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# FACTORS AFFECTING THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN AGRICULTURE: INSIGHTS FROM DIFFERENT AGRO-ECOLOGICAL ZONES OF NEPAL

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## ABSTRACT

ICT tools are very crucial in modern agriculture to address all the information needs of farmers. A logit model was applied to assess the factors influencing the use of ICT in agriculture across different agro-ecological zones of Nepal by using the household survey of 210 farmers consisting 70 farmers from each district (Chitwan, Lamjung and Jumla). Pretested semi-structured questionnaire survey was taken in the year 2022. The findings of study revealed that the usage of ICT tools in the study area was mostly determined by the socio-economic and institutional factors. Gender, age and income of farmers affected the probability of use of ICT in farming practices. Additionally, membership to cooperatives, contact to extension agents and training programs related to the operation of ICT tools increases the usage of ICT in agriculture. Thus, government bodies, concerned stakeholders and policy should focus on young male farmers and provide them with proper training and consultation with extension personnel which might be through increment in membership to cooperatives. As income directly influenced the use of such technologies, financial support to initial installation could be the better option for use of ICT in agriculture.

**Keywords:** age, cooperatives, extension, logit, subsidy

## INTRODUCTION

The implication of Information and Communication Technology (ICT) is vital for making efficient, competitive and sustainable agriculture (Salampasis & Theodoridis, 2013). Basically, ICT refers to any devices, tools and application which lets the extensive dissemination of information and allows the exchange or collection of data through transmission or interactions at faster rate (Kante *et al.*, 2016; World Bank, 2017; Nwafor *et al.*, 2020). In agriculture, ICT includes all the converging technologies which includes traditional telecommunications, radio, mobile phones, etc., and modern technologies like computers, internets, GIS, sensors, etc. Efficient utilization of all these ICT tools and services aid in improving the commercial viability of farming through increment in agricultural productivity (Lio & Liu, 2006; Chatterjee & Nath, 2015; Das *et al.*, 2016; Salemink *et al.*, 2017). ICT are very crucial in modern agriculture, which addresses abundant agriculture information needs of farmers' that includes real-time data on agricultural practices, seed varieties, pest management, diseases outbreaks, market prices, and weather information (Kapange, 2002; Ajani, 2014; Ogutu *et al.*, 2014). Unleashing the prospect of greater market participation and higher income level of farmers, information and communication technologies act as the better decision support system on several farm related activities and sustainable agribusiness (Katengeza *et al.*, 2011; FAO, 2017; Singh *et al.*, 2017). Similarly, it strengthens the agricultural value chain with the proper communication of farmers to traders, suppliers, extension personnel, etc. (Furuholt & Matotay, 2011). It is the powerful enabler and aids agriculture development agendas as it provides price and other necessary agriculture information, seeks and expands national and international market and increases

production efficiency more specifically (Zelenika & Pearce, 2013). Furthermore, farmers are also benefitted indirectly with the transformation and development of agro advisory services and effective agriculture research through fresh approaches of ICT (Kim & Nielson, 2017).

Nepal is pursuing the broader use of ICT in diverse sectors to enhance the productive capacity and improves the overall economy. ICT has tremendously improved with the rapid penetration of mobile phones and internet nationwide (Sharma & Kim, 2016; Angello, 2017). Mobile phones and internet are supposed to link the lower income group of farmers with necessary agriculture information in simpler and cost-effective way to increase the agriculture productivity (Masuki *et al.*, 2010; Razaque & Sallah, 2013; Duncombe, 2016; Quandt *et al.*, 2020). The national sectoral strategy of Nepal, Agriculture Development Strategy (ADS) spanning from 2015 to 2035, emphasizes the promotion of ICT in agricultural extension to achieve higher productivity and the prioritization of ICT for the purpose of achieving profitable commercialization (MoAD, 2016). Meanwhile, implementation of ICT policy (2072), Digital Framework Nepal and Project for Agriculture Commercialization and Trade (PACT), Agriculture Management Information System (AMIS) under the MoALD are successfully increasing the access of ICT tools to rural farmers in Nepal. Several agricultural applications, such as *Smart Krishi, Krishi Ghar, IFA Krishi*, along with other government and privately initiated projects, like call center of Agriculture Information and Training Center (AITC) Nepal and Agriculture and Forestry University (AFU) Nepal, have escalated the number of ICT users in farms. Scheduled agriculture programs broadcasted through radio and TV like *Krishi Karyakram* are reaching rural farming communities. Specifically, farmers use information technologies for variety selection, plant protection and market price information for their product (Gautam, 2018). Additionally, ICT based initiatives can be taken for digital financing and payments (*kishan credit card*), promotion of agriculture insurance, transfer of technologies with right and real time information and selling of outputs (Singh *et al.*, 2017). However, the expansion and utilization of ICT tools are lagging and has sluggish growth in case of Nepal. The major impediment to adopt ICT are reported to be lack of technical knowledge, customer's awareness, IT infrastructures, initial investment and many other social factors (Hosseini *et al.*, 2009; Salemink *et al.*, 2015; Sangwan & Komal, 2016; Dhital, 2017; Kumar & Kansara, 2018; Salehi *et al.*, 2021; Sigdel *et al.*, 2022).

Despite the realized benefits of ICT in agriculture, there is a huge gap on the adoption of these technologies in the real ground of Nepal (Mishra *et al.*, 2023). With the differences in the agroecological zones, there exists the differences in the socio-economic conditions, diffusion of information and adoption of new technologies. ICT enabled solutions in farming practices is more related to affordability, accessibility and adaptability to rural farmers. Along with this, proliferation of ICT tools depends upon the various factors: social, economic, institutional, infrastructures, geography, etc. Very limited studies were done till now for assessing the factors that directly influence the use of ICT in agriculture with the perspective of agroecological regions. This paper aims to examine the influence of several socio-economic factors on the use of ICT in different agro-ecological zones of Nepal.

## MATERIALS AND METHODS

### Study area

The study was conducted in the three districts namely Chitwan, Lamjung and Jumla which represents terai, hills and mountain region of Nepal, respectively. Those districts were

selected purposively for the study due to operation of government led agriculture project Prime Minister Agriculture Modernization Project (PMAMP), proper access to ICT tools and accessibility of transportation.

Chitwan district lies in the inner terai zone with fertile plains and tropical hot climate. Here, the survey was carried out in the local bodies namely Bharatpur metropolitan, Kalika municipality and Ratnanagar municipality. Majority of farmers here are engaged in the cultivation of crops like paddy, wheat, vegetables, and banana and livestock rearing. Similarly, Lamjung is one of the districts of mid hills which have moderate climatic condition. Here, the survey was done in local bodies namely Sundarbazar municipality and Rainas municipality and supports the farming of paddy, maize, citrus, cardamom and vegetables and livestock rearing. Jumla is popular district of the mountain zones having temperate cold climate. Here, the survey was carried out in local bodies namely Chandannath municipality, Tila rural municipality and Tatopani rural municipality. Farmers here are involved in the farming practices of apple, beans, buckwheat, millet, barley, potato and paddy (*Marshi dhan*).


**Figure 1. Map of Nepal showing study area**

## Sampling technique and data collection

Multistage random sampling was employed in the study. The first stage was the selection of districts from each agro-ecological zones of Nepal. Chitwan, Lamjung and Jumla were taken as the representative of the terai, hills and mountain, respectively. At second stage, the selection of local bodies was done. For the third stage, face to face interview survey was taken from farmers chosen randomly. A total sample of 210 farmers was taken which

constituted 70 respondents from each district. Equal number of ICT users and non-users were selected in each study district.

Primary data was obtained from the household survey using self-administered and semi- structured questionnaire in the year 2022. Further, Focus Group Discussion (FGD) and Key Informant Interview (KII) were done with government officials, local representatives and progressive farmers for the triangulation of data. Secondary information was derived from the various scientific publications, government and non-government reports, statistics and related literatures. The collected information was coded and entered in MS EXCEL. Descriptive analysis, t-test, f-test and chi-square test were done in IBM SPSS Statistics 25. Logistic regression was done in Stata/SE 12.1.

**Analytical model and variables**

Logistic regression was run to estimate the factors affecting the use of ICT by farmers of different agroecological zones of Nepal. Logistic regression analysis has also been used particularly to investigate the relationship between binary or ordinal response probability and explanatory variables by the method of maximum likelihood. Logit model was preferably used over probit model for the study due to simplified mathematical comparisons (Wawire *et al.*, 2019). Additionally, this model is useful in giving relative effect of each explanatory variables in the adoption decision of ICT measures.

The explanatory variables were considered reviewing the previous studies and consultations with expert in related field. The dependent variable was basically the adoption of ICT usage which takes the binary value of 0 and 1. In the study, usage of ICT was taken for 1 and no usage of any ICT tools was represented as 0 in the binary logistic regression.We assumed that the trajectory of dependent variables was X and the likelihood that Y = 1 is P.

The logistic regression in this study can be stated as follows:

$$Zi=\ln [Pi/(1-Pi)]=a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+b_9X_9+b_{10}X_{10}+U$$

Where,

Pi= probability of use and no use of ICT

Pi=1 indicates use of ICT

Pi=0 indicates no use of ICT

a= intercept

$b_1$ to $b_{10}$ = regression coefficients of the dependent variables

U = error term

The details of dependent variable (Zi) and independent variables ($X_n$) are given in Table 1.

The marginal probabilities of the factors influencing the use of ICT tools by farmers in different districts was estimated based on expressions derived from the marginal effect of the logit model. $dZ/dQ = \beta i\{Pi(1-Pi)\}$

Where,

$\beta i$ = Estimated logit regression coefficient with respect to the ith factor

Pi = Estimated probability of using ICT tools by farmers

**Table 1. Description of the variables used in the study**

| Variables | Description | Expected sign |
|---|---|---|
| Dependent | | |
| Use of ICT | =1 if respondent use ICT in agriculture, 0 otherwise | |
| Independent | | |
| Gender ($X_1$) | Gender of the respondent (=1 if male, 0 female) | +/- |
| Age ($X_2$) | Age of the respondent (year) | - |
| Experience ($X_3$) | Farming experience of respondent (year) | + |
| Education ($X_4$) | Formal education of the respondent (year) | + |
| Income ($X_5$) | Yearly income of household (NPR) | + |
| Distance to agriculture office($X_6$) | Distance between household and nearest agriculture office (km) | - |
| Distance to ICT center ($X_7$) | Distance between household and nearest ICT center (km) | - |
| Membership to cooperatives ($X_8$) | =1 if respondent is member in agricultural cooperatives, 0 otherwise | + |
| Contact to extension agents ($X_9$) | =1 if respondent has regular contact with extension worker, 0 otherwise | + |
| Training ($X_{10}$) | =1 if respondent has received training related to ICT in agriculture, 0 otherwise | + |

## RESULTS AND DISCUSSION

### Socio-demographic characteristics

#### *Socio-demographic characteristics of respondent's household by study areas*

Table 2 shows the socio-demographic characteristics (continuous variable) of the respondent households by the study area. The average age of the respondent was 44.31 years, significantly different at 1 % level in study areas. The years of experience was higher in the Lamjung (23.26 years), compared to other two districts, significant different at 1 % level. An average year of academic education was found significantly higher in the farmers of Chitwan district (10.37 years), significant at 1 % level. Similarly, the average distance of respondent's household to agriculture office and ICT center was 9.48 km and 10.43 km, respectively. Those distance was found greater in Jumla district, significant at 1 % level. The average total annual income of the respondent household was found NPR 849623.81, highest in Chitwan district.

**Table 2. Socio-economic characteristics of respondents by study area (continuous data)**

| Variables | Chitwan | Lamjung | Jumla | Overall | f value | p value |
|---|---|---|---|---|---|---|
| Age | 48.93 | 44.80 | 39.19 | 44.31 | 11.827*** | 0.000 |
| Experience | 7.97 | 23.26 | 10.90 | 14.04 | 97.187*** | 0.000 |
| Education | 10.37 | 9.41 | 7.06 | 8.95 | 13.211*** | 0.000 |
| Distance to agriculture office | 2.00 | 7.53 | 18.92 | 9.48 | 100.779*** | 0.000 |
| Distance to ICT center | 1.2 | 6.63 | 23.46 | 10.43 | 370.341*** | 0.000 |
| Income | 1623871.42 | 335000 | 590000 | 849623.81 | 10.825*** | 0.000 |

Source: Field survey, 2022

Note: *** indicate significant at 1% level of significance.

Similarly, Table 3 shows that there was significant association between the gender and study areas. Females accounted for the higher percentage in all the three districts. Similarly, majority (59.5%) of the respondents in the study area had no membership to the cooperatives and there was significant association between membership to cooperatives and study areas at 5% level of significance. Furthermore, more than the half of the respondents had contact to the extension agents with significant association to study areas at 10% level. In overall, 65.7% of farmer had received the training from different government and non-government organizations.

**Table 3. Socio-economic characteristics of respondents by study area (categorical data)**

| Variables | Chitwan | Lamjung | Jumla | Overall | Chi-square value |
|---|---|---|---|---|---|
| Gender | | | | | |
| Male | 11(15.7) | 8(11.4) | 28(40.0) | 47(22.4) | 19.133*** |
| Female | 59(84.3) | 62(88.6) | 42(60.0) | 163(77.6) | |
| Membership to cooperatives | | | | | |
| Yes | 37(52.9) | 20(28.6) | 28(40.0) | 85(40.5) | 8.578** |
| No | 33(47.1) | 50(71.4) | 42(60.0) | 125(59.5) | |
| Contact to extension agents | | | | | |
| Yes | 33(47.1) | 44(62.9) | 32(45.7) | 109(51.9) | 5.074* |
| No | 37(52.9) | 26(37.1) | 38(54.3) | 101(48.1) | |
| Training | | | | | |
| Yes | 42(60.0) | 5(64.3) | 51(72.9) | 138(65.7) | 2.663 |
| No | 28(40.0) | 25(35.7) | 19(27.1) | 72(34.3) | |

Source: Field survey, 2022

Note: *, **, *** indicate significant at 10%, 5%, 1% level of significance, respectively. Figure in the parentheses indicate percentage.

**Socio-demographic characteristics of respondent's household by ICT usage**

As mentioned earlier, ICT users and non-users were classified as per the adoption of different ICT measures like TV, radio, phone call, software application etc., for agriculture activities. Frequency estimation revealed radio, phone call, TV and social media (facebook) through smart phones were in order according to usage in each district. From Table 4, it was clear that the average age of ICT adopters was higher, significant at 1 % level. ICT users (14.38 years) were more experienced than non-users. The academic years of education was 8.71 years in ICT users and 9.18 years in ICT non- users. For ICT users, the distance to agriculture and ICT centers was lower. The average annual income of ICT users was found relatively lower than that of the non-users.

**Table 4. Socio-demographic characteristics of respondent's household by ICT usage (continuous variable)**

| Variables | ICT users | ICT non users | Mean difference | t value | p value |
|---|---|---|---|---|---|
| Age | 46.24 | 42.37 | 3.87 | 2.264** | 0.025 |
| Experience | 14.38 | 13.71 | 0.68 | 0.513 | 0.609 |
| Education | 8.71 | 9.18 | -0.47 | -0.814 | 0.416 |
| Distance to agriculture office | 9.27 | 9.71 | -0.44 | 0.315 | 0.753 |
| Distance to ICT center | 9.76 | 11.11 | -1.34 | 0.906 | 0.366 |
| Income | 661866.67 | 1037380.95 | -375514.29 | -1.503 | 0.134 |

Source: Field survey, 2022

Note: ** indicate significant at 5% level of significance.

**Table 5. Socio-demographic characteristics of respondent's household by ICT usage (categorical variable)**

| Variables | ICT users | ICT non users | Overall | Chi-square value |
|---|---|---|---|---|
| Gender | | | | |
| Male | 29(27.6) | 18(17.1) | 47(22.4) | 3.317* |
| Female | 76(72.4) | 87(82.9) | 163(77.6) | |
| Membership to cooperatives | | | | |
| Yes | 65(61.9) | 20(19.0) | 85(40.5) | 40.024*** |
| No | 40(38.1) | 85(81.0) | 125(59.5) | |
| Contact to extension agents | | | | |
| Yes | 69(65.7) | 40(38.1) | 109(51.9) | 16.042*** |
| No | 36(34.3) | 65(61.9) | 101(48.1) | |
| Training | | | | |
| Yes | 85(81.0) | 53(50.5) | 138(65.7) | 21.643*** |
| No | 20(19.0) | 52(49.5) | 72(34.3) | |

Source: Field survey, 2022

Note: *, *** in.dicate significant at 10%, 1% level of significance, respectively. Figure in the parentheses indicate percentage.

In Table 5, the average number of females was higher in both ICT users and non-users. There was association between the gender and the ICT usage, significant at 10% level. Higher percentage of ICT users (61.9%) was found members in the cooperatives and there was also significant association between ICT usage and membership to cooperatives at 1% level. Similarly, 65.7% of ICT users and 38.1% of ICT non-users had contact to extension agents. Likewise, 81% of sampled ICT users were accessed with the trainings in the study area. There was significant association between contact to extension agents and training to ICT usage at 1% level of significance.

**Factors affecting the use of ICT in agriculture**

A logit model was used to identify the factors affecting the use of ICT in agriculture in different agroecological zones of Nepal. For every sampled district, logit model was run

separately (Table 6). The explanatory variables used in the model with significant relation to the ICT usage are described below:

Gender: In Chitwan district which is the representative of terai region of Nepal, gender was found positively related to the ICT usage at 1% level of significance, while there was not significant relationship in other two districts. Gender was the important determinants of the adoption and use of ICT tools in the study areas (Odiaka & Obinne, 2010). Male farmers are more accessible to the new ICT tools and has readiness to acquire and share agriculture technology through them. The interplay of different factors for female such as limited education level, financial restrictions and inability to operate ICT tools were the reason for the less adoption of ICT tools in agriculture (Zougmoré & Partey, 2022). Additionally, the result is in line with the previous studies (Wawire *et al.*, 2017; Mdoda & Mdiya, 2022) which showed more number of male ICT users as majority of farmers were male and in need of agriculture information.

Age: In Lamjung district, age was found negative determinants of the ICT usage, significant at 5% level of significance. This result is in line with previous studies (Taragola & Van Lierde 2010; Ali, 2012; Wawire *et al.*, 2017; Katunyo *et al.*, 2018; Mdoda & Mdiya, 2022). Young farmers are more accepting and open to new technologies and ideas compared to old ones. Increase in age causes the reluctance to change and improved technologies. Ghosh *et al.* (2022) also revealed negative attitude of older people towards the use of ICT tools in agriculture related activities. Adoption and operation of ICT tools needs skill and knowledge which aged people could not get right easily unlike young people who learns the usage of ICT tools in acquiring information regarding inputs, farming techniques, weather forecast and market more easily.

Income: Income was expressed in the natural log which was positively significant to ICT usage at 5% level of significance in Chitwan district. The result is supported by Yaseen *et al.* (2016). High cost of the ICT tools and services were considered as the major barrier of ICT adoption in developing countries (Kante *et al.*, 2016). Thus, only farmers having higher income level opt for the use of the ICT tools like mobile phones, internet etc. in farming decisions. Similarly, farmer having higher income shows more tendencies to diversify the sources of agricultural information and opt for new technology.

Membership to cooperatives: In all districts (Chitwan, Lamjung and Jumla), there was positive relationship of ICT usage to membership of cooperatives. The result supports the findings of previous studies (Wawire *et al.*, 2017; Mdoda & Mdiya, 2022). In general, agriculture cooperatives plays an important role in delivering required knowledge and skills to farmers related to market, inputs and new technologies which is possible through the ICT sources (Adenegan, 2012; Nwafor, 2020). Cooperatives, itself use ICT tools to exchange information and also trains the farmers to use them properly to acquire farming skills increasing production and productivity. Accessibility and applicability seem to be major barriers of ICT adoption which could be reduced through the coordination of cooperatives in rural areas and increase the ICT usage in agriculture.

Contact to extension agents: The relationship of ICT usage and contact to extension agents were positive, significant at 5% level, in Jumla district. This result is in line with previous studies (Okello, 2020; Mishra *et al.*, 2023). ICT literacy can be extended through the contact of extension agents, providing necessary skills and developing positive attitude toward the benefits of ICT usage.

Training: In Lamjung and Jumla, there was positive influence of training received by farmers to ICT usage at 5% and 10% level of significance respectively. Due to complexity of application, many farmers couldnot harness the benefits of ICT (Udemezue, 2019). Thus, training programs with the assistance of extension agents helps to increase the use and effectiveness of the ICT.

**Table 6. Logit estimates of the factors influencing the use of ICT by the study area**

| Variables | Chitwan | | Lamjung | | Jumla | |
|---|---|---|---|---|---|---|
| | dy/dx | p value | dy/dx | p value | dy/dx | p value |
| Gender | 0.609 | 0.008*** | -0.107 | 0.679 | -0.128 | 0.680 |
| Age | 0.011 | 0.472 | -0.020 | 0.029** | -0.007 | 0.502 |
| Experience | -0.021 | 0.470 | 0.015 | 0.172 | -0.008 | 0.725 |
| Education | 0.013 | 0.682 | -0.008 | 0.755 | -0.036 | 0.321 |
| Lnincome | 0.891 | 0.037** | 0.181 | 0.533 | -0.280 | 0.161 |
| Distance to agriculture office | -0.002 | 0.782 | -0.030 | 0.509 | -0.155 | 0.198 |
| Distance to ICT center | 0.001 | 0.969 | 0.019 | 0.544 | -0.175 | 0.541 |
| Membership to cooperatives | 0.779 | 0.001*** | 0.318 | 0.073* | 0.425 | 0.051* |
| Contact to extension agents | 0.305 | 0.177 | 0.054 | 0.759 | 0.519 | 0.011** |
| Training | 0.022 | 0.933 | 0.414 | 0.014** | 0.431 | 0.071* |
| Summary statistics | | | | | | |
| R square | 0.57 | | 0.2939 | | | 0.4974 |
| LR $chi^2$ | 55.31 | | 28.52 | | | 48.15 |
| Log likelihood | -20.864 | | -34.2585 | | | -24.329 |
| Prob> $chi^2$ | 0.000 | | 0.0015 | | | 0.000 |

Source: Field survey, 2022

Note: *, **, *** indicate significant at 10%, 5%, 1% level of significance, respectively.

## CONCLUSION

The study focused on the different factors influencing the probability of the ICT usage among famers of different agroecological zones of Nepal. Findings of logit regression revealed that gender, age, income, membership to cooperatives, training and contact to extension agents significantly influenced the probability of farmers to use ICT tools for their farming activities. Therefore, there was the substantial scope for increasing the use of ICT in agriculture addressing the key determinants from the study. In conclusion, government and other concerned stakeholder should focus on the training programs to males and young farmer with increase in the membership to cooperatives and contact to extension agents for greater use of ICT. Similarly, financing for the initial investment to purchase ICT tools could be the effective measure to enhance the ICT usage among farmers for efficient and sustainable agriculture of Nepal.

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