

DRIVERS OF ICT UTILIZATION AMONG POTATO GROWERS IN GUJARAT: EVIDENCE FROM A BINARY LOGISTIC REGRESSION MODEL

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ABSTRACT: The adoption of Information and Communication Technology (ICT) in agriculture plays a critical role in enhancing farm productivity and improving decision-making. This study examines the extent of ICT utilization and its determinants among potato growers in Banaskantha district of Gujarat using a Binary Logit (BL) model. Primary data were collected from 150 farmers across three talukas, namely Dantiwada, Deesa, and Lakhani. The results indicate that mobile phones, television, and internet services are widely used by farmers, whereas Agricultural Information Services such as web portals and Kisan Call Centres remain underutilized. The Binary Logit analysis identifies income ($p = 0.000$, OR = 96.10), source of information ($p = 0.066$, OR = 1.461), attitude towards ICT ($p = 0.039$, OR = 1.203), and knowledge level ($p = 0.001$, OR = 2.306) as significant determinants influencing ICT adoption. The large odds ratio associated with income reflects the effect of categorical income measurement rather than a marginal increase in income, highlighting the importance of financial capacity in facilitating ICT adoption. Model diagnostics indicate a good fit, as confirmed by the Omnibus Test ($\chi^2 = 106.565$, $p < 0.001$) and the Hosmer-Lemeshow test ($\chi^2 = 5.023$, $p = 0.755$). The model achieved an overall classification accuracy of 84.0%, correctly predicting 88.4% of non-adopters and 78.1% of adopters. The findings suggest that strengthening rural ICT infrastructure, improving digital literacy, and enhancing affordability, along with reinforcing digital agricultural extension services, are essential for promoting ICT adoption and reducing the digital divide among farmers.

KEYWORDS: Digital Agriculture, ICT Tools, ICT Utilization, Binary Logit Model, Potato farmers.

INTRODUCTION

Information and Communication Technology (ICT) is increasingly transforming agriculture by improving farm productivity, decision-making, and resilience. Digital transformation in agriculture through ICT integrates tools such as mobile applications, Geographic Information Systems (GIS), Internet of Things (IoT) sensors, artificial intelligence (AI)-driven solutions, and e-market platforms to provide real-time information on crop

management, pest control, weather forecasting, and market trends. These technologies enable precision farming, enhance knowledge access, and strengthen market linkages, thereby supporting sustainable agricultural development. Despite the substantial potential of ICT, its adoption in agriculture remains constrained by several challenges, including limited digital literacy, inadequate internet connectivity, cost constraints, and trust-related issues.

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While ICT-enabled solutions have demonstrated productivity gains of up to 20% in some regions through precision farming, real-time advisories, and improved pest management (Kumar *et al.*, 2024), their effective utilization largely depends on farmers' socio-economic capacity and access to digital infrastructure. Gujarat is a major potato-producing state in India, contributing about 6.69% of the country's total potato production and ranking fourth after Uttar Pradesh (33.46%), West Bengal (24.12%), and Bihar (15.09%) (Singh & Dutt, 2024). Potato cultivation in Gujarat faces challenges related to climate variability, irrigation management, pest incidence, and market fluctuations. ICT interventions such as IoT-based irrigation systems can reduce water use by up to 30% (Obaideen *et al.*, 2022), while AI-powered platforms like e-Krishi Mitra provide localized crop advisories to a large number of farmers. However, access to advanced ICT tools remains limited, as only about 35% of rural areas have reliable internet connectivity, and high costs restrict farmers' ability to adopt digital technologies (Panigrahy & Kalamkar, 2024). Bridging these gaps through targeted digital literacy initiatives and affordable technological solutions could potentially enhance productivity by 15–25%, positioning Gujarat as a leader in technology-driven agriculture (Samaddar *et al.*, 2023). Addressing infrastructural and behavioural barriers is therefore essential for enabling farmers to effectively harness ICT and improve farm performance and market resilience. Although existing studies on agricultural technology adoption provide broad insights, crop-specific analyses remain limited. Potato farming, characterized by high input intensity and sensitivity to climatic and market risks, requires targeted digital interventions aligned with local conditions. Understanding ICT utilization patterns

among potato growers is crucial for designing effective extension strategies and evidence-based policy interventions. Accordingly, the objectives of the study were to i) assess the extent of ICT utilization among potato growers ii) to identify the key socio-economic and behavioural determinants influencing ICT adoption among potato growers in Gujarat.

MATERIALS AND METHODS

The study was conducted in Banaskantha district, one of the leading potato-producing regions in Gujarat. Within Banaskantha, three talukas—Dantiwada, Deesa, and Lakhani—were purposively selected based on their high contribution to potato production. Given the heterogeneity in ICT adoption patterns among farmers, a random sampling approach was employed to ensure representation across different farming communities. A total of 150 potato growers were selected, with 10 respondents from each of the 15 villages across the three talukas: Dantiwada Taluka: Dantiwada, Deri, Dharni, Bhakarmoti, Bhakar Nani, Deesa Taluka: Juna Deesa, Vasana, Athamno Vas, Ugamno Vas, Vachlovas, Lakhani Taluka: Vasana, Dharanva Manki, Dera Agathala. The selection of villages was based on potato cultivation intensity and accessibility, ensuring diverse insights into ICT adoption patterns among farmers with varying socio-economic backgrounds. In order to gather primary data through in-person interviews, a structured survey questionnaire was created. Its validity, reliability, and clarity were checked through pre-testing. ICT access and usage patterns (ownership, frequency of use, purpose), demographic and socioeconomic variables (age, education, income, landholding, debt level), and farmers' attitudes, knowledge, and behavioural elements connected to ICT adoption were all collected through the survey. Participation

in extension activities and agricultural information sources were also examined. To acquire qualitative insights into the factors that encourage and hinder the adoption of ICT, focus groups and key informant interviews with progressive farmers, input dealers, and agricultural extension agents were also carried out. To systematically assess the extent of ICT adoption among potato farmers, a composite framework was developed to cover 14 widely used ICT tools in agriculture, including traditional ICT (Radio, Television), modern ICT devices (Mobile Phone, Laptop/Desktop, Internet), social media and digital platforms (WhatsApp, Facebook, YouTube, Video Conference, e-mail), and agricultural information services (CD/DVD, E-Magazines, Kisan Call Centre, Web Portals). Respondents reported ownership, access, and usage frequency, which were categorized as high, moderate, or low based on frequency and purpose. Determinants of ICT adoption were examined, considering demographic factors (age, education level), economic variables (income, landholding, debt level), information sources and awareness (source of agricultural information, knowledge of ICT tools), behavioural and social factors (attitude toward technology, social participation, extension participation), and the innovation diffusion stage (innovator, early adopter, early majority, late majority, or laggard). These variables were hypothesized to influence ICT adoption likelihood based on respondents' socio-economic and behavioural profiles. For the Binary Logistic Regression analysis, the Extent of Utilization Pattern Index (EUPI) was converted into a dichotomous variable using the mean score as the cut-off point, classifying respondents as ICT adopters (1) and non-adopters (0). Binary Logistic Regression was employed to examine the factors influencing ICT adoption among potato growers, as it is appropriate for analyzing binary outcome

variables. The model accounts for non-linear relationships between the dependent and independent variables and ensures that predicted probabilities of ICT adoption are bounded between 0 and 1 through the logistic function:

$$P(Y = 1 | X) = \frac{e^{\beta_0 + \beta_1 X_1 + \dots + \beta_n X_n}}{1 + e^{\beta_0 + \beta_1 X_1 + \dots + \beta_n X_n}}$$

The logistic regression model was specified as: $\log[P(Y=1)/(1-P(Y=1))] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n$. Here, $P(Y=1|X)$ denotes the probability that a respondent belongs to the higher ICT-utilization/adoption category; β_0 is the intercept; β_i represents the regression coefficient for the i th explanatory variable; and X_i represents the corresponding independent variable.

In this equation:

$P(Y = 1 | X)$ is the probability of the dependent variable Y being 1 given the independent variables X .

β_0 is the intercept.

$\beta_0, \beta_1, \dots, \beta_n$ are the coefficients for the independent variables $X_1, \dots, X_n$.

where X_n represents independent variables (e.g., age, education, income, landholding, knowledge, attitude). The model outputs odds ratios (OR), where $OR > 1$ indicates a positive influence (e.g., higher education increases ICT adoption), $OR < 1$ suggests a negative impact (e.g., older farmers are less likely to adopt), and $OR = 1$ implies no effect (Hossain *et al.*, 2024). Statistical significance is assessed using p-values (< 0.05 indicates a meaningful effect) and Wald statistics. Model fitness is evaluated using the Likelihood Ratio (LR) Test (Lal *et al.*, 2025), Pseudo R^2 (Nagelkerke R^2 range between 0 to 1), and the Hosmer-Lemeshow test ($p > 0.05$ suggests a good fit). A well-fitting model should have a high classification accuracy of $>70\%$ (Davies *et al.*, 2024), correctly predicting ICT

adoption patterns. If the model does not fit well, modifications like including interaction terms or alternative regression approaches (e.g., Probit) may be considered. The Logit model thus provides critical insights into how socio-economic and behavioural factors shape ICT utilization, aiding policymakers in developing targeted interventions to enhance digital adoption in agriculture.

RESULTS AND DISCUSSION

The findings of this study provide empirical insights into the extent of ICT utilization among potato growers in Gujarat, along with the determinants influencing their adoption.

Table 1 exhibited the frequency distribution of ICT usage by respondents. Traditional ICT tools such as radio (65.34%) and television (70.00%) are frequently used on a daily basis, indicated their continued relevance in agricultural information dissemination. Mobile phones (78.00%) emerged as the most widely used ICT tool. However, a majority of

respondents reported non-use of advanced ICT tools such as video conferencing (62.00% never used), e-mail (95.33% never used), CD/DVD (96.00% never used), e-magazines (90.66% never used), and web portals (98.00% never used), reflecting limited penetration of advanced digital platforms.

Figure 1 presented the aggregate ICT utilization index across four broad ICT categories. Traditional ICT recorded the highest utilization index (81.34%), followed by modern ICT (54.00%), media and digital platforms (28.00%), and agricultural information services (4.17%).

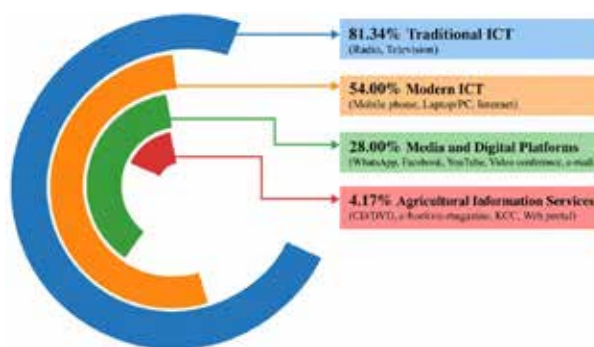


Fig. 1. Four Broad Spectrum of Utilization of ICT

Table 1. Extent of utilization of ICTs by the farmers

Sr. No.	ICTs		Daily		Weekly		Fortnight		Occasionally		Never	
			f	%	f	%	f	%	f	%	f	%
1	Traditional ICT	Radio	98	65.34	9	6.00	8	5.33	14	9.33	21	14
2		Television	105	70.00	16	10.67	8	5.33	4	2.67	17	11.33
3	Modern ICT	Mobile phones	117	78.00	14	9.33	9	6.00	6	4.00	4	2.67
4		Laptop/personal computer	0	0	0	0	8	5.33	4	2.67	138	92.00
5		Internet	74	49.33	15	10.00	6	4.00	3	2.00	52	34.67
6	Social Media And Digital Platform	WhatsApp	68	45.33	18	12.00	6	4.00	1	0.67	57	38.00
7		Facebook	24	16.00	9	6	1	0.67	50	33.33	66	44.00
8		You Tube	23	15.33	12	8.00	3	2.00	5	3.33	107	71.34
9		Video conference	0	0	3	2.00	39	26.00	15	10.00	93	62.00
10	Agricultural Information Services	e-mail	0	0	0	0	4	2.67	3	2.00	143	95.33
11		CD/DVD	0	0	0	0	0	0	6	4.00	144	96.00
12		e-books/e- magazine	0	0	0	0	4	2.67	9	6.00	137	91.33
13		Kisan Call Centre (KCC)	0	0	3	2.00	18	12.00	16	10.66	113	75.34
14		Web portal	0	0	0	0	0	0	3	2.00	147	98.00

(4.17%). The results indicated greater reliance on traditional and commonly accessible ICT tools, while specialized agricultural information services remained comparatively underutilized. Due to poor ICT utilization for Laptop/personal computer, Video conference, e-mail, CD/DVD, e-books/e- magazine, Kisan Call Centre (KCC) & Web portal none of the respondents fell in the high utilization category.

Extent of Utilization patterns of ICT tools

The majority of farmers were classified under low (57.33%) followed medium (42.67%) ICT utilization categories. No respondents were found in the high utilization category, indicating limited penetration of diverse and advanced ICT tools (Table 2). The mean utilization score of 18.126 (SD = 4.92) suggested low overall ICT engagement, with a majority of farmers lacking access or awareness of diverse ICT tools beyond mobile phones and traditional media.

As the classification in Table 2 revealed only two categories Low & Medium; so binary logit model was used instead of multinomial logistic model which predicted the probability of a categorical dependent variable with binary unordered choices based on 11 independent variables. Since no respondent was observed in the high-utilization category, the two observed categories, namely low and medium utilization, were used to construct the binary dependent variable. Respondents

Table 2. Distribution of respondents according to their utilization pattern of ICT tools

Sl. No.	Category	f	%
1	Low (0-19)	86	57.33
2	Medium (20-38)	64	42.67
3	High (39-56)	0	0.00
Total		150	100.00

$\bar{x}=18.126$; $\sigma= 4.92$

with EUPI scores ranging from 0 to 19 were coded as 0 (lower ICT utilization/non-adopter), whereas respondents with scores ranging from 20 to 38 were coded as 1 (higher ICT utilization/adopter)..

The classification accuracy of 84.0% (Table 3) indicates the model's robust predictive capability, effectively categorizing ICT users and non-users. The model correctly predicts 88.4% of non-users and 78.1% of users, supporting the reliability of the identified determinants. This highlights the necessity of targeted interventions to enhance digital access and ICT-driven agricultural extension in Gujarat. The Binary Logit regression model was employed to analyze the key factors influencing ICT adoption among farmers. The Omnibus Tests of Model Coefficients indicate a highly significant model fit ($\chi^2=106.565$, $p = 0.000$), confirming that the selected independent variables significantly influence ICT adoption.

The model summary (Nagelkerke $R^2 = 0.683$) demonstrates that 68.3% of the variation in ICT utilization is explained by the independent variables, indicating a strong explanatory power of the model (Table 4). The Hosmer and Lemeshow test ($\chi^2= 5.023$, $p = 0.755$) confirms that the model is well-calibrated, as the non-significant p-value suggests a good fit (Shukla *et al.*, 2024). The Binary Logit regression analysis identifies four

Table 3. Classification statistics of the Binary logistic regression model apropos EUPI

Observed		Predicted			
		EUPI		% Correct	
		0	1		
Step 1	EUPI	0	76	10	88.4
		1	14	50	78.1
	Overall Percentage				

a. The cut value is .500; *EUPI: Extent of Utilization Pattern Index; 0 = lower ICT utilization/non-adopter and 1 = higher ICT utilization/adopter. (EUPI)

Table 4. Parameter Estimates of Binary Logistic Regression Analysis apropos EUPI

EUPI	B	S.E.	Wald	df	Sig.	Exp(B)	EXP (β)95% CI	
							LB	UB
Age	-.097	.088	1.224	1	.269	.907	.763	1.078
Education	.168	.297	.320	1	.572	1.183	.660	2.119
Laggard	.000	.000	.493	1	.483	1.000	1.000	1.000
Income	4.565	1.042	19.192	1	.000***	96.100	12.464	740.920
Source of information	.379	.206	3.378	1	.066*	1.461	.975	2.188
Landholding	.081	.148	.300	1	.584	1.084	.812	1.448
Debt	.437	.899	.237	1	.627	1.548	.266	9.010
Attitude	.185	.090	4.269	1	.039**	1.203	1.010	1.435
Knowledge	.836	.249	11.255	1	.001***	2.306	1.415	3.757
Extension Participation	-.020	.111	.033	1	.855	.980	.788	1.218
Social Participation	-.004	.026	.022	1	.883	.996	.946	1.049
Constant	-15.666	4.520	12.013	1	.001	.000		
-2 Log likelihood								98.141 ^a
Cox & Snell R Square								.509
Nagelkerke R Square								.683

***, **, *, depict level of significant at 1%, 5%, 10% respectively.

LB = Lower Bound; Upper Bound.

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

Variable(s): Age, Education, Income, Laggard, Source of information, Landholding, Debt, Attitude, Knowledge, Extension Participation, Social Participation.

significant variables influencing the extent of ICT utilization among potato farmers in Gujarat: Income, Source of Information, Attitude, and Knowledge. These factors play a crucial role in shaping farmers' adoption behaviours, as supported by the empirical findings. Income ($p = 0.000$, $\text{Exp}(\beta) = 96.100$, 95% C.I. = 12.464 – 740.920): Income is the most significant determinant at the 1% level, indicating that higher-income farmers are substantially more likely to utilize ICT tools. The odds ratio of 96.10 indicated that farmers belonging to higher income categories have substantially greater odds of ICT adoption compared to those in lower income categories. This large odds ratio reflects the effect of income measured in discrete categories rather than a marginal percentage increase in income, underscoring the role of financial capacity in enabling access to ICT tools such

as smartphones, internet services, and digital agricultural advisory platforms. In Gujarat, where commercial potato farming (Patel *et al.*, 2025) is capital-intensive, wealthier farmers are better positioned to invest in modern ICT tools for price forecasting, weather updates, and market linkages (Chetri *et al.*, 2023). Additionally, prosperous farmers in Banaskantha, a leading potato-producing district (Banaskantha District, 2024), often have stronger ties with contract farming companies (e.g., McCain Foods) (Fernandes, 2013), which facilitate ICT-based agricultural advisory. Source of Information ($p = 0.066$, $\text{Exp}(\beta) = 1.461$, 95% C.I. = 0.975 – 2.188): Source of Information At the 10% significance level, the availability and accessibility of reliable information sources positively influence ICT adoption. Farmers with multiple information channels (e.g., Krishi Vigyan

Kendras (KVKs), agricultural universities, private advisory services) are 1.46 times more likely to engage with ICT tools (Pachamuthu, 2024). This aligns with the fact that Gujarat has a strong extension network, including Anand Agricultural University (AAU), Gujarat Agricultural University (GAU), and KVKs, which actively promote ICT-based advisories (Alvi *et al.*, 2021). However, limited awareness and fragmented access to agricultural digital platforms (Hackfort, 2020) (e.g., Kisan Suvidha, IFFCO Kisan App) among smallholder farmers highlight the need for better outreach strategies. Attitude ($p = 0.039$, $\text{Exp}(\beta) = 1.203$, 95% C.I. = 1.010 – 1.435): Attitude towards ICT is a significant determinant at the 5% level, with a positive impact on adoption behaviours. Farmers with a progressive mindset and openness to technological innovations are 1.2 times more likely to use ICT tools. This reflects Gujarat's entrepreneurial agricultural landscape, where progressive farmers in districts like Banaskantha and Sabarkantha are early adopters (Mahida & Cariappa, 2022) of digital marketing platforms for contract farming and e-NAM (National Agricultural Market) participation. However, resistance from conventional farmers, particularly older individuals with limited digital literacy, poses a challenge to widespread ICT adoption. Knowledge ($p = 0.001$, $\text{Exp}(\beta) = 2.306$, 95% C.I. = 1.415 – 3.757): Knowledge is highly significant at the 1% level, indicating that better-informed farmers are 2.3 times more likely to integrate ICT tools into their agricultural practices. Farmers with higher technical know-how can effectively navigate digital platforms for weather forecasting, market price tracking, pest control advisories, and input procurement. The presence of progressive farmer groups and agribusiness networks in Gujarat has facilitated knowledge dissemination. However, the digital divide,

particularly among small and marginal farmers in remote villages, underscores the need for capacity-building programs and ICT literacy training to bridge the gap.

CONCLUSION

This study examined the extent of ICT utilization and its determinants among potato growers in Banaskantha district of Gujarat using a Binary Logistic Regression approach. The findings indicate that farmers predominantly rely on traditional ICT tools such as radio and television, along with mobile phones, while the adoption of advanced digital tools and web-based agricultural information services remains limited. The overall level of ICT utilization was low to moderate, with no respondents falling under the high utilization category, highlighting a persistent digital divide in the study area. The regression results reveal that income, access to information sources, attitude towards ICT, and knowledge significantly influence ICT adoption among potato growers. Farmers belonging to higher income categories exhibited substantially higher odds of ICT adoption, underscoring the importance of financial capacity in accessing digital tools and services. Positive attitudes toward technology and higher levels of ICT-related knowledge further enhanced the likelihood of adoption, while exposure to multiple and reliable information sources supported greater ICT use. The study provided empirical evidence on ICT utilization behaviour among potato growers in Gujarat and demonstrates the relevance of socio-economic and behavioural factors in shaping digital adoption. These findings offer valuable insights for policymakers and extension agencies in designing targeted digital extension strategies focused on improving affordability, strengthening information dissemination mechanisms, and enhancing

farmers' knowledge and attitudes toward ICT. Strengthening such interventions is essential for promoting inclusive digital transformation and improving decision-making in agriculture.

ETHICAL CONSIDERATIONS

Participants in the study took part voluntarily, giving informed consent before any data was collected. We maintained the confidentiality of both personal and financial information. Additionally, farmers were informed that the purpose of this study was to help create policy recommendations aimed at enhancing access to information and communication technologies (ICT) in agriculture.

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