0. [a]This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom

5. Conclusion

The application of ICT can work as a driving force in the development process of agricultural sector by means of dissemination of required information to the end user. This paper has made an effort to comprehend the role of ICT use in enhancing the farmers profit in the existing market scenario. A significant positive impact of ICT use has been observed on the net price received by the farmers of Uttar Pradesh. Education has a significant impact on the use of ICT. In the present study, the secondary level educated people are more efficient users of ICT. Land holding type has also influenced the use of ICT. It is interesting to mention that age has no barrier for the use of IT. Finally, it can be said that the scope of empowering the agricultural marketing facilities in India by use of latest technologies, made available through ICT projects, is enormous. More focus on education, awareness, training, etc., is required to reap the benefits of ICT to a greater degree for agricultural marketing in India.

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