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Factors affecting usage of digital advisory tools and services by vegetable farmers in Nepal

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ABSTRACT

It is evident that several factors condition the usage of Digital advisory tools and services (DATS) namely the internet, mobile phone, TV, radio, social media in the agricultural sector. The core, socio-economic factors and regional differences in technology adoption are being addressed. With the use of a multistage purposive sampling technique the study was steered to assess factors affecting the DATS use in Lumbini province. Using survey research design and administering pre-tested semi-structured interview schedule; 135 samples were randomly selected from Rupandehi (Terai), Palpa (Midhill) and Rukum East (Mountain) districts. The data were analyzed using multivariate probit regression model along with apt scaling and indexing techniques. The findings reveal that the tool's performance expectancy, the ease of use and relevance to user needs were the core factors while age, education level, experience, group membership and geographical variation were influencing factors shaping farmers' behavior for choosing different information sources. The results indicate that vegetable farmers rely on a variety of information resources which can be grouped under locality, cosmopolite, traditional and modern DATS. These sources either complement or substitute one another. This implies that no single source fully satisfies all of a farmer's information needs. If information providers get abreast of how likely it is that farmers will choose any particular source of information, they can guide efforts and shape policies to communicate via those channels in specific areas, generating higher impact. In light of the findings, the study accentuates the need for policy reforms to boost information sources that are tailored to specific regional and socio-economic profile of farmers.

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1. Introduction

The use of agricultural information by farmers has become increasingly crucial for taking decisions in farm management (Opara, 2008). Additionally, farmers' need for dire information have evolved as a result of depleting natural resources, diversifying farming practices, transforming dietary habits, increasing agro-business and overt climate change impacts. With rapid technological advancements and rapidly changing agricultural systems, there is a heightened need for efficiently transferring up-to-date knowledge to growers via different media platforms (Birkhaeuser et al., 1991).

Commercially done vegetable farming occupies a noteworthy role in uplifting rural lives in the Lumbini Province. The voice telephony has reached 126.04% and the internet coverage up to 130.64% in the country (Nepal Telecommunication Authority [NTA], 2022). Digital advisory tools and services (DATS) has not only changed the farming style but also the life-style of commercial farmers (Gyawali, 2022). Agricultural information plays significant role in enabling vegetable growers to take decision on sowing, soil improvement, controlling pests and diseases and seeking the best market prices for their produces (Armstrong et al., 2012). Information on vegetables and price in the market develops confidence and income to farmers (Pudasainee and Chaulagain, 2020). With real time market information, farmers can make informed decisions on vegetable crop selection, timing of harvest, and market channels to go through. Vegetable farmers can also get forecasting on heavy rains and floods; which enables them to prepare better for reducing the possible loss (GC et al., 2022). Overall, DATS have the potential to revolutionize commercial farming by enhancing productivity, reducing risks, and promoting sustainable practices.

Vegetable growers often face challenges related to crop management, market access, and profitability. The supply chain of agri-inputs was highly disturbed during the months long COVID-19 pandemic (FAO, 2020). It either left famers devoid of guidance and supervision in their farming or delays in advisory services (Pradhan, 2020). In such crisis, farmers can remain in touch with the agricultural advisors through DATS (Bhusal, 2020). The adoption of DATS among vegetable growers in Nepal is still low and there is a need to evaluate the factors that undermine their adoption and usage (Bhusal et al., 2021).

Thapa (2018) report that farmers in Nepal are least benefitted by using digital tools in terms of access to timely information about quality seeds, market rates, agriculture loans and subsidies, livestock and irrigation. The source of information for farmers is their local social network or their own experience. Chhetri (2016) argue that famers prefer local resources to professional resources for fetching information. In regard to weather forecast information, they rely on past occurrences and farming practices which are less precise. For instance, unseasonal rains in 2021 destroyed huge amount of ready-to-harvest paddy in Nepal which could have been substantially reduced provided that farmers were pre-informed via weather forecast mechanisms (Prasain, 2021). Moreover, the bargaining power of farmers is also compromised. Traders may exploit farmers by offering lower price due to farmer's ignorance of existing market price (Svensson and Yanagizawa, 2009).

Alike other developing countries: with the development of DATS, vegetable farmers in Nepal are embracing different digital tools for fetching farming related information. In addition to the written and audio-visual media digital technologies like information and communication technologies (ICTs), sensor, robotics, analytical technologies, machine learning, and artificial technologies have emerged. The digital tools used in Nepal of concern in this research are mobile SMS, agriculture related applications, websites and agri-web portals, e-mail, digital display boards, call centers, social media, radio, TV, mobile calls.

Some studies have revealed essential features that could make digital advisory tools appealing to users for adoption. These features include simplicity, user-friendliness, availability, and reliability. The accessibility and interoperability of these tools were also recognized as core factors for their successful use (Bracken, 2022). By the same token, research conducted by Mittal and Mehar (2016), Nwokoye et al. (2019) and Nikam et al. (2021) have suggested that age, sex, education level, farm size, income, ownership of smart phones, internet access effect on the farmer's choice decision for available DATS. Eloquently, it is necessary to understand the governing core and influencing factors associated with farmers in preferring amongst available information source.

Amongst all these, this research aims to empirically analyze the factors determining the usage of DATS by vegetable farmers in Lumbini province. This research's findings will be helpful in guiding the extension community for sustainable and impactful use of DATS in the vegetable farming sector.

2. Materials and methods

2.1. Data collection

This study used a survey research design. Three districts namely Rupandehi (Terai), Palpa (Mid hill) and Rukum East (High hill) were purposefully selected considering the geographical variation. The selected districts are vegetable baskets of major cities like Butwal, Tansen, Ghorahi, Tulsipur, Nepalgunj in the region. The study was accomplished utilizing a multistage sampling technique. Right after fixing the research districts, vigorous discussion with concerned stakeholders was organized to purposefully select the respective local levels, Gaindahawa Rural Municipality, Siddarthanagar municipality and Butwal Sub-metropolitan municipality in Rupandehi, Tansen municipality, Rampur municipality and Tinau Rural Municipality in Palpa and Sisne RM, Bhume RM and Putha Uttarganga RM in Rukum East (Figure 1). Altogether 135 households were randomly sampled, 15 from each local level using the random table in excel.

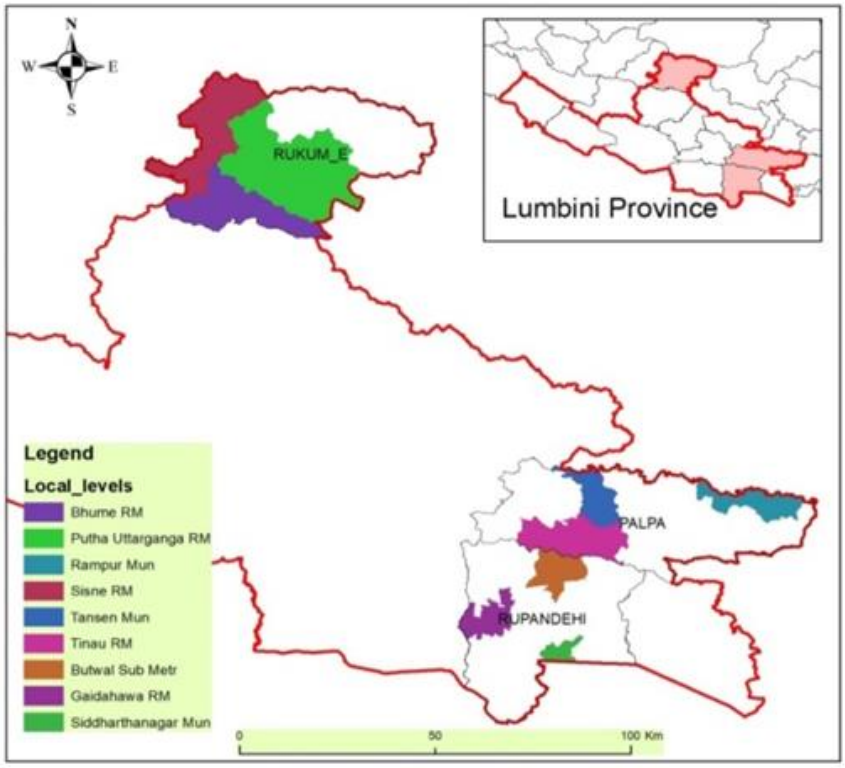

Figure 1. Map of the study site

The primary data was collected using household survey (135), Focused Group Discussion (FGD 3) and Key Informants Interview (KII 5) methods. The sampled respondents were interviewed by face-to-face method using semi-structured pre-tested interview schedule. An array of published materials like bulletins, books, journals, research articles, web surfing, progress reports and relevant publications served as secondary sources.

2.2. Operationalization of DATS

Digital advisory tools and services means software, programs, platforms, applications that can be run with computers or electronic gadgets. DATS incorporate text, audio and visual stimuli (Oikonomou and Patsala, 2020) that enable farmers to make informed decisions.

Computer, web sites, web portals, e-mail, RSS are regarded under the term internet whereas the Youtube and official Facebook pages are treated under the term social media. The term printed media encompasses newspaper, booklets, pamphlets, posters, agriculture magazines. The basis of consideration is on the review of the study of Sigdel et al. (2022). In the field survey, vegetable farmers identified 14 different sources for obtaining information on agricultural activities. For analysis, based on common characteristics, these various sources were classified into four domains (Table 1). The four categories are personal locality, cosmopolite, traditional DATS and modern DATS.

Table 1. Assembling different information sources according to common traits

S.N.	Class	Agricultural information-sources included
1	Personal Locality	Neighbors, local leaders, peer farmers
2	Cosmopolite	Extension workers, Farmer groups/ co-operatives, agrovets/ input suppliers
3	Traditional DATS	Radio, TV and printed media (newspaper, leaflet, pamphlet, folder)
4	Modern DATS	Mobile (Call and SMS), Internet, Agricultural applications (online and offline), social media and video conferencing

2.3. Explanation of variables (explanatory and dependent) used

Four different information sources' use is taken as dependent variable. Age, years of schooling, number of educated family members, years of experience in vegetable farming, association in farmer group/ co-operative, farm size and physiographic parameters represented by the district dummies are explanatory variables. Mittal and Mehar (2015) have recorded that age, level of education, and farm income are key factors influencing farmers' decisions when choosing among various information sources. The explanation of individual variables used in this research are described in Table 2.

Table 2. Explanation of the variables

Variables	Elaboration
1. Dependent variable	
Use of different sources of agriculture information	Use of one of the mentioned sources (personal locality, cosmopolite, traditional DATS and modern DATS for agriculture information (users=1; non-users=0)
2. Independent/ Explanatory variables	
Age	Respondents' age (in years) during data collection
Education (Years of schooling)	Years of formal education of the respondents
Farm size	Total land used for cultivation purpose (ha)
Membership in Farmer's group/ co-operative	Membership (=1 If respondent is a member of any farmers group/ co-operative, 0 otherwise)
Farming experience	Vegetable farming experience in years
Educated family size	Number of educated members in the respondent's family
District dummies	Representing different districts to address geographical variability
Rupandehi dummy	Terai (=1 if respondent is resident of Rupandehi, 0= otherwise)
Palpa dummy	Midhill (=1 if respondent is resident of Palpa, 0= otherwise)

Note: Rukum East is taken as benchmark

2.4. Likert scale for perception measurement

Perception of respondents regarding use of DATS for fetching agricultural information was analyzed using 5-point Likert scale. Rensis Likert (1932) developed it for measuring opinion, perception and attitudes of individuals. Perception of respondents was measured at 5 agreement levels; strongly agree (SA), agree (A), neutral (N), disagree (DA) and strongly disagree (SDA). The weightage values 1, 0.5, 0, -0.5, -1 was assigned for SA, A, N, DA and SDA responses respectively.

Scoring of scale (Tanujaya et al., 2022)

Respondent's perception regarding various DATS for agriculture information was analyzed using index value. As, the index of agreement was estimated by:

Iagg=Σ(Si fi)/N

Σ= Summation

Iagg= Index of agreement

Si= Scale weightage

Fi= Frequency of respondents occupying a given level of agreement

N= Number of respondent farmers in total

Then, specific points were assigned to each classification and index value was calculated.

$$\text{Index value of particular statement} = \frac{\begin{array}{c}\text{Frequency of SA}\times 1+\\ \text{Frequency of A}\times 0.5+\text{frequency of N}\times 0+\\ \text{Frequency of DA}\times -0.5+\text{ Frequency of SDA}\times -1\end{array}}{\text{Frequency of total respondents}}$$

Based on a comparison of mean index value of each statement calculated from index values of Rupandehi, Palpa and Rukum East, ranking was done.

2.5. Multivariate probit regression analysis

The data gathered show that farmers utilize a variety of information sources, and it is believed that these sources are used concurrently to meet similar information needs. The null hypothesis states that no significant link exists between vegetable growers' socio-economic and institutional characteristics and use of the given sources. It infers that, regardless of factors like age, education, experience, farm size, number of educated members in family, organizational involvement, or geographic location, farmers tend to rely on certain information sources. To assess their choice among four groups of information sources, either multinomial or multivariate regression models can be used. Multinomial models assume that irrelevant alternatives are independent, meaning the error components of the alternatives are unrelated (Greene, 2003). Since farmers often rely on multiple sources simultaneously, the error terms of these sources may be related. In the wake of contemporaneous correlation amongst given choices, the multivariate regression model is ideal. Previous studies; too have employed multivariate probit regression to analyze the factors distressing the usage of varied agricultural information sources (Jenkins et al., 2011; Mittal and Mehar, 2015). Mittal and Mehar (2015) used this method to investigate the factors influencing farmers in adopting "face-to-face communication, advice from other farmers, traditional media, and modern ICT". They suggest that the multivariate probit model improves estimation efficiency when multiple sources are used at the same time.

Model specification

Mathematically,

$$Y_{i1} = X'_{ij_1}\beta 1 + \varepsilon_{i1}$$

$$Y_{i2} = X'_{ij_2}\beta 2 + \varepsilon_{i2}$$

$$Y_{i3} = X'_{ij_3}\beta 3 + \varepsilon_{i3}$$

$$Y_{i4} = X'_{ij_4}\beta 4 + \varepsilon_{i4}$$

Where, i= farmer identification, Y_i1=1 for respondent using locality sources (0: if not), Y_i2=1 if respondent using cosmopolite sources (0: if not), Y_i3=1 if farmer using traditional DATS (0: if not), Y_i4=1 if farmer exploiting modern DATS (0: if not), X_i^'= vector of factors determining access to the sources, β_j= vector of unidentified parameters (j=1, 2, 3, 4) and ε = error term. By assuming, error terms are mutually exclusive, four individual binary logit or binary probit forms can be employed. But in this case, the error terms are stochastically dependent on each other. Therefore, it will be wise to run the multivariate probit equation as mentioned below.

$$Y_{ij} = X'_{ij}\beta'_j + \varepsilon_{ij}$$

Where, Y_ij (j=1, 2, 3, 4) are four varied information pathways confronted by the ith respondent (i= 1, …., 135), X_ij^' is a 1 × k vector of observed variables determining the choice decision, β_j is a 1 × k vector of unrealized parameters and ε_ij is the unseen stochastic error term. Let's assume the error terms (in j= 1, 2, 3, 4) terms follow normal distribution with mean vector = 0 and are multivariate in nature. Then, simulated maximum probability can be used to calculate the unidentified Ass parameters. This technique applies to the Geweke, Hajivassiliou and Keane (GHK) smooth recursive conditioning simulator) for evaluating the multivariate normal distribution (Cappellari and Jenkins, 2003). The widely preferred software: STATA (version 17) is administered for estimation.

Question of multicollinearity between the explanatory variables was resolved computing a condition index factor which was typically recommended by Belsley et al. (1980). The condition index value measured less than 4, which showed that there would be no severe multicollinearity problem in our data. Furthermore, we calculated pairwise correlation amongst error terms for endogeneity testing where farmers' choice of information sources was endogenously determined and tested it significant to show that if multivariate probit model was appropriate.

3. Results

3.1. Core factors affecting DATS use

Table 3 depicts the core factors that motivate the respondent farmers for using digital advisory tools and services in vegetable farming. Result depicted that the ease of use (0.75) was the major motivating core factor in Rupandehi followed by performance expectancy (0.72). Similar case was found in Rukum East, whereas in Palpa performance expectancy of tool (0.84) followed by relevance to user needs (0.78) were the major motivating core factors for the vegetable growers in the surveyed region. Overall, the performance expectancy of tools (0.78) was the major driving factor while the cost of tools (0.39) and farmer advisory compatibility (0.37) were found to be the least motivating core factors in all three districts.

Table 3. Core factors affecting the use of specific DATS by respondents

Statements	Index Value			Mean	Rank
	Rupandehi	Palpa	Rukum East		
Performance expectancy of tool	0.72	0.84	0.77	0.78	I
The ease of use	0.75	0.67	0.78	0.73	II
Peer recommendations	0.64	0.48	0.46	0.53	V
Trust in embedded technology	0.64	0.67	0.55	0.62	IV
The cost of tool	0.42	0.31	0.43	0.39	VIII
Usual habits	0.47	0.48	0.47	0.47	VI
Relevance to user needs	0.58	0.78	0.69	0.68	III
Farmer advisor compatibility	0.37	0.35	0.39	0.37	IX
Farmer skills and behavior	0.45	0.45	0.47	0.46	VII

The above index value varies from -1 to 1; positive value reverberates to agreement

3.2. Influencing factors affecting decision-choice of different information-sources

Table 4 presents regression results of the run probit model. It highlights the calculated results on the aspects influencing selection-decision of four information sources available to the farmers in Lumbini province. We justify the application of multivariate probit model by the existence of positive likelihood ratio value. The conjoined nullity of variable coefficients comprised in the calculation is rejected as the value of wald $\chi 2$ test is significant.

This study uses seven explanatory variables to analyze their effect on usage of different sources. The results obtained by the model show that age, years of schooling, number of educated family members, years of experience in vegetable farming, association in farmer group/ co-operative have negative coefficient for personal locality sources while farm size and physiographic dummy variables have positive coefficients. Among them, education level, experience years and membership in FG/co-operatives have significant effects at 5%, 5% and 1% respectively.

Farm size and age do not have any significant effect while the Rupandehi and Palpa are positively significant for personal locality sources of information. In context of cosmopolite sources age, schooling years, group membership and farm size have positive coefficient. Years of schooling and membership in groups act significantly at 5% level of significance. Likewise, the number of educated family members, years of experience in vegetable farming and physiographic dummies possess negative values. Among them, vegetable farming years is significant at 1%.

As shown by run model results, for the traditional media sources; age, number of educated family members, experience, membership in group and physiographic dummies have positive coefficients out of which only age variable is significant at 5% significance-level. Education level and farm size affect negatively but have no significant effect on use of traditional DATS for agricultural information.

In the case of modern DATS use for agriculture information; age, years of schooling, vegetable farming experience, association in FGs/ co-operative, physiographic dummies are the factors that affect positively. Years of schooling, Rupandehi dummy and number of educated family members have positive and significant effect on the use of modern DATS at 1%, 5% and 10% respectively.

Table 4. Estimated farmer characteristics regarding utility of agricultural information sources

Attributes	Personal locality	Cosmopolite	Traditional DATS	Modern DATS
Age	-0.016	0.026	0.032**	0.039
	(0.015)	(0.020)	(0.015)	(0.035)
Years of schooling	-0.085**	0.095**	-0.034	0.537***
	(0.036)	(0.045)	(0.035)	(0.146)
Number of educated family members	-0.063	-0.074	0.025	0.419*
	(0.095)	(0.117)	(0.094)	(0.231)
Year of experience in vegetable farming	-0.086**	-0.160***	0.017	0.025
	(0.041)	(0.054)	(0.042)	(0.086)
Association in Farmer Group or co-operative	-0.932***	0.817**	0.081	1.105
	(0.331)	(0.369)	(0.305)	(0.755)
Farm size	0.378	0.803	-0.220	-0.447
	(0.420)	(0.570)	(0.406)	(1.326)
District dummies				
Rupandehi	0.872**	-0.648	0.587	4.769**
	(0.361)	(0.484)	(0.377)	(1.964)
Palpa	0.623**	-0.139	0.147	0.001
	(0.308)	(0.411)	(0.309)	(0.622)
Constant	2.561***	-0.185	-0.955	-4.850**
	(0.895)	(1.147)	(0.837)	(2.444)
Log Likelihood value	-74.73	-41.74	-75.72	-16.95
Wald $\chi 2$ test (9)	28.82***	25.56***	19.12**	20.38***
LR test of errors		12.37*		
Number of observations		135		

Source: Field survey, 2022, Note: Rukum East is used as benchmark dummy. Figures in parentheses represent robust standard errors. *, **, *** represent statistical significance at 10%, 5% and 1% level of significance.

4. Discussion

4.1. Core factors affecting DATS use

The results highlighted that the performance expectancy of tools, the ease of use and relevance to user needs were the major driving factor while the cost of tools and farmer advisory compatibility were found to be the least motivating core factors in all three districts. Similar to the findings, Brackley (2022) reported that simplicity, easy to use, accessibility and perceived usefulness characteristics of DATS motivated users to adopt them.

4.2. Influencing factors affecting DATS use

Results indicate that years of schooling, experience in vegetable farming, membership in farmer groups or cooperatives, and physiographic factors significantly influence farmers' choice of personal locality sources for agricultural information. The negative coefficients for years of schooling, experience in vegetable farming, and group membership suggest that as farmers' education, experience, and group involvement increase, they tend to rely less on locality sources. Conversely, the positive and significant coefficients for the Rupandehi and Palpa dummies indicate a higher likelihood of using local sources for agricultural information compared to the reference district. Additionally, the significant-positive constant value suggests, all other factors remaining the same, the studied vegetable farmers are highly inclined towards personal locality sources.

In case of cosmopolite information sources, the coefficients for years of schooling and membership in farmer groups or cooperatives are positively significant, indicating that as education level and group membership increase, vegetable farmers highly remain confident on cosmopolite resources. However, the negatively significant coefficient for years of experience in vegetable farming suggests that more experienced farmers are less inclined to prefer cosmopolite sources for agricultural information.

Regarding 'Traditional media' information sources, the positive and significant coefficient for age implies that older farmers place greater value on information provided by traditional media. The coefficients for education level and farm size are not significant in relation to the use of traditional media.

Modern DATS, which includes mobile phone calls and SMS, internet, social media, and agriculture applications, exhibit positive-significant linkage with years of schooling and the number of educated family members. This indicates that educated farmers put huge confidence to modern DATS, as they can easily access, integrate, and use these sources according to their needs. Interestingly, the likelihood of using modern digital tools increases with the number of educated family members, as farmers may receive assistance from their spouse, children, or siblings in operating these tools. Group membership has a positive but not significant effect on DATS use for agricultural information. This is in contrary to the findings of Nwafor et al. (2020), who argue that group associated vegetable farmers are more aware of DATS. The district Rupandehi positively and significantly influences the adoption of modern DATS by farmers. The negative-significant coefficient advocates that, ceteris paribus, the respondents rarely solely rely on modern DATS. Though users appear more motivated to use modern DATS, they do so mainly as a complement to traditional sources.

In summing up, the estimated results reject the Ho that posited farmer characteristics don't affect the use of above agricultural information-sources. As level of education of respondent's augments, they incline towards modern DATS for information than that of locality sources. The findings are in congruent with Bakari et al. (2018), and Mittal and Mehar (2015), who also found education to significantly impact DATS usage. The significant-negative coefficient of years of experience suggest that experienced farmers already have extensive knowledge regarding vegetable farming. So, they regard local and cosmopolite sources of less worth. Though, "farm size is considered as proxy for farmer's economic status", it does not have any significant effect on adoption of different sources. This gist accords with Bakari et. al. (2018) where non-significant result was recorded. The result contradicts Luqman et. al. (2019) and Derso et. al. (2014). They arbitrated; large farmers have more resources, market surplus, interconnection with stakeholders unlike most of the small farmers whose production is subsistence type. Members of farmer's group/ co-operative are preferring cosmopolite sources to locality sources as they have higher exposure to first-hand information delivered from agrovets, group executives, extension advisors. The physiographic dummy variable captures the variation due to physical infrastructure, demography, and geographic constraints. Empirically, these findings remain in line with the results presented by Mittal and Mehar (2015).

5. Conclusion

This study focused to evaluate the factors affecting the DATS usage in the farm information uptake by vegetable growers. There are a wide range of DATS coming downstream that are promising to significantly improve the way farmers can complete their work. The study also identified key factors that influence farmers' decision in choosing them.

The results revealed that the performance expectancy of tool, the ease of use and relevance to user needs were the core driving factor. Similarly, socio-economic-institutional traits of farmers such as age, education level, experience, size of farm and group membership, are significantly linked with the application of various agricultural information sources. These findings can be utilized to develop programs tailored to farmers' specific profiles. In simpler terms, information providers can use these insights to better communicate with their target growers either solely or in companion with other sources. The insights highlight the complementary nature of different information sources, and the vital role education can play in connecting users to new exciting avenues. Overall, while farmers manifest belief on numerous sources, they heavily depend on locality and cosmopolite sources yet. Additionally, we acknowledge that the existing policy should be directed towards enhancing farmer's access to, expertise in and high quality of information consistent to farmer's conditions for motivating them to use DATS.

6. Limitations and future research direction

Acknowledging the limitations of the current study, there exists a considerable scope for conducting additional research on the utilization of DATS by farmers.

- The present study solely concentrated on vegetable farmers of Rupandehi, Palpa and Rukum East district of Lumbini province; however, replication of the research should be carried in other crops and locations in the future.
- Future research could investigate the factors determining use of specific DATS by extension personnel.

Compliance with Ethical Standards

Conflict of interest

No competing interest attested.

Authors' contributions

Kiran Kumar GUPTA: Conceptualization, project administering, Data curing and analysis, Writing original draft . **Udit Prakash SIGDEL**: Formal analysis, review and editing. **Om Prakash SINGH**: Review and editing. **Pankaj Raj DHITAL**: Draft preparation. **Ram Hari TIMILSINA**: Draft preparation. **Asmita GUPTA**: Draft preparation. **Raksha UPRETI**: Draft preparation

Ethical approval

The participants in the sensory evaluation voluntarily took part and scored the samples with full satisfaction.

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Data availability

The data underlying this study are available on request from the corresponding author.

Consent for publication

Not applicable.

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