Use of Information Communication Technology for Agriculture Extension Services in the Western Dzongkhags of Bhutan

Chimi Rinzin[h], Thubten Sonam[i], Tirtha Bdr Katwal[h]

ABSTRACT

This study examines the Information and Communication Technology (ICT) in the extension services in Bhutan. Using survey data from Agriculture and Livestock Extension Supervisors across four Dzongkhags, the research explores ICT access, utilization, and competency levels. While most respondents had access to mobile internet (84.2%) and used platforms like WhatsApp (89.5%), the study found gaps in proficiency with advanced tools, such as GIS and data analysis software. Only 18.4% of participants reported receiving ICT training, highlighting a critical need for capacity building. Challenges such as slow internet, insufficient equipment, and limited technical support were identified as barriers to ICT integration. The findings emphasize the need for strategic investments in ICT infrastructure, skills training, and resource availability to empower extension workers and improve agricultural outreach. This research underscores the transformative potential of ICT in bridging information gaps and fostering sustainable agricultural practices in Bhutan.

Keywords: *ICT in Agriculture Extension; Extension Worker Capacity Building; Social Media for Agricultural Services*

1 Introduction

Agriculture contributes 14.96 % of Bhutan's GDP and supports 41.7% of the population (National Statistic Bureau [NSB], 2024a; NSB, 2024b). The Ministry of Agriculture and Livestock (MoAL), through its decentralized extension network in the Dzongkhags, delivers technologies, information, and development services to farming communities. Represented by agriculture and livestock extension officials at Dzongkhag and Gewog levels, MoAL ensures technical coordination, backstopping, and farmer skill development through outreach, training,

Corresponding Author: chimirinzin@moal.gov.bt
[h] National Centre for Organic Agriculture-Yusipang, Department of Agriculture, Ministry of Agriculture and Livestock
[i] Department of Sustainable Development, College of Natural Resources

and field visits. However, challenges such as scattered settlements, poor infrastructure, and monsoon conditions hinder timely service delivery (DoA, 2020).

The rugged terrain of Bhutan exacerbates delays, complicating the extension workers' ability to address diverse farmer needs. Studies highlight the potential of Information and Communication Technology (ICT) in improving service efficiency. ICT fosters market activities, facilitates information exchange, and promotes economic growth (Saidu et al., 2017).

Shruti and Rao (2023) emphasize that ICT transforms extension systems by accelerating and enhancing service delivery. Similarly, a study in Ethiopia found that video-mediated communication led to higher adoption rates of recommended technologies compared to conventional methods (Abate et al., 2023). In Nigeria, ICT improved outreach, provided market prices, addressed farm issues, and delivered weather forecasts (Okeke et al., 2015). In India, ICT increased awareness and encouraged modern farming practices (Fu & Akter, 2017).

MoAL has introduced several ICT initiatives in Bhutan. These include the e-RNR Crop Advisory system, e-Pest Surveillance system, Marketing and Cooperative Information System, Interactive Voice Response (IVR) system, Virtual Extension & Communication Network System (VERCON), Food and Agriculture Statistical Information System, and Transboundary Animal Disease Information System (GIS-based) (Tshering, 2019).

The Marketing and Cooperatives Information System (www.agrimarket.gov.bt), developed by the Department of Agriculture Marketing and Cooperatives (DAMC), supports cooperatives and farmer groups. In 2009, DAMC launched the IVR system to provide farmers with updated market prices from auction yards. Additionally, the Food and Agriculture Organization (FAO) established the Virtual Extension and Research Communication Network (VERCON) to improve communication between policy, research, and extension actors. Veterinary epidemiology and animal disease surveillance also benefit from ICT, as demonstrated by the FAO's Transboundary Animal Disease Information System (TAD info). This software helps veterinarians manage real-life issues effectively (Tshering, 2019). The Agriculture Extension Strategies 2019–2028 recommends using print media, radio, ICT, and television for mass communication to reach farmers. However, the documentation of ICT usage in these efforts is limited (DoA, 2020).

Despite prioritizing ICT in agriculture, gaps in adoption, benefits, ICT skills of the agriculture and livestock extension officials and challenges remain unassessed. This study focuses on understanding the status of ICT use, adoption, aptitude, and challenges faced by extension

workers in Bhutan's western Dzongkhags, aiming to bridge these gaps and enhance service delivery.

2 Materials And Method

2.1 Study site

The study was carried out in the West Central Region of Bhutan, which includes the Dzongkhags (Districts) of Thimphu, Paro, Haa and Chuukha as presented in Figure 1. These districts benefit from their proximity to the capital city and their location along the main highway connecting western and central Bhutan, improving connectivity and access to ICT facilities. Approximately 29,951 farmers reside in this region, with Thimphu having the least (3180) (DoA, 2017). The region comprises of 34 gewogs, and agricultural and livestock research outreach, and extension services are delivered by the Agriculture and Livestock Extension Supervisor in each gewog.

2.2 Sampling method and sample size

There are 34 Gewogs in the west region with a total of 56 Extension Workers for agriculture and livestock services. The sample size was calculated using Yamane's formula, resulting in a selection of 38 extension workers from the total population of 56 using random sampling method. The primary data was collected using a semi-structured questionnaire via an online survey.

2.3 Data analysis

The data was cleaned, coded, and ranked using Microsoft Excel 360. R-Statistics was used for major statistical analysis, including testing assumptions and hypotheses. Descriptive statistics such as central tendency, frequency and variance were employed to study the features of various nominal and categorical data, while inferential tests such as correlation and Chi-square were used to assess associations between variables.

3 Results And Discussion

3.1 Demographic characteristics

The respondents were predominantly male (65.8%) and mainly represented Chhukha Dzongkhag (36.8%). Most were aged 30-40 (44.7%), held diploma qualifications, and had 10-20 years of service (63.2%). The group comprised Agriculture (52.6%) and Livestock Extension Supervisors (47.4%) as in Table 1.

Table 2. Demographic variables

		Count	Count %
Dzongkhags	Chhukha Dzongkhag	14	36.8
	Haa Dzongkhag	8	21.1
	Thimphu Dzongkhag	7	18.4
	Paro Dzongkhag	9	23.7
Gender	Male	25	65.8
	Female	13	34.2
Qualification	Certificate	1	
	Diploma	25	
	Bachelors	12	
Age	20-30	4	
	30-40	17	
	40-50	15	
	50-60	2	
Designation	Agriculture Extension Supervisor	20	52.6
	Livestock Extension Supervisor	18	47.4
Service Years	01-Oct	7	18.4
	Oct-20	24	63.2
	20-30	6	15.8
	30-40	1	2.6

3.2 ICT Resources and Tools available to Extension Workers

3.2.1 Radio, TV, Mobile internet and Broadband Internet

The accessibility of ICT resources varies significantly among respondents (Table 2). Most of the respondents rated access to digital learning resources, access to computers and radio as neither good nor poor. However, access to television and mobile internet is being rated as good by most of the respondents.

Table 3. Access to ICT resources by respondents

ICT resources	**Accessibility (%)**				
	Very Poor	**Poor**	**Neither good nor poor**	**Good**	**Very Good**
Access to digital learning resources (Online courses, YouTube, Udemy and etc).	2.6	21.1	50	21.1	5.3
Access to the computer internet	7.9	15.8	50	21.1	5.3
Access to Television	5.3	13.2	26.3	39.5	15.8
Access to Radio	15.8	26.3	34.2	21.1	2.6
Access to Mobile Internet	0	13.2	31.6	34.2	21.1

A study has reported that 19 of the 20 Dzongkhags have fully operational cable TV services, which are fully operational, offering about 40 channels, with only two in Dzongkha channel (T & T, 2015). The Bhutanese newspaper also reported that mobile phones are a common ICT among Bhutanese people. Almost all residents (98%) have a mobile phone which is around 2.7 mobile phones for a household (Choki, 2023). The Bhutan Information and Media study (2013) noted that radio remains popular in rural population. These findings further indicates that Bhutanese have good access to ICT resources. Therefore, extension workers can leverage these tools - mobile internet, mobile phones, TV and Radio to share information on new technologies, crop management, pest control, market prices, and agromet advisory services.

3.2.2 Access to computers and other ICT tools

The study found varying levels of access to ICT tools among respondents. Specifically, only 2.63% reported having access to a digital camera, while 60.53% had access to Wi-Fi, 21.05% to tablets, 10.53% to fixed-line phones, 5.27% to microphones and speakers, 18.42% to data cards, and 18.42% to projectors (Figure 1).

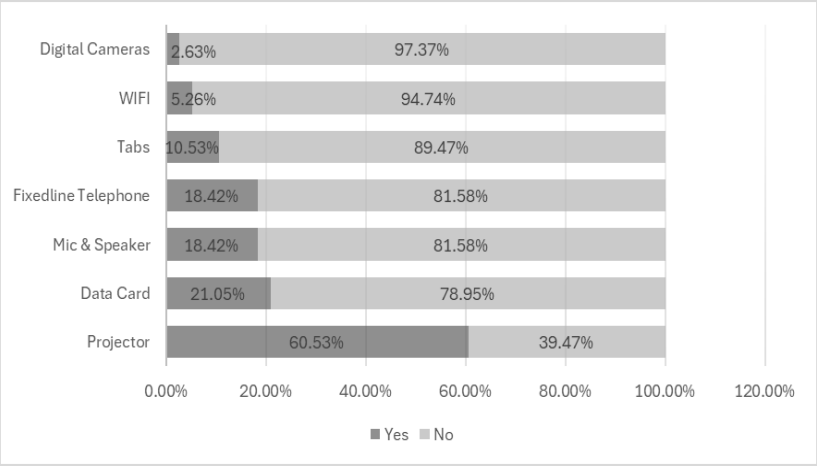

Figure 1: Access to different ICT facilities

These findings indicate significant gaps in the availability of critical ICT tools, particularly digital cameras, microphones, and fixed-line phones, which are essential for effective communication and data collection in extension services. According to Verma (2009), such tools are use for the transfer of agriculture technologies. For instance, personal digital entertainment devices such as camers, projectors and tablets are used for streaming media, podcasts, vodcasts, blogs and operating social media sites enabling the transfer of the techonolgy and informations. Further, it is observed that the use of radio, public phone, telephone, television shorth messages service and computer in the extension services can be considered as an innovation. This would benefit in interacting and reaching out more to the

farmers (OLUYOMI, nd). In light of these findings, it is recommended that targeted interventions prioritize improving access to underutilized tools like digital cameras, microphones, and fixed-line phones, as well as increasing the availability of tablets and projectors

Further, as presented in table 3, the majority (97.4%) of the respondents had access to a computer while only 2.6% did not have. Among those who had access to a computer, 15.8% have a computer with i3 specifications, 39.5% have a computer with i5 specifications, and 21.1% have a computer with i7 specifications while 23.7% could not recall the specifications of their computers.

Table 4: Specification, age, and computer of the respondents

Access to Computer	**Yes**	**No**		
Response (%)	97.4	2.6		
Computer Specification	**i3**	**i5**	**i7**	**I don't know the specification**
Response (%)	15.8	39.5	21.1	23.7
Computer Age (years)	**1 to 5**	**5 to 10**	**10 to 15**	
Response (%)	73.7	18.4	7.9	

These findings suggest that while access to computers is widespread, a significant proportion of respondents either have outdated hardware or lack awareness of their device's capabilities, which could impact their ability to perform advanced tasks effectively.

3.3 Use of ICT in extension services

3.3.1 Use of social media in the extension services

Social media use in the extension system varies as presented in Figure 2, 47.4% of respondents use Facebook, 84.2% use WeChat and Telegram, and 89.5%, use WhatsApp. This finding highlights the dominant use of social media by the extension officials in western Dzongkhags. Similarly, a study also found Facebook to be most widely used platform in Bhutan, (77%), followed by WeChat (72%) and YouTube (58.4%) (BMF, 2021). According to a study on the role of social media in extension, it is found that farmers use various social media platforms to share knowledge and innovation, and to solve problems (Ankita, Verma, & Rani, 2023). Accordingly, the extensions could utilize this platform to share knowledge, innovations, and solve problems collaboratively.

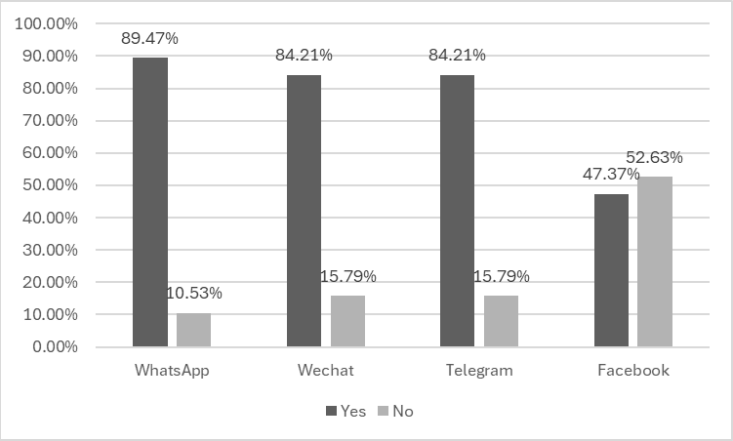

Figure 2: Use of social media in Extension Services

3.3.2 Application of ICT in the Extension services

As shown in figure 3, the primary use of ICT by extension officials is for information collection (41.9%). This is followed by using ICT in creating awareness programs (19.8%). Linking farmers to markets is another significant use, representing 17.4%, while exploring solutions for issues makes up 14%. However, ICT is used less frequently for official communication (4.7%) and record keeping (2.3%). These findings highlight that ICT tools are primarily utilized for gathering and disseminating information, while their application in administrative tasks like communication and record-keeping remains limited. A study resported that ICT can transform agricultural extension by improving efficiency, effectiveness, and reach. It provides farmers with real-time information on weather, market prices, and crop management, as well as access to financial services and value-added services (Samadder & Rao, 2023). Another study concluded that the use of ICT in the service delivery system has not only achieved the greater awareness and knowledge, but it has also enhanced the farmers attitudes towards trying new technology and new way of life positively (Fu & Akter, 2017). It is also found out that the ICT aids provide up-to-date information on commodity market prices, input costs, and consumer patterns, which can help farmers in having

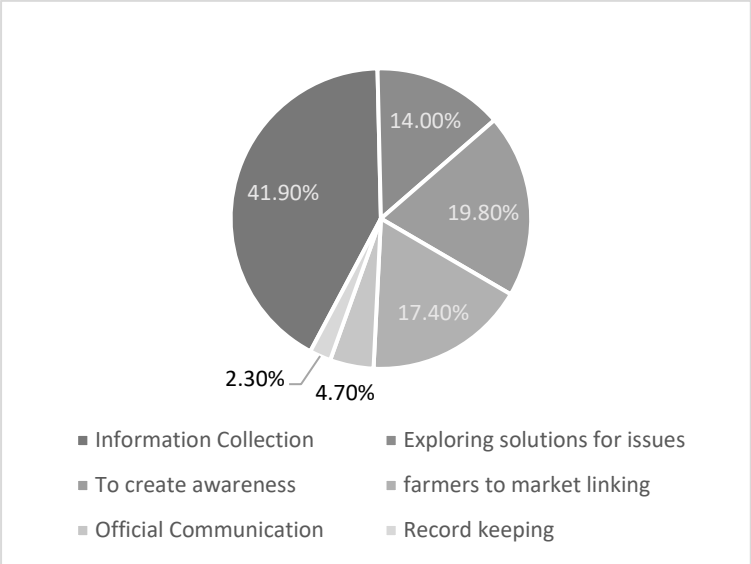

Figure 3: Application of ICT across different fields

a better position in negotiations and livelihood development (Rohila, Yadav, & Ghanghas, 2017). This suggests potential areas for improvement in integrating ICT into broader extension services.

3.4 Proficiency level in ICT skills

3.4.1 ICT Capacity Development in Extension Services

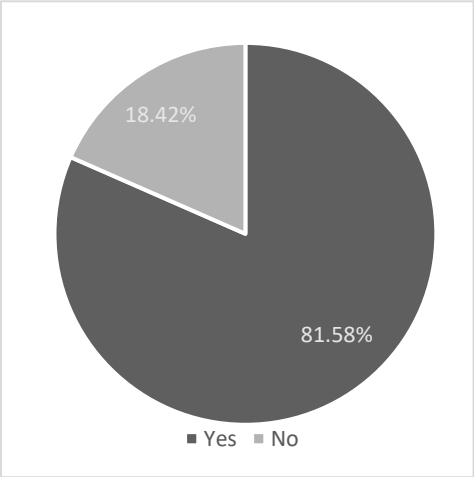

Figure 4: ICT training attended

Of all the respondents, 18.4% received ICT training, while the remaining 81.6% did not receive any training on ICT as presented in figure 4. A study by Nyarko (2021). observed a perfect positive relationship between the ICT training and ICT tools used for communicating agriculture and extension services. The training of Extension Workers on the use of ICT tools is likely to further enable them to make efficient use of ICT for extension services.

3.4.2 Basic proficiency in resolving computer issues

As presented in table 4, most of the respondents indicated either good, poor or very poor skills in Basic computer troubleshooting skills. A report highlighted that basic software management and system maintenance improves reliability and stability, performance of the computer and reduces downtime and disruption (Davidson, 2023). These indicate an opportunity for targeted interventions, such as tailored educational programs or workshops, aimed at improving the understanding and practical execution of software management and system maintenance.

Table 5. Basic computer troubleshooting skills of respondents

	Very poor %	Poor %	Good %	Very good %	Excellent %
Software installation and uninstallation	23.70%	31.60%	23.70%	18.40%	2.60%
Cleaning computers	21.10%	31.60%	36.80%	7.90%	2.60%
Computer set up	18.40%	26.30%	42.10%	10.50%	2.60%

3.4.3 Competency in Microsoft Office applications

Table 5 presents the competency in Microsoft office applications. Most of the respondents rated their skills to be good. However, there is also a presence of respondents with very poor or poor skills. These results suggest that the respondents generally had moderate skills in using the Microsoft office application. To improve overall proficiency in the use of productivity software, targeted training programs should be prioritized, focusing on advanced features and practical applications to address gaps in skills, particularly for those who rated themselves as "Poor." Efforts should aim to elevate moderate skill levels to "Excellent" by teaching advanced functionalities, creative techniques, and effective use of collaborative tools.

Table 6. Rating of Skills in utilizing the Microsoft Office

Microsoft office	Very poor %	Poor %	Good %	Very good %	Excellent %
Word processing	2.6	13.2	47.4	34.2	2.6
PowerPoint Production	2.6	23.7	50	21.1	2.6
Excel usage	2.6	23.7	42.1	31.6	0

3.4.4 Proficiency in creating information and communication packages

As observed in Table 6, the respondent's ability to produce effective communication and information materials were rated either poor or very poor by most of the respondents. The skills in production of information and communication packages are critical for effective extension services as it can achieve the desired impact and promote sustainable practices. Further, the ability to produce quality communication materials ensures that the information is effectively conveyed and understood by the target audience. A video- mediated agriculture extension services in Ethiopia pointed out that this method reaches wider audience, and it also leads to the higher understanding in farmers (Abate, 2019). The Agriculture Extension Strategies highlights that the use of print media, radio, ICT and Television to support the farmers (DoA, 2020). Therefore, to improve proficiency, targeted training programs may be prioritized, focusing on the audio-visual training courses for the extension officials.

Table 7. Ability to produce effective communication and information materials by respondents

	Very poor %	Poor %	Good %	Very good %	Excellent %
Skills on Video Production	23.7	44.7	26.3	2.6	2.6
Skills on Audio information Production	26.3	47.4	23.7	0	2.6
Skills on production of pamphlets	26.3	42.1	26.3	2.6	2.6

3.4.5 Skills in data management and record keeping

The skills in data management and record keeping (Table 7) have the highest level of proficiency in using Google Applications and Microsoft Excel, with 44.7% rating their skills as "good". In using MS Access Database, the highest proportion rated their skills as "poor" (44.7%), with only 7.9% rating their skills as "very good". Effective data management and record-keeping are essential for all Extension Workers as it enables them to professionally collect, store, analyze, and use data to make informed decisions. Further, it is reported that extensions are supposed to maintain consistent and reliable data for agriculture importance (DoA, 2020). Therefore, regular training in data management and record keeping may be conducted to improve the skills further. On the other hand, the online data storing and collection can be encouraged to promote the continuous use of google applications and Microsoft Excel.

Table 8. Rating of Skills on data management and record keeping

	Very poor %	Poor %	Good %	Very good %	Excellent %
Google Applications	7.9	28.9	44.7	15.8	2.6
Excel	5.3	26.3	44.7	23.7	0
MS Access Database	15.8	44.7	31.6	7.9	0

3.4.6 Skills in the use of analytical and decision-making tools

The skills of the respondents on the use of analytical and decision-making tools are presented in Table 8. Most of the respondents rated their skills as either poor or very poor, and only a few rated their skills as good. These skills help develop cost-effective solutions, analyze data, and use trends for planning. Tools like SPSS, R-statistics, and GIS are valuable for data analysis and spatial planning. GIS aids in feasibility studies, mapping, and network analysis for agricultural activities. Studies suggest that Big Data and GIS in agriculture can optimize production, predict yields, and support precision farming, adding value to the extension services (Kosior, 2017). Further, the study also shows that the simple application of GIS in the sampling of sites, mapping plots in field and examining the soil types leads to the improvement of production and yields. To address significant skill gaps in SPSS, R-Statistics, Python, and GIS, prioritize foundational and advanced training programs, focusing on practical, hands-on learning. Encourage mentorship, use of online resources, and self-paced learning platforms to build proficiency.

Table 9. Skills of respondents on the use of Analytical Software

Software	Very poor %	Poor %	Good %	Very good %	Excellent %
SPSS	36.8	47.4	15.8	0	0
R-Statistics	57.9	26.3	15.8	0	0
Python	71.1	26.3	2.6	0	0
GIS	44.7	31.6	23.7	0	0.00%

3.5 Challenges of ICT development in Extension Services

ICT development in Bhutan's extension services faces challenges such as infrastructure limitations, limited ICT skills, and resource constraints as presented in the table 9. Similarly, a report highlights that the low adoption of ICT programs in Bhutan is often attributed to budget and human resource limitations (MOIC, 2015). Addressing these obstacles will require investment in infrastructure, training, and support for extension agents to effectively use ICT tools

Table 10. Challenges of ICT development in extension field as per the respondents

Challenges	Strongly disagree (%)	Disagree (%)	Agree nor disagree (%)	Agree (%)	Strongly agree (%)
Slow internet	5.3	5.3	39.5	31.6	18.4
No internet	21.1	23.7	26.3	15.8	13.2
Insufficient high-end computers	0	13.2	39.5	21.1	26.3
Issues with the maintenance of Lack of equipment's	2.6	10.5	39.5	26.3	21.1
Or software	5.3	10.5	42.1	28.9	13.2
Weak ICT skills	2.6	13.2	31.6	26.3	26.3
Weak ICT technical support	2.6	18.4	36.8	31.6	10.5
Not enough ICT capacity building	2.6	13.2	18.4	28.9	36.8
No budget for ICT facilities	5.3	5.3	21.1	36.8	31.6
Weak policy support	2.6	7.9	44.7	34.2	10.5

4 Conclusions

The study reveals that ICT resources, tools, and skills among extension workers in Bhutan are moderately accessible but limited in scope, particularly in areas like advanced analytical tools, multimedia production, and data management. While access to mobile internet, social media platforms, and computers is widespread, gaps in training, outdated equipment, and limited proficiency in essential software hinder the full utilization of ICT in extension services. The

findings emphasize the need for targeted interventions to address skill deficiencies and improve access to critical tools like digital cameras, projectors, and advanced software.

Addressing these challenges will require a multi-pronged approach, including investment in infrastructure, regular ICT capacity-building programs, and the integration of advanced tools into extension services. Leveraging ICT for knowledge dissemination, market linkages, and decision-making can transform Bhutan's agricultural extension system, ensuring more effective service delivery and empowering farmers with timely and actionable information.

5 Limitation of the Study

This study's findings are based on self-reported data from extension workers, which may be subject to biases such as social desirability or recall inaccuracies. Additionally, the sample size and scope are limited to certain regions or Dzongkhags, which may not fully represent the diversity of ICT access and usage patterns across Bhutan. The study also does not account for the impact of contextual factors, such as geographic remoteness or socio-economic status, which could influence the accessibility and effectiveness of ICT resources. Furthermore, while the paper discusses the challenges faced by extension workers, it does not explore in-depth the perspectives of farmers or other stakeholders involved in the extension process. Future studies could benefit from a more comprehensive, multi-stakeholder approach to capture a fuller picture of ICT's role in agricultural extension.

6 Acknowledgement

The authors would also like to acknowledge the support provided by the Dzongkhag Agriculture Officers and Dzongkhag Livestock Officers of the Paro, Haa, Chhukha, and Thimphu Dzongkhag during the fieldwork phase of this study. The National Centre for Organic Agriculture deserves special thanks for their consistent support throughout the entire research process.

7 Authors' contribution statement

Mr. Chimi Rinzin, Corresponding Author, lead for conceptualizing the research, developing the survey questionnaire, coordinating the survey and lead data analysis. Mr. Thubten Sonam is the research advisor and supervisor. Mr. Tirtha Bdr Katwal, lead for the development of the conceptual framework for designing this research and article, writing and overall guidance for this research.

8 References

Abate, G. T., Bernard, T., Makhija, S., & Spielman, D. J. (2023). *Accelerating technical change through ICT: Evidence from South Asia*. Elsevier, 1–2.

Ankita, V., Verma, V., & Rani, E. (2023). *Role of social media in extension – a review. International Journal of Humanities, Social Sciences and Management*. Retrieved from https://shorturl.at/uI8MU

Choki, P. (2023). 18% of *students studying overseas and each household has 2.7 phones*. The Bhutanese, July 1.

Davidson, T. (2023). *Importance of software maintenance in software engineering.* Clean Commit. Retrieved from https://cleancommit.io/blog/importance-of-software-maintenance-in-software-engineering/

Department of Agriculture (DoA). (2020). *Agriculture extension strategy (2019–2028)*. Thimphu: Department of Agriculture, Ministry of Agriculture and Forests. Retrieved from https://doa.gov.bt/guidelines-and-manuals/

Fu, X., & Akter, S. (2017). *The impact of ICT on agricultural extension services delivery*: *Evidence from the Rural e-Services Project in India*. ResearchGate. Retrieved from https://shorturl.at/jsZNr

Kosior, K. (2017). *Agriculture education and extension in the age of big data.* Research Gate Retrieved from https://shorturl.at/wCo3g

MoIC. (2015). *Bhutan ICT road map*. Thimphu: MoIC. 12-14

NSB. (2024a). *2024 Labour Force Survey Report*. National Statistics Bureau, Royal Government of Bhutan, Thimphu.

NSB. (2024b). *National Accounts Statistics 2024.* National Statistics Bureau, Royal Government of Bhutan, Thimphu.

NSB. (2023). *Integrated agriculture and livestock census report (IALC) 2023*. Thimphu: NSB. Retrieved from https://www.nsb.gov.bt/integrated-agriculture-and-livestock-census-of-bhutan-2023/

Nyarko, D. (2021). *Information and communication technologies (ICTs) usage among agricultural extension officers and its impact on extension delivery in Ghana*. Journal of the Saudi Society of Agriculture Sciences. 164-172

Okeke, M. N., Nwalieji, U. H., & Uzuegbunam, C. O. (2015). *Emerging role of information communication technologies in extension service delivery in Nigeria: A review*. Journal of Agricultural Extension, 19(1), 128–141.

Oluyomi, S. M. (n.d.). *Application of information and communication technology (ICT) in agricultural extension delivery system*. Journal of Teacher Perspective. Retrieved from https://www.globalacademicgroup.com/journals/coconut/Application%20of%20.pdf

Rohila, A. K., Yadav, K., & Ghanghas, B. S. (2017). *Role of information and communication technology (ICT) in agriculture and extension.* Journal of Applied and Natural Science, 9(1), 632–639.

Samadder, S., & Rao, D. (2023). *Role and importance of ICT in agricultural extension.* Role and importance of ICT in agricultural extension (Chapter 13). ResearchGate. Retrieved from https://shorturl.at/latv8

Saidu, A., Clarkson, A. M., Mohammed, M., Adamu, S., & Jibo, I. (2017). *Application of ICT in agriculture: Opportunities and challenges in developing countries.* International Journal of Computer Science and Mathematical Theory, 3(2),8–18.

T., L., & T., O. (2015). *The role of mass media in Bhutan: Accessibility, influence and its impacts. Journal of Mass Communication & Journalism*. Retrieved from https://shorturl.at/Vj8on

Tshering, K. (2019). *Use of information and communication technology (ICT) for agriculture in Bhutan*. ICT in Bhutan. Retrieved from https://medium.com/ict-in-bhutan/use-of-information-communication-technology-ict-for-agriculture-in-bhutan-64683bfb9c70

Verma, S. R. (2018). ICTs for agriculture extension. SlideShare. Retrieved from https://www.slideshare.net/srverma10/icts-for-agriculture-extension