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Digital Literacy Among Agricultural Extension Agents in North Maluku, Indonesia

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Authors' contributions

This work was carried out in collaboration among all authors. Author CS did data curation, and data analysis, performed the methodology, and wrote and prepared the original manuscript draft. Author SPW did the formal analysis. Authors SPW and SSH wrote, reviewed, and edited the manuscript. Author SSH conceptualized the work and supervised the study. All authors read and approved the final manuscript.

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ABSTRACT

This study assesses the digital literacy of agricultural extension agents in North Maluku Province, Indonesia, and its implications for service delivery. A survey of 252 extension agents, conducted from November 2022 to February 2023, employed a validated questionnaire based on five key indicators: Information and Communication Technology (ICT) usage, digital data and information literacy, digital communication and collaboration, digital learning and extension skills, and digital

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identity and security literacy. Descriptive statistical analysis revealed an overall digital literacy level of 54.3% (SD = 10.8), indicating moderate proficiency. While ICT skills proficiency was high (61%), proficiency in other areas was lower, ranging from 50.8% to 55%. Younger agents and those with higher educational levels demonstrated higher digital literacy. These findings underscore the need for targeted interventions by government and academic institutions to bolster the digital capabilities of agricultural extension agents, thereby enhancing their capacity to leverage digital technologies for effective service provision in North Maluku's agricultural sector.

Keywords: Digital literacy; agricultural extension; Indonesia; capacity building.

1. INTRODUCTION

The digital revolution, driven by advancements in Information and Communication Technology (ICT), has significantly transformed global agricultural practices [1]. In Indonesia, this transformation is evident in the widespread adoption of mobile technology (125.6% penetration) and internet access among farmers (93.9%), leading to a notable shift towards digital agriculture [2–4]. However, this transition also challenges agricultural extension services, the primary providers of non-formal education to farmers [5].

In North Maluku Province, agriculture plays a pivotal role in the local economy, contributing 13.08% to GDP [6] and absorbing 28.5% of the labor force [7]. However, the sector faces complex issues such as climate change [8], market inefficiencies [1], fragmented supply chains [9], and limited adoption of innovative technologies [9]. These complexities further underscore the challenges faced by agricultural extension agents, who often operate with constrained resources and rising operational costs [10-13].

In light of these challenges, enhancing the digital literacy of agricultural extension agents is posited as a critical solution [14]. Digital platforms, such as virtual groups, offer potential avenues for knowledge sharing and social learning. However, the success of such initiatives relies heavily on the agents' digital literacy – their ability to effectively utilize ICT tools to improve agricultural performance and productivity [15].

Given these dynamics, mastering digital literacy becomes imperative for agricultural extension agents. Digital literacy, defined as the ability to effectively use ICT to enhance agricultural performance and productivity, is essential in addressing the complexities faced by farmers [15]. It offers two key benefits: the information opportunity effect and the technology opportunity effect [16]. Through digital literacy, extension agents can enhance the effectiveness of their services by introducing innovative agricultural practices, addressing climate and environmental challenges [17], and expanding market access by providing real-time information on prices and consumer demands [15]. Empowering farmers with digital literacy enhances their participation in the digital economy and contributes to sustainable development, as evidenced by Yang et al. [18] findings in rural China.

Despite its importance, the study of digital literacy within agriculture, particularly among extension agents, remains limited. Existing research often focuses on the impact of digital literacy on farmers' capacities and incomes. For instance, Bai et al. [19] found that digital literacy enhances entrepreneurial behaviors among Chinese farmers, while Liu et al. [17] reported that it increases agricultural incomes in rural China. However, some studies also indicate that digital literacy can widen income gaps in rural areas. Research by Magesa [16] primarily addresses digital literacy indicators for smallholders, emphasizing access, evaluation, creation, and utilization of digital information.

This study addresses a critical knowledge gap by assessing the digital literacy levels of agricultural extension agents, who play a vital role in providing non-formal education to farmers. It aims to offer a new understanding of their digital literacy levels and develop context-specific digital literacy indicators distinct from those applicable to the general public or academia [17,20–23].

To effectively design targeted capacity-building interventions and empower extension agents to achieve optimal digital literacy, it is crucial to understand their self-perceived proficiency in utilizing digital technology for extension. A comprehensive assessment of their strengths and weaknesses in ICT usage, information data processing, communication and collaboration, digital learning, digital security, and problem-

solving is essential. This study aims to provide this granular understanding, enabling the development of training programs that precisely address the specific needs and skill gaps of extension agents in North Maluku. By identifying the primary areas for improvement, this research will inform the creation of focused and impactful interventions, ultimately enhancing the digital capabilities of extension agents and their capacity to drive agricultural development in the region.

2. METHODOLOGY

This study employed a quantitative cross-sectional survey design to assess the self-perceived digital literacy of agricultural extension agents in North Maluku, Indonesia. After various digital literacy indicators have been assessed in detail, the next goal is to design a capacity-building or training program that suits their actual needs related to agricultural extension.

2.1 Instrument Development and Validation

To assess digital literacy, questionnaires are used as data collection instruments because they are considered suitable for this purpose. The questionnaire was developed based on a comprehensive digital literacy framework adapted from JISC [19], UNESCO [23], and the Indonesian Ministry of Communication and Information Technology [24,25]. This framework encompassed five key indicators of digital literacy:

1. ICT Skills: Ability to operate computers, smartphones, and relevant software for agricultural extension tasks.
2. Data and Information Literacy: Ability to access, manage, and utilize digital data, information, and content in agricultural extension practices.
3. Digital Communication and Collaboration: Ability to communicate effectively using ICT and engage in digital collaboration.
4. Digital Learning and Extension: Ability to participate in self-directed learning and deliver technical training/guidance both online and offline.
5. Digital Identity and Security: Ability to manage and protect digital accounts, and understand online risks and threats.

The questionnaire was developed in three phases, following the recommendations of Azwar [26] and Boateng [27]:

- Item Development: Initial items were adapted from existing digital literacy instruments and contextualized for agricultural extension. These items were reviewed and refined by five experts in extension and digital literacy with expertise in psychometrics. Each indicator was assessed using 19-24 closed-ended questions on a 5-point Likert scale (1 = Very not capable, 2 = Not capable, 3 = Average, 4 = Capable, 5 = Very capable).
- Scale Development: A pilot test with 60 respondents was conducted to refine the questionnaire and convert ordinal responses into interval data on the Likert scale.
- Evaluation: The validity and reliability of the questionnaire were assessed using Corrected Item-Total Correlation (C-ITC) and Cronbach's alpha (α). All items as seen in Table 1 demonstrated acceptable validity (C-ITC > 0.254) and the instrument showed high reliability (Cronbach's alpha > 0.9) for each indicator, confirming the questionnaire's internal consistency and suitability for the study [27].

Table 1. Validity and reliability of the digital literacy questionnaire

Component of digital literacy	Validity Test {N =60; r-table (α = 0.05; df=58) = 0.254}	Reliability test
	Total of Valid items	Cronbach's alpha
ICT skills	22	0.954
Data and information literacy	24	0.968
Digital communication and collaboration	20	0.957
Digital learning and extension skills	19	0.972
Digital identity and security literacy	20	0.970

Source: Own elaboration

2.2 Population and Sample

The study population consisted of 468 agricultural extension agents across eight districts in North Maluku Province, Indonesia. A sample size of 252 agents was selected using simple random sampling, adhering to Hair's rules for sample adequacy and representativeness [27]. Data collection occurred between November 2022 and February 2023. A mixed-mode approach was employed, with 150 respondents completing an online questionnaire through a provided Google Forms link, and the remaining 102 respondents completing the questionnaire in person (offline).

2.3 Data Analysis

Data were analyzed using IBM SPSS Statistics version 25. Descriptive statistics were employed to characterize the digital literacy levels of the respondents. To determine the overall digital literacy proficiency level, individual scores for each of the five indicators were summed and then standardized as a percentage (0-100 scale) of the maximum achievable score, using the following formula: *Digital Literacy Level (%) = (Total Achieved Score / Total Maximum Score) * 100%.* Higher percentages indicate greater digital literacy proficiency. Pearson correlation analysis was conducted to examine the relationship between demographic variables (e.g., age, education level) and digital literacy scores. To inform the development of targeted capacity-building initiatives, qualitative insights regarding specific areas for improvement were derived from open-ended survey responses and field observations.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics

The survey revealed a relatively balanced gender distribution among agricultural extension agents in North Maluku, with 52.8% male and 47.2% female respondents. However, a closer examination of age groups reveals nuanced differences. The workforce is predominantly comprised of individuals aged 43-57 (49.2%), classified as Generation X, and those aged 26-42 (46.4%), classified as Millennials, according to Fry & Parker's generational framework [28,29]. Notably, women constitute a larger proportion (26.2%) of Millennial agents, while men dominate the Generation X cohort (31.0%). The presence of younger generations, particularly Millennials, aligns with Prensky's theory of digital natives [30], suggesting a potential inclination towards technology adoption and utilization among a significant portion of the agents.

Educational attainment among the agents is noteworthy, with 67.5% having completed more than 15 years of formal education, indicating a substantial proportion hold bachelor's degrees and a smaller percentage possess master's degrees. This high educational attainment, predominantly observed among female agents (36.5%), suggests a strong foundation for acquiring and applying digital skills. However, the presence of agents with lower educational levels (29.8% of high school graduates) underscores the need for tailored training programs to bridge potential digital literacy gaps.

The distribution of work areas reflects the predominantly rural nature of agriculture in North Maluku, with 85.3% of agents assigned to rural communities. Interestingly, women constitute a larger proportion (12.3%) of urban-based agents. While most respondents (81.3%) reported having access to mobile networks, a significant minority (18.7%) indicated a lack of cellular coverage in their work areas. This disparity in access highlights a potential digital divide, particularly in rural regions, which could hinder the effective utilization of digital tools for extension services. Table 2 summarizes the demographic characteristics of the agricultural extension agents who participated in this study.

3.2 Digital Literacy of Agricultural Extension Agents

Table 3 illustrates the self-perceived digital literacy proficiency of agricultural extension agents across five key indicators. ICT skills demonstrate the highest proficiency (61.0% ± 14.5), while digital identity and security exhibit the lowest (50.6% ± 15.7). The remaining indicators—data and information literacy (54.8% ± 14.7), digital learning and extension (53.8% ± 12.3), and digital communication and collaboration (51.1% ± 15.0)—reveal moderate proficiency levels. These findings highlight the need for targeted interventions to strengthen specific areas of digital literacy, particularly digital identity and security, to enhance the overall effectiveness of extension services.

3.2.1 ICT skill

Table 4 reveals that, while agricultural extension agents in North Maluku generally possess

capable ICT skills, specific areas require improvement. Proficiency in operating virtual meeting software, creating user accounts, conducting mobile banking transactions, utilizing cyber extension platforms, creating articles through cyber extension, and identifying market potential is currently at an average level. This suggests that while extension agents are comfortable with basic ICT tools, they may lack the specialized skills needed to fully leverage digital technology for their work. Furthermore, the data indicate a notable deficiency in drone operation skills, with proficiency levels categorized as not capable. Given the increasing potential of drones in agriculture for tasks such as crop monitoring and pesticide application [31], this finding highlights a critical skill gap that warrants immediate attention.

Table 2. Demographic characteristics of agricultural extension agents in North Maluku, Indonesia

Characteristic	Male (n=133)		Female (n=119)		Total	
	Frequency	%	Frequency	%	Frequency	%
Age (years)						
• <26	1	0,4	7	2,8	8	3,2
• 26-42	51	20,2	66	26,2	117	46,4
• 43-57	78	31,0	46	18,3	124	49,2
• >57	3	1,2	0	0,0	3	1,2
Years of Education						
• <13	51	20,2	24	9,5	75	29,8
• 13-15	4	1,6	3	1,2	7	2,8
• >15	78	31,0	92	36,5	170	67,5
Work Area						
• Rural	127	50,4	88	34,9	215	85,3
• Urban	6	2,4	31	12,3	37	14,7
Mobile Network Access						
• Yes	101	40,1	104	41,3	205	81,3
• No	32	12,7	15	6,0	47	18,7

Source: Authors Dataset 2023

Table 3. Self-perceived digital literacy levels of agricultural extension agents

Component of digital literacy	Proficiency level (%)	Standard deviation	Category
ICT skills	61,0	14,5	Capable
Data and information literacy	55,0	14,7	Average
Digital communication and collaboration	51,1	15,0	Average
Digital learning and extension skills	53,8	12,3	Average
Digital identity and security literacy	50,8	15,7	Average
Mean	**54,3%**	**10,8**	**Average**

Source: Authors Dataset 2023

Table 4. Self-perceived ICT skills of agricultural extension agents

Item	Score		Proficiency Level (%)	Category
	Interval	Mean		
Operating a computer	0-4	2,4	65,9	Capable
Operating a smartphone	0-4	2,9	69,3	Capable
Operating a drone	0-4	1,4	32,3	Not capable
Operating a virtual meeting	0-4	2,2	57,9	Average
Operating Microsoft Office	0-5	3,9	74,5	Capable
Downloading files using the smartphone	0-4	2,6	66,8	Capable
Uploading files using the smartphone	0-4	2,9	69,6	Capable
Operating WhatsApp	0-4	2,7	70,2	Capable

Item	Score		Proficiency Level (%)	Category
	Interval	Mean		
Installing software through the Play Store	0-4	2,3	61,8	Capable
Logging in and creating a user account	0-4	2,3	59,4	Average
Activating GPS features and reading locations on the smartphone	0-4	2,5	62,9	Capable
Sharing location using the smartphone	0-4	2,3	61,0	Capable
Using an open camera based on coordinates	0-4	2,6	67,3	Capable
Activating WIFI on a smartphone	0-4	2,3	65,7	Capable
Utilizing cyber extension	0-4	2,1	56,6	Average
Using M-Banking	0-4	2,0	54,0	Average
Creating counseling articles through the cyber extension	0-4	2,0	51,1	Average
Using a laptop to compile programs	0-4	2,4	61,4	Capable
Using the smartphone to make videos of counseling materials	0-4	2,2	56,6	Average
Creating booklets/leaflets using a computer	0-4	2,4	59,7	Average
Performing coordinate digitization for land	0-4	2,4	62,0	Capable
Identifying market potential in the marketplace	0-4	2,4	56,3	Average
Score	**0-87**	**2,4**	**61,0**	**Capable**

Source: Authors Dataset 2023

3.2.2 Data and information literacy

Table 5 indicates that extension agents are generally hesitant to utilize data, information, and digital media. This hesitation suggests that most surveyed extension agents struggle to use digital data and information effectively in their work. Although they have access to digital devices, they do not recognize the potential of vast digital data sources. For instance, the Central Bureau of Statistics offers free online access to extensive data, and the climatology station provides daily climate data freely accessible online. Additionally, extension agents' digital media literacy is average, particularly in creating creative agricultural content and critically evaluating messages. To address these issues, extension institution leaders need to prioritize enhancing the capacity of extension agents to use data, information, and digital media.

Table 5. Self-perceived data and information literacy of agricultural extension agents

Item	Score		Proficiency Level (%)	Category
	Interval	Mean		
Searching and accessing statistics online data	0-4	2,3	58,5	Average
Searching and accessing climate online data	0-4	2,3	54,2	Average
Searching and accessing online data on agricultural commodity prices	0-4	2,3	56,9	Average
Searching and accessing online data on the potential of the extension work area	0-5	2,6	56,8	Average
Assessing the benefits of statistics data for extension programs	0-4	2,2	53,6	Average
Assessing the benefits of climate data for preparing planting calendars	0-4	2,2	53,6	Average
Assessing the benefits of commodity price data to increase farmers' bargaining position	0-4	2,3	55,3	Average
Assessing the benefits of regional potential data for policy recommendations	0-4	2,3	54,8	Average
Processing and analyzing raw data	0-5	2,1	46,7	Average
Processing and analyzing climate data	0-4	2,0	46,3	Average
Processing and analyzing commodity price data	0-4	2,1	49,3	Average
Processing and analyzing regional potential data	0-4	2,3	53,2	Average
Searching and finding crop cultivation technology information	0-4	2,2	60,2	Capable

Item	Score		Proficiency	Category
	Interval	Mean	Level (%)	
Searching and finding livestock technology information	0-4	2,3	60,5	Capable
Searching and finding post-harvest technology information	0-4	2,4	60,8	Capable
Assessing, evaluating, and validating agricultural information data	0-4	2,2	56,3	Average
Comparing various sources of agricultural data and information	0-4	2,2	53,5	Average
Using data and information for counseling materials	0-4	2,3	58,4	Average
Storing and managing data and information in the form of digital files	0-4	2,2	55,8	Average
Creating social media accounts	0-4	2,2	58,5	Average
Creating counseling video content on social media	0-4	2,0	49,3	Average
Making agricultural innovation status	0-4	2,4	56,2	Average
Using social media to disseminate agricultural information	0-4	2,2	57,9	Average
Criticizing messages/information related to agriculture on social media	0-4	2,0	52,5	Average
Score	**0-98**	**2,2**	**55,0**	**Average**

Source: Authors Dataset 2023

3.2.3 Digital communication and collaboration

Table 6 reveals moderate proficiency levels among agricultural extension agents in utilizing digital communication tools for disseminating information, collaborating with researchers and academics, and engaging with business actors. This could be attributed to concerns regarding the effectiveness of digital communication in reaching diverse audiences, particularly farmers with varying cultural and linguistic backgrounds. The limitations of digital platforms in conveying nuanced language, local idioms, and non-verbal cues may lead to misinterpretations or misunderstandings [32]. Additionally, skepticism about the ability of digital tools to adequately convey complex agricultural concepts may contribute to the hesitancy of some extension workers [33].

3.2.4 Digital learning and extension skills

Table 7 highlights areas where agricultural extension agents in North Maluku require further development in their digital learning and extension skills. While proficiency in basic tasks like accessing online information and participating in webinars is evident, specific skills such as seeking and participating in online technical guidance, creating vlogs, maintaining learning motivation, co-producing knowledge with farmers, facilitating online learning, seeking scholarship opportunities, and facilitating virtual meetings between farmers and stakeholders require significant improvement. These findings align with previous research that has identified challenges in integrating digital technologies into agricultural extension practices, particularly in developing countries [34]. Barriers such as limited access to reliable internet connectivity, lack of digital skills training, and resistance to change among both extension agents and farmers can hinder the effective adoption of digital tools for learning and knowledge sharing [35].

3.2.5 Digital identity and security

Table 8 reveals notable limitations among agricultural extension agents in North Maluku regarding their digital identity and security management skills. A majority lack proficiency in creating profiles on popular social media platforms like Instagram, TikTok, YouTube, and Twitter, hindering their ability to engage with wider audiences and leverage these platforms for extension purposes. Additionally, the data indicate a significant hesitancy in understanding the dangers of social engineering tactics such as phishing, smishing, and vishing, leaving them vulnerable to cyber threats. These findings align with broader concerns about digital literacy and cybersecurity awareness among agricultural professionals in developing countries [36]. The rapid growth of digital technologies in agriculture has outpaced the development of corresponding training and support systems, leaving many extension agents ill-equipped to navigate the digital landscape safely and effectively [37].

Table 6. Digital communication and collaboration skills among agricultural extension agents

Item	Score		Proficiency Level (%)	Category
	Interval	Mean		
Communicating agricultural innovations through websites	0-4	2,1	46,8	Average
Communicating agricultural innovations through social media	0-4	2,2	53,4	Average
Communicating agricultural innovations through virtual communities	0-4	2,1	51,5	Average
Dialogical consultation through voice/video call	0-4	2,3	54,9	Average
Establishing interactions with farmers on social media	0-4	2,2	55,0	Average
Communicating in English in digital media	0-4	1,4	36,4	Not capable
Establishing communication with researchers/academics using ICT	0-4	2,0	50,8	Average
Establishing cooperation with seed producers	0-4	2,0	52,2	Average
Establishing cooperation with fertilizer producers	0-4	2,2	53,1	Average
Establishing cooperation with pesticide producers	0-4	2,1	52,5	Average
Establishing cooperation with banks	0-4	2,0	47,1	Average
Establishing cooperation with machinery service providers	0-4	2,1	49,1	Average
Establishing cooperation with off-takers	0-4	2,0	51,1	Average
Establishing cooperation with government agencies/actors	0-4	2,1	51,8	Average
Establishing cooperation with extension agents from other countries	0-4	1,6	39,7	Not capable
Joining a virtual group	0-4	2,2	57,2	Average
Contributing/ideas in virtual discussions	0-4	2,1	54,3	Average
Following social media accounts of agricultural figures	0-4	2,0	50,9	Average
Sharing the latest information using ICT	0-4	2,1	55,0	Average
Updating the latest information regarding agricultural development issues	0-4	2,4	59,1	Average
Score	**0-81**	**2,1**	**51,1**	**Average**

Source: Authors Dataset 2023

Table 7. Digital learning and extension skills among agricultural extension agents

Item	Score		Proficiency Level (%)	Category
	Interval	Mean		
Increasing knowledge-related innovation latest	0-5	2,9	61,7	Capable
Monitoring and following the latest trends development of agriculture	0-4	2,5	56,1	Average
Searching and following online technical guidance	0-4	2,3	58,2	Average
Creating related vlogs for agriculture	0-5	2,2	47,8	Average
Looking for a chance scholarship	0-4	1,6	39,4	Not capable
Looking for cultivation tips for agriculture	0-4	2,3	55,0	Average
Looking for post-harvest and processing tips results from agriculture	0-4	2,3	55,0	Average
Looking for experience learning on YouTube	0-4	2,4	63,0	Capable
Maintaining motivation to learn and update knowledge counseling	0-4	2,4	55,5	Average
Producing knowledge together with farmer	0-4	2,5	55,6	Average
Facilitating Study together related technology agriculture	0-5	2,4	52,6	Average
Sharing information positive to the farmer	0-4	2,4	54,6	Average
Formulating recommendation practice cultivation for farmer	0-4	2,3	54,1	Average

Item	Score		Proficiency Level (%)	Category
	Interval	Mean		
Serving online consultation	0-4	2,3	52,7	Average
Giving training to farmer	0-4	2,1	50,1	Average
Facilitating virtual meetings of farmers with stakeholders	0-4	1,6	38,5	Not capable
Promoting product superior area by online	0-4	2,3	53,7	Average
Posting social media status for interesting interest partner	0-4	2,6	60,6	Capable
Sending data and information to holder interest	0-5	2,8	58,6	Average
Score	**0-82**	**2,3**	**53,8**	**Average**

Source: Authors Dataset 2023

Table 8. Digital security literacy among agricultural extension agents

Item	Score		Proficiency Level (%)	Category
	Interval	Mean		
Making a profile on Facebook (FB)	0-4	2,2	63,3	Capable
Making a profile on Instagram (IG)	0-4	2,0	55,3	Average
Making a profile on Twitter	0-4	1,4	36,5	Not capable
Making a profile on TikTok	0-4	1,7	45,1	Average
Making a profile on YouTube	0-4	1,8	47,3	Average
Nursing reputation digital identity	0-4	2,2	55,4	Average
Managing passwords from hacker interference	0-4	1,9	49,0	Average
Overcoming If forgot the password	0-4	2,0	52,5	Average
Understanding risk vishing	0-5	2,3	49,2	Average
Understanding risk phishing	0-4	2,1	47,0	Average
Understanding risk smishing	0-4	2,2	49,1	Average
Understanding risk impersonation	0-4	1,6	38,5	Not capable
Arranging who can see social media timeline	0-4	1,9	51,6	Average
Reporting abuse on social media	0-4	2,2	52,5	Average
Disabling the GPS option on the smartphone	0-4	2,1	54,0	Average
Selecting necessary personal data uploaded	0-4	2,2	56,9	Average
Using antivirus software	0-4	2,1	53,4	Average
Distinguishing emails that contain spam/malware	0-4	2,1	52,0	Average
Creating a secure password	0-4	2,0	52,4	Average
Backing up and saving data	0-4	2,0	54,3	Average
Score	**0-79**	**2,0**	**50,8**	**Average**

Source: Authors Dataset 2023

3.3 Correlations between Digital Literacy, Age, and Education Among Agricultural Extension Agents in North Maluku

Table 9 shows the Pearson correlation analysis reveals significant negative correlations between age and all digital literacy indicators ($p < 0.01$). This indicates that younger agricultural extension agents tend to exhibit higher proficiency levels in ICT skills, data and information literacy, digital communication and collaboration, digital learning and extension, and digital identity and security. Conversely, older agents demonstrate lower proficiency in these areas. In contrast, positive correlations were found between years of education and all digital literacy indicators ($p < 0.01$).

This suggests that agents with more years of formal education tend to possess greater digital literacy skills across all domains. These findings align with previous research highlighting the influence of age and education on technology adoption and proficiency. Younger individuals, often referred to as "digital natives," have grown up immersed in digital technologies, facilitating their acquisition of digital skills [38]. Similarly, higher educational attainment may equip individuals with the cognitive and analytical abilities necessary for navigating and utilizing digital tools effectively [39].

Table 9. Pearson correlation analysis of digital literacy, age, and education among agricultural extension agents

Digital literacy indicator	Age		Years of education	
	Pearson Correlation	*P< .01*	Pearson Correlation	*P< .01*
ICT skills	-.341	.000**	.355	.000**
Data and information literacy	-.247	.000**	.336	.000**
Digital communication and collaboration	-.229	.000**	.251	.000**
Digital learning and extension skills	-.184	.003**	.303	.000**
Digital identity and security literacy	-.351	.000**	.340	.000**

*Notes: ** Correlation is significant at the 0.01 level (2-tailed)*

3.4 Discussion

The study identifies specific areas for improvement in each digital literacy component, necessitating tailored training programs. These programs should address advanced ICT applications (e.g., virtual meetings, cyber extension platforms, and drone operation), data literacy (accessing, evaluating, and utilizing online agricultural data and information), digital communication (email etiquette, video conferencing, social media engagement), digital learning and extension (online guidance, content creation, farmer collaboration), and digital identity and security (social media profiles, cyber threat awareness).

However, potential barriers to successful implementation include limited access to ICT facilities, inadequate internet connectivity, insufficient infrastructure, lack of supportive policies, and resistance to change. Overcoming these challenges requires a multi-faceted approach involving government investment in digital infrastructure, academic institutions developing training programs, the private sector providing affordable technology solutions, media raising awareness, and active collaboration among all stakeholders to foster a culture of digital literacy.

4. CONCLUSION

This study reveals that the digital literacy of agricultural extension agents in North Maluku, Indonesia, is moderate overall, with strengths in ICT skills but notable weaknesses in data and information literacy, digital communication and collaboration, digital learning and extension, and digital identity and security. Digital literacy was found to be negatively correlated with age and positively correlated with educational attainment.

Based on these findings, the following policy recommendations are proposed: (1) Implement targeted training programs to enhance specific digital literacy skills among extension agents, particularly those related to data utilization, communication, online learning, and cybersecurity. (2) Encourage further education for extension agents with lower educational levels (e.g., high school graduates) and promote awareness of the benefits and applications of digital tools in agricultural extension. (3) Foster knowledge exchange and mentorship between younger and older generations of extension agents to leverage their respective strengths and experiences. (4) Invest in digital infrastructure in rural areas to ensure equitable access to online resources and improve internet connectivity.

While this study provides valuable insights, further research is needed to refine the digital literacy measurement instrument and assess its validity across a wider sample. Additionally, investigating the impact of digital literacy interventions on extension service delivery and farmer outcomes would be a valuable next step.

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Details of the AI usage are given below:

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2. Here's an input prompt: "Please review the following text for grammatical errors, awkward phrasing, and opportunities to improve sentence structure and clarity".

CONSENT

As per international standards or university standards, Participants' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

The authors have declared that no competing interests exist.

REFERENCES

1. Sugihono C, Juniarti HA, Nugroho NC. Digital transformation in the agriculture sector: Exploring the shifting role of extension workers, STI Policy Manag. J. 2022;7(2).
2. Social WA. Indonesia digital report 2023; 2023. [Online]. Available:https://datareportal.com/reports/digital-2023-indonesia.
3. Indraningsih KS, Septanti KS, Ar-Rozi AM. Agricultural extension in empowering farmers during the COVID-19 pandemic, Indonesian Center for Agricultural Socioeconomic and Policy Studies, Bogor; 2020.
4. Wei X, Liu Y, Liu Y. Study on the impact of internet usage, Aging on Farm Household Income, Sustain. 2023;15(19). DOI: 10.3390/su151914324.
5. Fielke S, Taylor B, Jakku E. Digitalization of agricultural knowledge and advice networks: A state-of-the-art review, Agric. Syst. Apr. 2020;180:102763. DOI: 10.1016/J.AGSY.2019.102763
6. BPS, North Maluku Province in Figures 2023. Ternate, North Maluku: Central Bureau of Statistics for North Maluku Province; 2023.
7. BPS, Official Statistical Release: Gross Domestic Product Growth, Jakarta; 2022.
8. Wei X, Liu Y, Liu Y. Study on the impact of internet usage, Aging on Farm Household Income, Sustain. 2023;15(19). DOI: 10.3390/su151914324.
9. Rusmono M. Agricultural extension transformation in the digital age: Mastering and Utilizing Science and Technology (3. Jakarta: Center for Agricultural Education, Ministry of Agriculture; 2021.
10. Lesmana R. The influence of work motivation on the performance of field agricultural instructors (Ppl) of the Bulungan Regency Agriculture Service, East Kalimantan, JBTI J. Bisnis Teor. and Implementation. 2016;7(2):251–277.
11. Ananda K R, D R K Saikanth, Vaishnavi Chaudam, Settipalli Sravani, S Harshitha Nayak, Adrita Dam, Anoop Shukla. Impact of mobile technology on extension service delivery in Remote Farming Communities: A Review. Journal of Scientific Research and Reports. 2024;30(3):1-13. Available:https://doi.org/10.9734/jsrr/2024/v30i31853
12. Gow GA, Dissanayeke U, Chowdhury A, Ramjattan J. Digital literacy and agricultural extension in the global south. In Digital Literacy and Inclusion: Stories, Platforms, Communities. Cham: Springer International Publishing. 2023 Oct 1;129-144.
13. Coggins S, McCampbell M, Sharma A, Sharma R, Haefele SM, Karki E, Hetherington J, Smith J, Brown B. How have smallholder farmers used digital extension tools? Developer and user voices from Sub-Saharan Africa, South Asia and Southeast Asia. Global Food Security. 2022 Mar 1;32:100577.
14. Wastutiningsih SP, Nugroho NC, Fatonah S. The challenges of being a modern extension worker in the era of Disruption, J. Penyul. 2024;20(01):29–40.
15. Gow GA, Dissanayeke U, Chowdhury A, Ramjattan J. Digital literacy and agricultural extension in the global South, in digital literacy and inclusion: Stories, Platforms, Communities, D. Radovanović, Ed. Cham: Springer International Publishing. 2024;129–144.
16. Magesa M, Jonathan J, Urassa J. Digital literacy of smallholder farmers in Tanzania, Sustain., 2023;15(17). DOI: 10.3390/su151713149
17. Liu B, Zhou J. Digital literacy, farmers' income increase and Rural Internal Income Gap, Sustainability. 2023;15(14).

DOI: 10.3390/su151411422
18. Yang C, Ji X, Cheng C, Liao S, Obuobi B, Zhang Y. Digital economy empowers sustainable agriculture: Implications for farmers' adoption of ecological agricultural technologies, Ecol. Indic. 2024;159.
DOI: 10.1016/j.ecolind.2024.111723
19. Bai Q, et al. Digital literacy and farmers' entrepreneurial behavior—Empirical analysis based on CHFS 2019 micro data, PLoS One. 7 July, 2023;18.
DOI: 10.1371/journal.pone.0288245
20. Jisc, Jisc digital capabilities framework: The six elements defined). 2019;1–8. [Online].
Available:http://repository.jisc.ac.uk/7278/1/BDCP-DC-Framework-Individual-6E-110319.pdf
21. Nalaila S, Wawire V, Gathara PM. Classroom support for students' digital literacy skills for learning in Tanzania's public universities, Dev. Pract. 2022;32(7): 867–878.
DOI: 10.1080/09614524.2022.2104219.
22. Cosby A, Fogarty ES, Manning J. Digital Literacy and Digital Self-Efficacy of Australian Technology Teachers, Educ. Sci. 2023;13(5).
DOI: 10.3390/educsci13050530
23. Cosby A, Fogarty ES, Manning J. Digital Literacy and Digital Self-Efficacy of Australian Technology Teachers, Educ. Sci. 2023;13(5).
DOI: 10.3390/educsci13050530
24. UNESCO, Digital Literacy and Beyond. March, 2018;11. [Online].
Available:https://www.unescap.org/sites/default/files/Digital literacy and beyond%2C UNESCO.pdf
25. Kominfo, The State of Digital Literacy in Indonesia 2020: A Survey of 34 Provinces. 2020;90. [Online].
Available:https://katadata-s3-public.s3.ap-southeast-1.amazonaws.com/media/kic/kominfo/Status Literasi Digital_Nasional.pdf.
26. Azwar S. Basic psychometrics, Second Edition, Yogyakarta: Pustaka Pelajar; 2015.
27. Boateng GO, Neilands TB, Frongillo EA, Melgar-Quiñonez HR, Young SL. Best practices for developing and validating scales for health, social, behavioral research: A primer, Front. public Heal. 2018;6:149.
28. Hair JF, Black WC, Babin BJ, Anderson RE. Multivariate data analysis: Pearson new international edition, Essex Pearson Educ. Ltd. 2014;1(2).
29. Fry R, Parker K. Early benchmarks Show'Post-Millennials' on Track to Be Most Diverse, Best-Educated Generation Yet: A Demographic Portrait of Today's 6- to 21-Year-Olds., Pew Res. Cent; 2018.
30. Prensky M. Digital natives, digital immigrants part 2: Do they really think differently?, Horiz; 2001.
31. Kitole FA, Mkuna E, Sesabo JK. Digitalization and agricultural transformation in developing countries: Empirical evidence from Tanzania agriculture sector, Smart Agric. Technol. 2024;7.
DOI: 10.1016/j.atech.2023.100379
32. Tanaka K. What hinders digital communication? Evidence from foreign firms in Japan, Japan World Econ. 2023; 66:101190.
DOI:https://doi.org/10.1016/j.japwor.2023.101190
33. Coggins S, et al. How have smallholder farmers used digital extension tools? Developer and user voices from Sub-Saharan Africa, South Asia and Southeast Asia, Glob. Food Sec. 2022;32:100577.
DOI:https://doi.org/10.1016/j.gfs.2021.100577.
34. Madan S, Baker A, Maredia K, Bates R. Agricultural extension capacity development in developing countries: An international training course at Michigan State University, Dev. Pract. 2022;32(3): 394–401.
DOI: 10.1080/09614524.2021.1958165.
35. Ahsan MB, et al. Barriers, challenges, requirements for ICT Usage among Sub-Assistant Agricultural Officers in Bangladesh: Toward Sustainability in Agriculture, Sustain. 2023;15(1).
DOI: 10.3390/su15010782
36. Herath TB G, Khanna P, Ahmed M. Cybersecurity practices for social media users: A systematic literature review, J. Cybersecurity Priv. 2022;2(1):1–18.
37. MacPherson J, et al. Future agricultural systems and the role of digitalization for achieving sustainability goals. A review, Agron. Sustain. Dev, 2022;42(4).
DOI: 10.1007/s13593-022-00792-6

38. Inan Karagul B, Seker M, Aykut C. Investigating students' digital literacy levels during online education due to COVID-19 pandemic, Sustainability. 2021;13(21): 11878.

39. Magesa M, Jonathan J, Urassa J. Digital literacy of smallholder farmers in Tanzania, Sustain. 2023;15(17). DOI: 10.3390/su151713149

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