Impact of ICT and use of social media on supply chain of horticultural crops in India: structural equation and predictive modelling approach

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Abstract: The objective of this research is to identify the impact of the adoption of information and communication technology (ICT), accesses of the information, availability, awareness, perceived usefulness, challenges, willingness to pay, reliability of the information available on the ICT and social media sites used by the farmers in India. The primary data collected from the three districts of Maharashtra, viz. Kolhapur, Nagpur, and Amaravati. Structural equation modelling (SEM) approach was used to understand the impact of all the factors of the supply chain of horticulture crops in India with the usage of ICT and social media sites and the further predictive model is also used to forecast the probability of the farmers to use the ICT and social media sites in the future. The study reveals that there is positive impact of availability, challenges and reliability and negative impact of adoption and awareness on the usage of ICT by the farmers.

Keywords: supply chain; horticultural crops; information and communication technology; ICT; logistics model; India.

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1 Introduction

The increases in horticulture in India, due to the high level of consumptions of high-value commodities, varying existence, market incorporation, globalisation, etc. Presently, more focussed on horticulture development was given by the Government of India through the knowledge-based technology and usage of social media sites. In 2005–2006, horticulture was promoted on a large-scale by National Horticulture Mission by Government of India. The more attentiveness was emphasised on the exports of horticulture products and the policy was developed accordingly. Due to the low crop efficiency, limited financial support, natural disaster, sudden weather fluctuations, etc., the Indian horticulture sector is facing severe difficulties in increasing the production of the crop. To overcome these issues, the SAFAL market and Namdhari Fresh tried to develop the linkages between the farmers and consumers for the efficient supply chain management. This study attempts to identify the factors which will impact the information and communication technology (ICT) and use of social media sites by the farmers in India.

In various countries mainly China and Europe, the reduction in poverty was reported two-to-four times increase due to the development in the agriculture sector (Ravallion and Chen, 2007; World Bank, 2008a). Increase in horticulture production in India due to the joint effort of the Government of India and National Horticulture Mission (Sharma, 2011; Goi, 2012).

Supply chain of horticulture crops in India is the flow of the products and information between the different producers to the end consumers. Today, use of technology helps the organisation to reduce inventory cost, extend resources, add product value, maximum profit to the end consumers and retain the customers. So in this regards, India became the second-largest producer of fruits and vegetables, export growth of fruits and vegetables increase by 14% and 16.27% due to the adoption of technology and appropriate supply chain management in horticulture crops in India.

The growth of economic largely depends on the development of agriculture which directly depends on the adoption of ICT, accesses of the information, availability, awareness, perceived usefulness, challenges, willingness to pay, reliability of the information available on the ICT and social media sites used by the farmers in India (Kumar and Mittal, 2003). There is a need for the adoption of ICT and the use of social media sites in the agriculture sectors for doing this certain step has to adopt. The foremost step to train the farmers and make them understand the use of ICT and social media sites. The more attentiveness should be on the efficient supply chain management to showcase the prices of agricultural product to the consumers. The awareness of supply chain for horticulture in India is lacking because of the small landholdings, illiteracy, less knowledge about the finances and market information (World Bank, 2008b) amongst the farmers and the consumers. In this study, we mainly focus on the flow of production from farmers to consumers. The challenging factors for supply chain in India are absence of

good quality seeds, lack of soil testing facilities and extension staff, poor access to credit, lack of information, huge post-harvest losses, lack of infrastructure like roads, cold storage, etc., poor market intelligence, high transportation cost, awareness, accessibility of the information, adoption of technology, etc. (Kumar et al., 2004; Mittal et al., 2008). In this regard to overcome this problem, prevailing technologies and effective use of social media sites would be vital in enhancing the productivity of the supply chain.

Mcnamara et al. (2011) refer that the technology includes the use of mobile phones and the use of social media sites for sharing the information and provides reliable data timely and accurately to the farmers. They can also share the problems by using the different social media sites and come up with the help of their different expertise. The influences of ICT and social media initiatives include an increase in crop yield, profit and access to information, and decrease in the use of pesticides, fertilisers, input cost and consumer price (Ramaraju et al., 2011; Jensen, 2007).

Most of the initiative taken by the Government of India for agriculture development by using ICT and social media. Many telecom industries are giving or providing a different plan to the farmers so they can afford to use the internet to access the social media sites, they are also working on the networking facility in the rural areas, which will increase the communication. Farmers are using social media sites to connect with farmers from geographical areas. There was a large of blogs and comments available on the different social media sites which explain a different theory, problems associated with the agriculture and development in the field of agriculture are stated (Rhoades and Hall, 2007).

The main aim of the paper is to identify the impact of the adoption of ICT, accesses of the information, availability, awareness, perceived usefulness, challenges, willingness to pay, reliability of the information available on the ICT and social media sites used by the farmers in India. Structural equation modelling (SEM) approach was used to understand the impact of all the factors of the supply chain of horticulture crops in India with the usage of ICT and social media sites and the further predictive model is also used to forecast the probability of the farmers to use the ICT and social media sites in the future.

2 Methodology

The primary data collected from the three districts of Maharashtra, viz., Kolhapur, Nagpur, and Amaravati during the agricultural year 2018–2019 from a randomly selected 349 farmers. The data collected on the two dependent variables, i.e., use of ICT and social media sites. Under the usage of ICT, the farmers are considered those who are using phones (both mobile and landline), radio and television were categorised as adopters and under the usage of social media sites, the farmers are considering those who are using social media sites, i.e., Facebook and LinkedIn were considered as adaptors. And the farmers those who are not using ICT and social media sites are categorised under non-adaptors. For the predictive modelling, various demographics were considered based on age, income and education level of the farmers. The independent variables considered for the study are the adoption of ICT, accesses of the information, availability, awareness, perceived usefulness, challenges, willingness to pay, reliability of the information

available on the ICT and social media sites used by the farmers. We used the convenience sampling process for the collection of the data.

All the questions of independent variables are framed by using five-point Likert scale (1 = strongly agree, 5 = strongly disagree) and the statistical techniques used were descriptive statistics, structural equation and logistic regression.

The aim of this research to identify the factors that affect the use of ICT and social media sites towards the supply chain of horticultural crops in India. Thus, the following questions are raised:

1 Do the adoption of ICT, accesses of the information, availability, awareness, perceived usefulness, challenges, willingness to pay, reliability of the information available affect the use of ICT and social media sites.

2 Predict the use of ICT and social media sites by using the various parameters, i.e., adoption of ICT, accesses of the information, availability, awareness, perceived usefulness, challenges, willingness to pay, reliability of the information available.

Based on the research questions, the objective of the study is identified as follows:

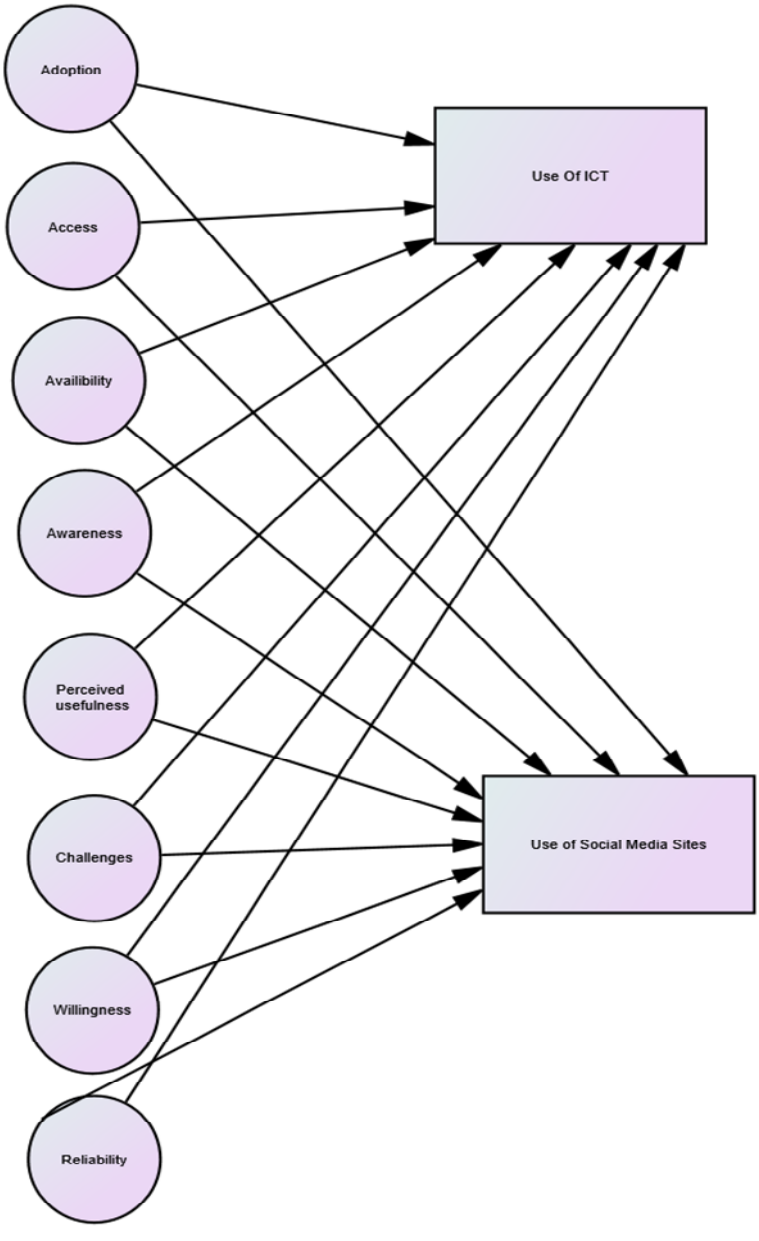
- Identify the impact of the adoption of ICT, accesses of the information, availability, awareness, perceived usefulness, challenges, willingness to pay, reliability of the information available affect the use of ICT and social media sites.
- Predict the use of ICT and social media sites by using the various demographics such as age, income and education of the farmers.

There is no previous literature available based on the study. So, the conceptual model is developed by the researchers that are presented in Figure 1.

Table 1 Description of the constructs

Construct	*Definition*
Adoption	Adopting technology for the development of the supply chain of horticulture crops in India.
Access	Accessibility here refers ability to use information and communication technology (ICT) and social media by the farmers in the proper way.
Availability	Availability here refers to the facilities available for the farmers to use technology in the supply chain of horticulture crops.
Awareness	Awareness here refers that the farmers are aware of the technology used in the supply chain of horticulture crops.
Perceived usefulness	Perceived usefulness is defined as the extent to which a farmer believes that using information and communication technology (ICT) and social media sites will enhance his productivity.
Challenges	Challenges are defined as the problems faced by the farmers to handle technology.
Willingness	Willingness here refers are the farmers are ready and interested to use technology for their development.
Reliability	Reliability is defined as the information shared by the technology is trustworthy.

Figure 1 Conceptual model of the study (see online version for colours)



The hypothesis of the above construct is as follows:

H_{0a} There is any significant impact of adoption on ICT and the use of social media on supply chain of horticultural crops.

H_{0b} There is any significant impact of access on ICT and the use of social media on supply chain of horticultural crops.

H_{0c} There is any significant impact of availability on ICT and the use of social media on supply chain of horticultural crops.

H_{0d} There is any significant impact of awareness on ICT and the use of social media on supply chain of horticultural crops.

H_{0e} There is any significant impact of perceived usefulness on ICT and the use of social media on supply chain of horticultural crops.

H_{0f} There is any significant impact of challenges on ICT and the use of social media on supply chain of horticultural crops.

H_{0g} There is any significant impact of willingness on ICT and the use of social media on supply chain of horticultural crops.

H_{0h} There is any significant impact of reliability on ICT and the use of social media on supply chain of horticultural crops.

3 Data analysis and results

3.1 Descriptive analysis

A questionnaire was distributed to farmers under districts of Maharashtra, viz., Kolhapur, Nagpur and Amravati. The number of farmers considered from Kolhapur is 107, from Nagpur it is 130 and from Amravati, it is 124, out of these, five respondents, five respondents and two respondents from Kolhapur, Nagpur, and Amravati were missing on one or two constructs, so we removed from our final data. So, the final sample size for the study is 340. Table 2 presents the demographic profile of the farmers.

Table 2 Demographic profile of the farmers

Variables	*Kolhapur*		*Nagpur*		*Amravati*	
	Frequency	*Percentage*	*Frequency*	*Percentage*	*Frequency*	*Percentage*
Age						
15–19 years	36	35%	41	32%	48	39%
20–23 years	34	32%	44	34%	47	38%
23+	32	30%	42	32%	37	30%
Education						
SSC/HSC	67	63%	71	55%	75	61%
Undergraduate	29	27%	39	30%	42	34%
Postgraduates income (monthly)	6	6%	51	39%	5	4%
5,000–10,000	52	48%	64	49%	57	46%
10,000–15,000	34	32%	42	32%	44	35%
More than 15,000	16	15%	19	15%	21	17%

Table 3 Items, constructs and measurement models

Construct	*Factor loading*			*AVE*			*CR*		
	Kolhapur	*Nagpur*	*Amaravati*	*Kolhapur*	*Nagpur*	*Amaravati*	*Kolhapur*	*Nagpur*	*Amaravati*
Adoption	0.74	0.92	0.64	0.75	0.89	0.70	0.92	0.89	0.67
Accesses	0.66	0.63	0.71						
Availability	0.86	0.61	0.74						
Awareness	0.65	0.69	0.83						
Perceived usefulness	0.89	0.80	0.66						
Challenges	0.67	0.79	0.83						
Willingness	0.74	0.89	0.75						
Reliability	0.89	0.65	0.69						

From Table 2, it is observed that in Kolhapur district the maximum farmers belong in the age group 15–19 years and maximum education level are SSC/HSC and the maximum monthly income is in between Rs.5,000–10,000 monthly. In Nagpur district, maximum farmers are in the age group of 20–23 years and maximum education level is SSC/HSC and the maximum monthly income is in between Rs.5,000–10,000 monthly. Similarly, in Amravati district the same demographics of farmers present.

3.2 Structural equation modelling

3.2.1 Measurement model

For the evaluation of the measurement model, we used convergent validity using:

1 individual item reliability

2 construct reliability.

The result was presented in Table 3.

Table 3 represented the factor loadings of all the construct. And we used average variance extracted (AVE) and composite reliability (CR), to assess construct reliability. All AVE scores for Kolhapur is 0.75, Nagpur is 0.89 and Amaravati is 0.70 exceeded the recommended value of .50 (Hair et al., 2001). Similarly, the CR for Kolhapur is 0.92, Nagpur is 0.89 and Amaravati is 0.67 exceeded the recommended value used as a cut-off of .70.

The model fit index is presented in Table 4.

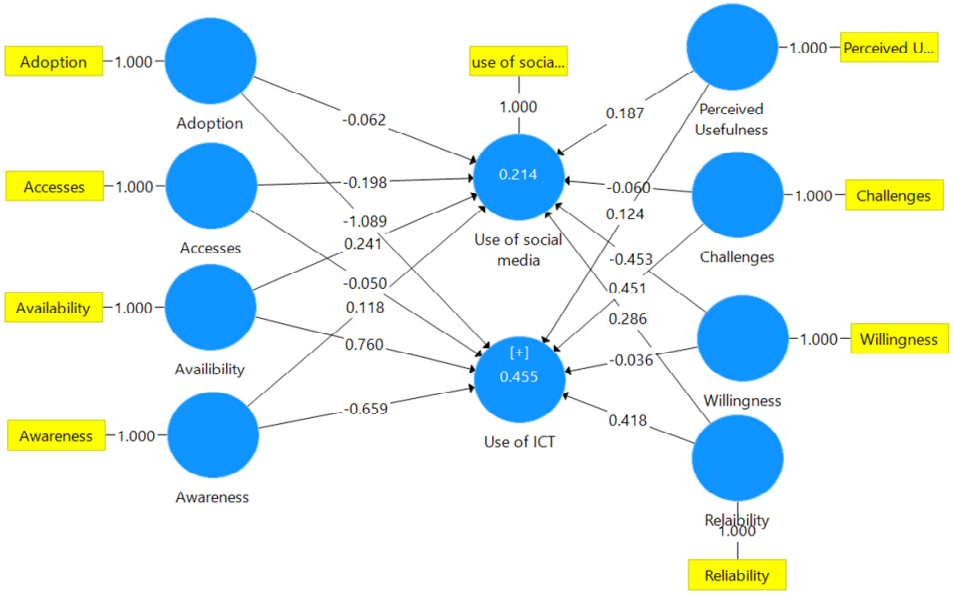
Table 4 Fit indices of the model

Fit measures	*Proposed SEM model I*	*Recommended values*
RMR	0.031	RMR < 0.08, model fit
RMSEA	0.070	RMSEA < 0.07, model fit
GFI	0.955	GFI ≥ 0.95, model fit
NFI	0.932	NFI ≥ 0.95, model fit
CMIN/df	1.235	CMIN/df < 3, model fit
AGFI	0.915	AGFI ≥ 0.80, model fit

Hair et al. (2001) claimed that there was not yet agreement among scholars regarding the standard of the goodness of fittest. Thus, he suggested researchers can pick any one or two indices to evaluate the goodness of fit towards the model. In this research, overall the results exhibited significant values of the goodness of fit to accept the proposed model.

The measurement model presented in Figure 2.

Figure 2 Measurement model (see online version for colours)



3.2.2 Structural model

To assess the structural model R^2 values (coefficient of determination), Stone-Geisser's predictive relevance (Q^2), path coefficients, t-values, and significance level were used and presented.

The R^2 value defines the variation in the dependent variables due to the independent variables. It is the overall predictive power of the model developed. The R^2 for the use of social media is 0.214 and use of ICT is 0.455. So, we can conclude that 21% variation is due to the use of social media sites and 45% variation is due to the use of ICT by the farmers (see Table 5).

Table 5 Assessment of model

Endogenous latent variable	R^2	Q^2
Use of social media sites	0.214	0.56
Use of information and communication technology (ICT)	0.455	0.89

The model has good predictive relevance for the two endogenous variables, i.e., Q^2 is larger than 0. The path coefficients show the relationship between the variables. The results of path analysis shown in Table 6.

The results show that there is a positive impact of access, adoption, availability, reliability, and willingness on use of social media sites by the farmers they found to be statistically significant at 99% and 95% level of confidence rest of the variables shows the positive impact but they are not statistically significant. Furthermore, the results show there is the positive impact of adoption, availability, awareness, challenges, and reliability on use of ICT by farmers, they found to be statistically significant at 99% and 95% level of confidence rest of the variables shows the positive impact but they are not statistically significant.

Table 6 Path analysis

	t-statistics	*P values*	*Path coefficients (ICT)*	*Sig. level*
Accesses -> use of information and communication technology (ICT)	0.932	0.352	–0.050	
Accesses -> use of social media	2.694	0.007	–0.195	***
Adoption -> use of information and communication technology (ICT)	13.141	0.000	–1.089	***
Adoption -> use of social media	0.569	0.570	–0.062	
Availability -> use of information and communication technology (ICT)	7.287	0.000	0.760	***
Availability -> use of social media	2.092	0.037	0.241	**
Awareness -> use of information and communication technology (ICT)	9.283	0.000	–0.659	***
Awareness -> use of social media	1.169	0.243	0.118	
Challenges -> use of information and communication technology (ICT)	5.465	0.000	0.451	***
Challenges -> use of social media	0.626	0.532	–0.062	
Perceived usefulness -> use of information and communication technology (ICT)	1.695	0.091	0.124	
Perceived usefulness -> use of social media	1.748	0.081	0.187	
Reliability -> use of information and communication technology (ICT)	7.465	0.000	0.418	***
Reliability -> use of social media	4.903	0.000	0.286	***
Willingness -> use of information and communication technology (ICT)	0.606	0.545	–0.036	
Willingness -> use of social media	6.512	0.000	–0.452	***

Note: *p < 0.1, **p < 0.05 and ***p < 0.01.

3.3 Predictive modelling

The logistic regression is used to identify the impact of and use of social media on supply chain of horticultural crops in India concerning the adoption of ICT, accesses of the information, availability, awareness, perceived usefulness, challenges, willingness to pay,

reliability of the information available. The model utilised for the study is given in equations (1) and (2):

$$y_{iSocial\ media} = \alpha + \sum \beta_i (x_i) + \varepsilon \tag{1}$$

$$y_{iSiuse\ of\ ICT} = \alpha + \sum \beta_i (x_i) + \varepsilon \tag{2}$$

where y_i defines whether farmers using social media sites and ICT in equations (1) and (2), under the use of social media and use of ICT were divided into the two groups, Group 1 represent the farmers using social and ICT that we can define as the adaptors and Group 2 represent the farmers not using the social media sits and ICT that we can define as non-adopters. whereas x_i is all the independent variables, i.e., adoption of ICT, accesses of the information, availability, awareness, perceived usefulness, challenges, willingness to pay, reliability of the information available and ε_i is the error term.

Table 7 Logistic regression variables: variables in the equation

		B	*SE*	*Wald*	*df*	*Sig.*	*Exp(B)*
Step 1[a]	Adoption	.311	.217	2.055	1	.000	.733
	Accesses	.242	.148	2.663	1	.001	.785
	Availability	.441	.178	6.103	1	.013	1.554
	Awareness	–.308	.147	4.399	1	.086	1.361
	Perceived usefulness	.145	.149	.955	1	.328	1.156
	Challenges	–.112	.137	.679	1	.410	.894
	Willingness	.747	.129	33.718	1	.000	.474
	Reliability	.602	.152	15.613	1	.000	1.826
	Constant	–.284	.458	.385	1	.535	.752

Note: [a]Variable(s) entered on Step 1: adoption, accesses, availability, awareness, Perceived_Usefulness, challenges, willingness and reliability.

The logistic regression results for the use of social media by farmers are presented in Table 7.

The results of the logistic regression inferred that there is a positive impact of adoption, accessibility, availability, willingness, and reliability on the use of social media by the farmers.

And, they found to be statistically significant at 5% level of significance. Further, we will represent the predicted classification table in Table 8.

Table 8 Classification table

Classification matrix		
Observed ↓	*Predicted*	
	Class 1 = positive (1)	*Class 2 = negative (0)*
Class 1 = positive (1)	115 (TP)	54 (FN)
Class 2 = negative (0)	59 (FP)	121(TN)

From the classification table, we inferred that out of 169 farmers using social media sites, 115 farmers are correctly classified that they will continue to use the social media sites

but 54 farmers will be predicted that they will stop using the social media site at the later on stage. Similarly, out of 180 farmers are not using social media sites, 59 farmers currently are not using social media sites but in near further, they will use the social media sites. Whereas 121 farmers are currently not using social media sites shortly also there is no chance that they will use social media sites. Now, we will calculate the sensitivity and specificity percentages:

$$\text{Sensitivity} = \left(\frac{TP}{TP+FN}\right) = \left(\frac{115}{115+54}\right) = 68\%$$

From the sensitivity, we can say that 68% are the chances that farmers currently using social media sites will continue to use social media sites shortly.

$$\text{Specificity} = \left(\frac{FP}{FP+TN}\right) = \left(\frac{59}{59+121}\right) = 33\%$$

From the sensitivity, we can say that 33% are the chances that farmers currently not using social media sites will not use social media sites shortly. So, our predictive model accuracy as follows:

$$\text{Model accuracy} = \left(\frac{TP+TN}{TP+FN+FP+TN}\right) = \left(\frac{115+121}{115+54+59+121}\right) = 68\%$$

So, the model accuracy or predictive accuracy of our model developed is 68%.

The logistic regression results for the use of ICT by farmers are presented in Table 9.

The results of the logistic regression inferred that there is a positive impact of availability, challenges, and reliability and there is the negative impact of adoption and awareness. And, they found to be statistically significant at 5% level of significance. Further, we will represent the predicted classification table in Table 10.

From the classification table, we inferred that out of 146 farmers using ICT sites, 115 farmers are correctly classified that they will continue to use the ICT but 31 farmers will be predicted that they will stop using the ICT at the later on stage. Similarly, out of 203 farmers are not using social media sites, 31 farmers currently are not using social media sites but in near further, they will use the social media sites. Whereas, 172 farmers they are currently not using social media sites shortly also there is no chance that they will use social media sites. Now, we will calculate the sensitivity and specificity percentages:

$$\text{Sensitivity} = \left(\frac{TP}{TP+FN}\right) = \left(\frac{115}{115+31}\right) = 79\%$$

From the sensitivity, we can say that 79% are the chances that farmers currently using ICT will continue to use social media sites shortly.

$$\text{Specificity} = \left(\frac{FP}{FP+TN}\right) = \left(\frac{31}{31+172}\right) = 15\%$$

From the sensitivity, we can say that 15% are the chances that farmers currently not using ICT will not use social media sites shortly. So, our predictive model accuracy as follows:

$$\text{Model accuracy} = \left(\frac{TP+TN}{TP+FN+FP+TN}\right) = \left(\frac{115+172}{115+31+31+172}\right) = 82\%$$

So, the model accuracy or predictive accuracy of our model developed is 82%.

Table 9 Logistic regression variables: variables in the equation

		B	*SE*	*Wald*	*df*	*Sig.*	*Exp(B)*
Step 1[a]	Adoption	–2.609	.310	70.721	1	.000	.074
	Accesses	–.076	.190	.161	1	.689	.927
	Availability	1.947	.290	44.977	1	.000	7.009
	Awareness	–1.583	.248	40.784	1	.000	.205
	Perceived usefulness	.169	.182	.863	1	.353	1.184
	Challenges	.914	.182	25.123	1	.000	2.494
	Willingness	.074	.149	.245	1	.620	1.076
	Reliability	.885	.161	30.409	1	.000	2.423
	Constant	1.410	.550	6.584	1	.010	4.098

Note: [a]Variable(s) entered on Step 1: adoption, accesses, availability, awareness, Perceived_Usefulness, challenges, willingness and reliability.

Table 10 Classification table

Classification matrix		
Observed ↓	*Predicted*	
	Class 1 = positive (1)	*Class 2 = negative (0)*
Class 1 = positive (1)	115 (TP)	31 (FN)
Class 2 = negative (0)	31 (FP)	172(TN)

4 Conclusions and limitations

There is two model approach were used for the study. The validity and the reliability of both the models are statistically significant. According to the first model, i.e., SEM, the factors availability and reliability are having a positive impact but the factors willingness and accessibility are having a negative impact. Whereas, there is a positive impact of availability, challenges and reliability and negative impact of adoption and awareness on the usage of ICT by the farmers.

To access the market information in the rural areas, the government or non-government organisation established some information centres. And, they can also create some social media groups with experts in the field so the farmers can access the market information as well they also share their problem and take the suggestions. Telecom industry should come with the schemes especially for the farmers in the rural areas so they can easily afford the facilities. And, from the predictive modelling, we should target the farmers those you are willing to use social media and ICT in near future and give them the different facility so the usage of social media sites and ICT will increase among the farmers.

Based upon the outcomes of the research, it is recommended that government or non-government organisation may provide relevant training to create the awareness for the usage of ICT and social media sites for the benefits of the farmers and others involved in the process. This approach is likely to have good impacts to make the supply chain of horticultural crops more ICT-friendly.

This research study was carried out in three districts of the state of Maharashtra. The primary data collected from the three districts, i.e., Kolhapur, Nagpur and Amravati. India has vast fertile areas which are also cultivated for horticulture. Due to time and resource limitations, only these three districts were selected for this research. Time and resource availability could make it possible to extend this study to the rest of the nation for wide applicability and more effective results.

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