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# Digital Literacy of Smallholder Farmers in Tanzania

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**Abstract:** The objective of this study was to assess the digital literacy of smallholder farmers in their agricultural production activities. Based on six proposed factors, the researchers developed questions to guide studying and measuring digital literacy (DL) of smallholder farmers. On a 5-point Likert scale, 23 questions measured the ability of smallholders to access, manage, interpret, evaluate, create and communicate agriculture information online. Moreover, 257 smallholder farmers were involved in the study. To measure DL level, descriptive statistics and mean scores for the responses were calculated. A comparison of low and high levels of DL with demographic variables was conducted. The item-wise distribution of responses show that smallholders have high DL in accessing and communicating information, while they had low DL in managing, integrating, evaluating and creating information. The item's mean score reveals that most of the responses were average. The overall mean score for the questionnaire was 75.17 + 5.79, and based on demographic characteristics, 58.0% of the smallholders reported high DL. Overall, smallholder farmers have an average level of DL. The study findings of this study may help governments and responsible institutions to develop strategies to ensure smallholders are digitally literate and use digital technologies in agricultural activities.

**Keywords:** digital literacy; smallholder farmers; confirmatory factor analysis; digital community; reliability of information; Tanzania



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## 1. Introduction

In agriculture, information and knowledge have become essential factors of production besides the traditional factors such as land, labor and capital. The improved utilization of information and knowledge within the agricultural sector is a key component in improving agricultural production, optimizing production costs and strengthening food security. These two factors are directly linked to how digital technologies collect, process and distribute information in order to create knowledge. Thus, in this information age, farmers need to develop their capabilities in digital technologies to become competitive in agricultural practices and production. Improving the digital literacy of smallholder farmers is considered among the strategies used to develop their capability to use digital technologies in agricultural production.

Digital technologies can revolutionize how rural communities secure and improve their livelihoods by helping smallholder farmers access customized, actionable agricultural information in real time [1]. Aker's [2] work on small-scale African farmers showed significant time and cost savings when using digital technologies for extension services. The spread of digital technologies such as mobile technologies, remote-sensing services and distributed computing are already improving smallholders' access to information, inputs, market, finance and training, thus integrating them into the broader agri-food system [3]. Digital technologies have spread quickly: more households in developing countries own mobile phones and about 70% of the poorest 20% in developing countries have access to

mobile phones [4]. Thus, digital technologies are believed to have the potential to end poverty and hunger faster, including in rural parts of developing countries, where the majority of people earn their living from agriculture [1].

In Tanzania, scholars have investigated use of digital technologies in agriculture. Smallholder farmers in Tanzania preferred radio and television as sources of agricultural knowledge and thus listened and watched agricultural programs [5]. In Tanzania and Kenya, small-scale farmers used ICT to transfer simple information (e.g., simple facts on weather or prices) as well as to exchange complex knowledge (e.g., production techniques) [6]. In assessing the effectiveness of ICTs (radio, television and mobile phone) in disseminating agricultural information in terms of the accessibility, timeliness and relevance of the information provided, farmers indicated that agricultural information was accessible, timely and relevant [7]. To enhance public extension services, Ortiz-Crespo et al. [8] created a digital service that addressed smallholders' different information needs: it gave farmers access to a set of pre-recorded messages and questions, and extension agents listened to the questions through an online platform and sent replies. Results showed that farmers who actively engaged with the service to access agricultural advice and extension agents were able to answer questions with reduced workload [8].

The process of adoption of digital technologies by farmers in Tanzania and other developing countries for accessing and sharing agricultural information and knowledge has not been smooth. Challenges and limitations have been reported by scholars. For example, while studying information needs for farmers in Morogoro, Myllynpää et al. [9] found that small amount of information was reported to be collected through television, radio, and the Internet. The transfer of complex knowledge such as agricultural production practices via ICT has been difficult due to high access costs [6]. Some ICT-based solutions for agriculture have not been adopted by farmers and other stakeholders in the agricultural value chain as they were initiated without involving farmers [10]. Sanga et al. [11] reported a high percentage of illiteracy among farmers, and Myllynpää et al. [9] found a relatively low percentage of ownership of digital devices such as smartphones. When assessing ICT literacy levels of irrigation farmers from South Africa, Alant and Bakare [12] found that smallholder farmers were not able to demonstrate use of the various ICT-related skills. The incorporation of digital technologies into agriculture and into the agricultural value chain raises a number of challenges for growth, and thus limitations in digital literacy are among the challenges that slow down the process of digital expansion [13].

The use of digital technologies for accessing information and sharing knowledge is associated with specific skills. In the literature, scholars have termed such skills digital literacy, digital skills, and digital competence. The use of these terms by scholars shows that there is an on-going debate and different interpretations within the educational science. The current study concentrates on the term digital literacy (DL).

There is a positive link between the dissemination of digital technologies at the sectoral level (such as agriculture) and productivity growth; and the associations between ICT skills and productivity are strong [14]. The development of digital skills is associated with advances in education. Knowledge and literacy in reading and writing and basic mathematical knowledge are required to use digital devices [13]. Thus, the ability to use ICT and the Internet becomes a new form of literacy, i.e., digital literacy [15]. Early works on DL such as that of Gilster [16] defined it in educational terms (i.e., the ability to understand and use information from a wide variety of sources when it is presented via computers) while recognizing the uniqueness of the Internet in storing and sharing the information. Since then, the DL concept has evolved, changed, and expanded, and its definition encompasses the ability to locate, extract, organize, manage, present and evaluate information in digital environments to produce broader, more complex conceptual frameworks that encompass a wide variety of skills, understandings, norms and practices [17].

Much research on DL has focused on what it means to be digitally literate and on the impact on human beings on not being digitally literate. As previously noted, scholars have indicated how the application of digital technologies has positively impacted

agricultural production. Scholars have attributed a lack of digital access to the lack of digital technologies and the lack of skills, understandings and practices required to operate digital devices. In agriculture, however, scholars are yet to explore the digital literacy of smallholder farmers to learn about their competence in accessing, using and sharing agricultural-related information.

### *1.1. Research Objectives*

The paper explores the landscape of digital literacy with an emphasis on smallholder farmers' capability in accessing, using, and sharing agricultural-related information. specifically, it:

(a) develops factors that can help in assessing the digital literacy of smallholder farmers;
(b) determines the level of digital literacy skills of farmers in agricultural production using the factors developed in (a) above.

The study has three major contributions. First, it enhances the literature of factors that are relevant while studying smallholder farmers' digital literacy in their access to online agricultural information. Second, the study's focus on Tanzania's smallholder farmers is unique due to the significance of agriculture in individuals and of the country's development at large. Third, the study provides empirical evidence that can potentially be used by policymakers in improving smallholder farmers' agricultural activities.

### *1.2. Digital Literacy*

Despite involving the ability to operate a digital device or use software, digital literacy includes cognitive, motor, sociological, and emotional skills that help users to work effectively in the information age [18]. Digital literacy can help individuals to use a growing variety of technical, cognitive, and sociological skills in order to perform tasks and solve problems in digital environments [18]. In the literature, digital literacy is associated with ability to use digital technology and communications tools, and/or networks to access, manage, integrate, evaluate, create and communicate information in order to function in a knowledge society. It was first defined by Gilster [16] in 1997 who described it as the ability to understand and use information in multiple formats from a wide variety of sources when it is presented via computers. The IICT Literacy Panel [19] considers technical proficiency as the basic component of digital literacy, which includes a foundational knowledge of hardware, software applications, networks, and elements of digital technology. In the literature, there is wide agreement among scholars [20–22] that different types of literacies related to ICTs (e.g., computer literacy, information literacy, media literacy, media education), and more generally to the media, all converge to the concept of digital literacy. The various proposed definitions of digital literacy converge around the retrieval and processing of information via digital technologies, as well as communication and the production of knowledge using digital technologies.

Digital literacy represents a set of discrete abilities, often characterized as the skills of the information age, expressed by individuals while using digital technologies [17,23]. The digitally literate individual knows when and how to effectively employ digital resources to resolve their information needs as well as how to evaluate digital information for currency, relevance and credibility [23]. The skills also include the ability to create and share information online, and on social network sites. Though most discussions on digital literacy remain primarily preoccupied with information, some studies insist on the broader cultural uses of the Internet, including the ability to use search engines for basic information retrieval [24].

Online searches for digital literacy reveal that scholars are also using the term digital competence to mean DL [25], and the digital competence concept describes technology-related skills [26]. Terms used to describe the skills and competence of using digital technologies include ICT skills, technology skills, information technology skills, 21st century skills, information literacy, digital literacy, and digital skills [26]. These terms are also often synonymous in the literature, e.g., digital literacy and digital competence [27].

Davydov et al. [25] describe digital competence as including four components: knowledge, skills, motivation and responsibility (related to security). Ferrari [28,29] defined digital competence as: the set of knowledge, skills, attitudes (thus including abilities, strategies, values and awareness) that is required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socializing, consuming, and empowerment.

The European Commission [30] defined competences as a combination of knowledge, skills and attitudes appropriate to the context. Key competences were those that all individuals needed for personal fulfilment and development, active citizenship, social inclusion and employment [30]. Though all the key competences were deemed equally important and inter-related, Phuapan et al. [31] argued that some competences (e.g., competence in the fundamental basic skills of learning, literacy, numeracy, and information and communication technologies) were described as an essential foundation for learning.

The discussions of the two concepts (digital literacy and digital competence) might somehow confuse a reader, though the concepts are increasingly used in public discourse. It is unclear how the concepts are used and how they are defined. Thus, the research needs to pay more attention to the origin of definitions and analyze how the different definitions are complementing or contradicting each other [32].

The literature has also indicated how scholars have assessed the digital literacy of users. Lazonder et al. [33] assessed the development of children's digital literacy skills by monitoring how their skills in collecting, creating, transforming, and safely using digital information progressed. Baro et al. [34] assessed the digital literacy skills possessed by library and information professionals working in university libraries in Africa by rating their skills in database search, document upload, social media and e-mail use, and using open-source software. Lwehabura [35] assessed the information literacy skills among postgraduate students at Sokoine University of Agriculture, Tanzania, to determine the challenges and problems facing them while searching and using various information resources. Based on these assessments, scholars have examined how users are accessing information and sharing knowledge, even outlining the prevailing challenges.

### *1.3. Digital Literacy in Agriculture*

Recently, the use of digital technologies has become essential to successfully master daily tasks and routines, as technology has permeated all sectors [36,37]. In the agricultural sector, scholars Krone et al. [6], Mtega [5] and Ortiz-Crespo et al. [8] have shown how farmers are using digital technologies in agricultural production. Undertaking tasks using digital technologies requires associated literacy skills, i.e., digital literacy. Based on the skills adopted, digital literacy can provide farmers with economic growth, crop protection from diseases and pests, an increase in both yield and income, better access to seeds and inputs, adaptation to climate change, favorable financial services, and better crop pricing [38]. In Rwanda, Digital Inclusion Newslog [39] posed that digital literacy skills help farmers decide which crops to grow depending on the climate conditions and access relevant and timely weather information, to help farmers make informed decisions on farming practices, which can prevent food losses. The information literacy of farmers is a prominent aspect for their growth: it can improve human capital, promote the efficiency of agriculture, and help in reaching better life conditions [40].

However, scholars have not much explored the digital literacy of farmers in agriculture. The literature has attributed the improved digital literacy of farmers to agricultural development and has also explored the constraining factors for improving the digital literacy of farmers. Sang and Cheruiyot [41] revealed that information literacy contributed to the horticultural productivity and profitability of smallholders in Kenya and recommended the capacity building of farmers regarding information literacy. In their study in China on the information literacy of farmers, Zhong and Qu [42] showed that farmers lacked skills in

identifying the sources of information they preferred, though they asserted that improved information literacy had a significant and positive relationship with enhanced agricultural productivity. A study of the rural community in India indicated that a lack of writing and reading skills and the inability to utilize languages other than their mother tongue limited farmers' ability to use digital technologies in agriculture [43]. Research on paddy farmers in Sri Lanka indicated that farmers were not very skilled in information literacy, and it was recommended that information literacy be taught to farmers [44].

Thus, low digital literacy has some consequences for the agricultural activities of smallholder farmers. Agricultural produce may be low and of low quality. Due to low digital literacy, the mastery of digital devices may be difficult, and smallholder farmers may lack the knowledge necessary for their agricultural production activities. The conclusion is that farmers may fail to realize the potential of digital technologies in agriculture.

### *1.4. Operational Framework for Digital Literacy*

Different scholars have conceptualized digital literacy as a multidimensional construct to assist in understanding the acquisition of digital literacy skills. Among the well-known frameworks for assessing DL in adolescents is the International Computer Literacy and Information Study (ICILS), which defines DL as an "individual's ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace and in society" [45]. The ICILS 2013 assessment framework comprises two strands, each with a specified number of aspects: collecting and managing information with three aspects and producing and exchanging information with four aspects [46]. The ICILS 2018 framework is a modification of the ICILS 2013 framework, which resulted in four strands, each with two aspects [45]. The four strands of the ICILS 2018 framework are: understanding computer use, gathering information, producing information and digital communication.

In its effort to contribute to the better understanding and development of digital competence in Europe, the European Commission developed the Digital Competence Framework (DigComp) [29]. The DigComp framework describes the components of digital competence in terms of the knowledge, skills and attitudes needed to be digitally competent. DigComp version 2.2 was a combination of 21 competences grouped into 5 main areas (Information and data literacy; Communication and collaboration; Digital content creation; Safety; and Problem-solving), which outline what digital competence entails [47]. DigComp 2.2 was a detailed and comprehensive DL framework that focused on examples of the knowledge, skills and attitudes applicable to each competence [47].

In the literature, organizations and nations have designed digital literacy frameworks to suit their local populations and transform learners. Additionally, groups of researchers and practitioners have worked to review digital literacy frameworks, with differing scopes and foci.

For higher learning institutions, College [48] provided a framework to help students reflect on the digital skills and critical perspectives they developed while in college; and UNESCO developed a framework to ensure youth/adults achieved at least a minimum level of proficiency in digital literacy skills [49]. In Australia, Johnston [50] developed a framework that outlined the skills and capabilities that students needed to succeed in the workforce. In the context of supply chain and port operation management, Kurnia et al. [51] proposed a digital literacy framework that could be used to assess and guide the development of digital skills in the context of supply chain and logistics management.

Governments have also developed frameworks. In Singapore, Ei and Soon [52] developed a comprehensive and unifying digital skills framework to strengthen policy coherence across different domains. Individual scholars have also developed digital literacy frameworks. Phuapan et al. [31] developed a framework that helped to identify digital literacy indicators and competences. McKinstry et al. [53] tested the usefulness of a digital literacy framework and mapping tool in identifying opportunities for students to develop their digital literacy within an entry-level occupational therapy program.

For the operationalization of digital literacy in the context of the agricultural production of smallholder farmers, we define digital literacy as competencies and knowledge that can help them identify, access, utilize and share agricultural information for enhanced agricultural productivity. This definition requires smallholder farmers to either own or have access to digital devices and to be literate (be able to read and write). Provided the communication infrastructure (e.g., the Internet) is available, smallholders can use digital devices to access, utilize and share agricultural information. Simple digital literacy skills can be demonstrated when using social media applications and sites such as Facebook, WhatsApp, Instagram and Twitter. Individuals with advanced skills are expected to access different websites, use search engines to find information and even download and upload content to the Internet. Based on this, a farmer demonstrates digital literacy in the following way:

**Access:** ability to identify/locate the source of data and retrieve such data, for repetitive usage;
**Manage**: includes collecting, classifying, storing, securing, and tracking information;
**Integrate:** to interpret and represent information, which may involve summarizing, inferring, comparing, contrasting and explaining information;
**Evaluate:** judging the quality, relevance, and usefulness of information based on criteria and standards;
**Create:** generating information by adapting, applying, designing, inventing or authoring information;
**Communicate:** ability to contact and interact with other individuals in the digital environment.

Adopted from Katz [54].

The first five components also represent a continuum of skills and knowledge as per the ICT Literacy Panel [19]. Using digital devices like mobile phones, computers, etc., farmers can identify and retrieve agricultural information of interest for use in their agricultural activities. Such digital devices can be installed with applications that can help farmers to manage the agricultural information. Farmers can interpret the agricultural information they access and make judgements about its quality and relevance, and whenever possible, farmers can share such information with others. DL can make farmers confident and critical and help them make creative use of digital technologies to achieve their goals in agriculture [29]. The digital literacy competencies include the ability to use digital software and hardware, which includes cognitive, motoric, sociological, and emotional skills [18].

Based on the literature on digital literacy skills, this study proposed the factors in Table 1. The factors are anticipated to help us understand the literacies of smallholder farmers, including their ability to: use digital tools; understand digital practices; find agricultural-related information; use information accessed or collected; and create and share agricultural-related information. With regard to smallholder farmers in their agricultural production activities, after several discussions, the researchers agreed to describe the factors as presented in Table 1.

Based on the above-mentioned factors, one can assess and measure the digital literacy of smallholder farmers. But how is digital literacy measured? Scholars have conceptualized the concept of digital literacy differently. Different factors have been adopted while learning about the concept of digital literacy. There is no exhaustive list of factors that can be used to conceptualize the construct of digital literacy. Likewise, there is no common approach to measuring the level of digital literacy, as scholars have measured the concept differently. To develop the measurement of digital literacy indicators for Thai undergraduate students, Techataweewan and Prasertsin [55] used confirmatory factor analysis; while investigating students' digital literacy skills in Yogyakarta, Perdana et al. [56] used descriptive statistics and independent sample *t*-test; and Deursen et al. [57] suggested the use of factor analysis to measure Internet skills.

**Table 1.** Conceptualizing factors for digital literacy of smallholder farmers.

| Factors | Descriptions |
| --- | --- |
| Access | Ability to navigate online through different websites, to locate agricultural information sources online, to retrieve agricultural information, and to search agricultural information online using search engines like Google |
| Manage | Ability to collect agricultural information found online, to classify agricultural information collected online, and to store agricultural information found online |
| Integrate | Ability to interpret agricultural information found online, to summarize agricultural information found online, and to share such agricultural information |
| Evaluate | Ability to critically assess agriculturally information found online, to compare such agricultural information, to check the usefulness of such agricultural information, to assess validity and credibility of agricultural information accessed online, and to judge for the quality and relevance of agricultural information accessed online |
| Create | Ability to demonstrate knowledge of 'copy, 'cut', 'paste' and 'undo' skills online, to create agricultural information and post it online and to make basic editing to content produced by others online |
| Communicate | Ability to contribute to online discussion on agriculture matters, to share agricultural knowledge with others online, to post queries on agriculture matters online and to use online access to help make decisions |

Based on the above understanding and the lack of clear factors and procedures to guide in assessing digital literacy, the researchers decided to consider the agricultural sector and study the digital literacy of smallholder farmers. It was felt that the research results would be beneficial to the sector and help develop smallholders' digital literacy skills while improving their quality of life and possibly engaging more people in the sector. The results could also lead the government and responsible institutions to strengthen the provision of ICT training. The factors proposed could help to gauge the ability of institutions providing ICT training. It is hoped that the research results can lead to the development of strategies to develop digital literacy skills in different sectors in the future.

## 2. Materials and Methods

### *2.1. Method*

The research started by scanning through the literature to capture the concept of digital literacy. This helped to identify six factors to guide the study of digital literacy. A thorough literature review helped us to learn about and identify items that described each factor. These items helped us to design questions that assessed individuals' digital literacy level in the six factors. The factor Access had six items: Manage and Integrate had three items each, Evaluate had five items, and Create and Communicate had four items each. Responses to these questions were considered within a 5-point Likert scale (where 1—Very low and 5—Very high). These questions, together with questions capturing demographic characteristics, composed a self-reported questionnaire.

Research participants were smallholder farmers from three districts in Tanzania: Hai in Kilimanjaro, Muheza in Tanga, and Kilosa in the Morogoro region. Due to good climate and arable soils, smallholder farmers in the selected regions grow various cash and food crops. The regions are also among the key crop-producing regions in Tanzania. The major food crops grown in the Morogoro region are maize, rice, sorghum, bulrush millets, and beans, whereas the main cash crops include sugarcane, rice, cotton, sisal, and tobacco [58]; maize, beans, bananas, potatoes, sweet potatoes, and cassava are commonly grown in Kilimanjaro [59]; and in Tanga, the food crops grown include maize, beans, yams, banana, and cassava, while commercial crops include spices (cardamom, cinnamon, clove, and black

pepper), sugarcane, fruits (jackfruit), and some horticultural produce (tomatoes, onions, leafy vegetables) [60].

Through use of questionnaire data were collected from smallholder farmers in the three districts. Smallholder farmers were randomly approached and asked to participate in the research, provided they had a digital device that enabled them to access the Internet. The survey was conducted by experienced researchers who, with support from local assistants, visited smallholder farmers in their villages and asked them to participate in the study.

### *2.2. Data Collection*

Though we conducted a pilot study to pretest the data collecting instrument, the results did not help to improve the questionnaire. Smallholder farmers who volunteered to participate in the study were requested to gather at identified centers. Instructions were provided by researchers, and participants were asked to respond to all questions individually without support from their peers, except from the researchers. In the questions assessing digital literacy, smallholder farmers were required to score the level of their literacy. Regarding ethics, the data collected were encoded to prevent the identification of the digital literacy of certain individuals.

### *2.3. Data Analysis*

Data were analyzed using SPSS 20.0 and Amos 26 software. Descriptive statistics in the form of numbers and percentages were calculated to analyze demographic characteristics, digital devices ownership, training attended, and levels of digital literacy (this was also represented in a bar chart). To test the relationship between the six factors and the underlying latent construct, digital literacy, a confirmatory factor analysis using the maximum likelihood estimator algorithm was employed. Then, model fit indices were determined. Both the reliability and validity of the model were assessed. A total item score was calculated by adding up each score within that item; the minimum score for each item was 1, and the maximum was 5. Item mean score and overall mean score for the responses were calculated and compared based on demographic characteristics using a *t*-test for two variables and ANOVA for three variables. Scores were categorized as low and high levels of digital literacy based on the mean, which was taken as a cut-off. The higher the score, the higher the digital literacy level. The scores less than or equal to the mean were considered as low digital literacy, and scores above the mean were considered as high digital literacy. A comparison of low and high levels of digital literacy with demographic variables was conducted.

## 3. Results

### *3.1. Demographics*

A total of 257 smallholder farmers from Hai, Kilosa and Muheza districts participated in the study. Over a half (i.e., 59.0%) were males, and 104 (40.9%) were females. Most smallholder farmers had a primary (i.e., 44.1%) and secondary (i.e., 43.0%) education. The research involved 33 (13.0%) smallholders with university degrees. The age ranged between 19 and 71 years; 32.7% had an age below 30 years, 45.7% had an age between 30 and 50 years, and 21.7% had an age above 50 years. The average age was 38.89 years, with a standard deviation of 12.77 signifying that smallholders of different ages were involved in the research. Table 2 summarizes the demographic characteristics of the respondent smallholder farmers involved in the research.

**Table 2.** Demographic characteristics of smallholder farmers.

| Characteristic | | | Female n (%) | | Male n (%) | |
|---|---|---|---|---|---|---|
| District | | Hai | 75 | 29.50 | 60 | 23.60 |
| | | Kilosa | 18 | 7.10 | 44 | 17.30 |
| | | Muheza | 11 | 4.30 | 46 | 18.10 |
| Educational level | | Primary | 45 | 17.70 | 67 | 26.40 |
| | | Secondary | 39 | 15.40 | 70 | 27.60 |
| | | University | 20 | 7.90 | 13 | 5.10 |
| Age in years | | 19–30 | 32 | 12.60 | 51 | 20.10 |
| | | 31–50 | 50 | 19.70 | 66 | 26.00 |
| | | 51–71 | 22 | 8.70 | 33 | 13.00 |
| | Mean | 38.89 | | | | |
| | SD | 12.77 | | | | |

The ownership of digital devices by smallholder farmers, as well as the training they had attended on computers and on access to information, are presented in Table 3. Most respondents indicated that they owned digital devices, i.e., mobile devices like smartphones, tablets and laptop computers. The majority owned smartphones, and a few owned tablets and laptops. A few had attended training, e.g., 15.2% had attended basic computer skills training; 31.5% had attended training on accessing online agricultural extension information; 33.9% had attended training on social media use; and 43.6% had attended training on accessing online agricultural market information. Moreover, a few respondents (i.e., 29.6%) had social media account.

**Table 3.** Ownership and Digital training.

| Ownership and Training | Yes | | No | |
|---|---|---|---|---|
| | n | % | n | % |
| Digital device ownership | 237 | 92.2 | 16 | 6.2 |
| Attended basic computer training | 39 | 15.2 | 186 | 72.4 |
| Attended training on accessing online agricultural extension information | 81 | 31.5 | 146 | 56.8 |
| Attended training on social media use | 87 | 33.9 | 142 | 55.3 |
| Attended training on accessing online agricultural market information | 112 | 43.6 | 115 | 44.7 |
| Have social media account like Facebook | 76 | 29.6 | 175 | 68.1 |

### *3.2. Measuring Digital Literacy*

#### 3.2.1. Confirmatory Factor Analysis

The study identified 6 factors for measuring the digital literacy of smallholder farmers, with a total of 25 items. To test the hypothesis that a relationship between the observed variables (i.e., the six factors) and their underlying latent construct, digital literacy, exists, a confirmatory factor analysis (CFA) was employed. The CFA procedure was conducted with the maximum likelihood estimator (MLE) algorithm, which, according to Finch et al. [61], is the most popular normal theory estimator because it has been found to produce asymptotically unbiased, consistent estimates of parameters.

The analysis started by including all the 25 items of the 6 factors into the CFA model of digital literacy. After performing the initial analysis, two factors were deleted as their factor loadings were <0.5. The CFA model was re-run, and all model fit indices were found to be within the acceptable level, and the factor loadings of all 23 items were >0.5. The model fit measures used to assess the model's overall goodness of fit were CMIN/df, GFI, CFI, TLI, SRMR and RMSEA. The six factors model yielded a good fit for the data, as presented in Table 4. The values obtained were CMIN/df = 2.458, GFI = 0.972, CFI = 0.933,

TLI = 0.915, SRMR = 0.0671 and RMSEA = 0.075, and all were within their respective acceptable levels [62,63]. Values for the factor loading (LD) can be observed in Table 5.

**Table 4.** Model fit indices.

| Fit Indices | Recommended Value | Value Obtained | Status |
|---|---|---|---|
| *p* | Insignificant | 0.000 | Pass |
| CMIN/DF | 3–5 | 2.458 | Pass |
| GFI | >0.90 | 0.972 | Pass |
| CFI | >0.90 | 0.933 | Pass |
| TLI | >0.90 | 0.915 | Pass |
| SRMR | <0.08 | 0.0671 | Pass |
| RMSEA | <0.08 | 0.075 | Pass |

**Table 5.** Establishing the reliability and validity of a confirmatory factor analysis model.

| Factor | | LD * | CA ** | CR | AVE |
|---|---|---|---|---|---|
| Access (ACC) | | | 0.908 | 0.912 | 0.721 |
| AC1 | Ability to navigate online through different websites | 0.812 | | | |
| AC2 | Ability to locate the agricultural information sources online | 0.901 | | | |
| AC3 | Ability to retrieve agricultural information online | 0.883 | | | |
| AC4 | Ability to search for agricultural information online using Google | 0.796 | | | |
| Manage (MNG) | | | 0.890 | 0.891 | 0.731 |
| MN1 | Ability to collect agricultural information online | 0.876 | | | |
| MN2 | Ability to classify agricultural information collected online | 0.862 | | | |
| MN3 | Ability to manage agricultural information found online and store it for future use | 0.826 | | | |
| Integrate (INT) | | | 0.861 | 0.866 | 0.683 |
| IT1 | Ability to interpret agricultural information found online | 0.831 | | | |
| IT2 | Ability to summarize agricultural information found online | 0.880 | | | |
| IT3 | Ability to share agricultural information found online | 0.764 | | | |
| Communicate (COM) | | | 0.927 | 0.928 | 0.763 |
| CM1 | Ability to contribute to an online discussion on agriculture or on social media | 0.858 | | | |
| CM2 | Ability to share agricultural knowledge with others online | 0.884 | | | |
| CM3 | Ability to post queries on agriculture matters online | 0.886 | | | |
| CM4 | Agricultural information accessed online or on social media helps me to make decision related to agricultural activities | 0.866 | | | |

**Table 5.** *Cont.*

| Factor | | LD * | CA ** | CR | AVE |
|---|---|---|---|---|---|
| Create (CRT) | | | 0.917 | 0.918 | 0.737 |
| CR1 | Ability to demonstrate the knowledge of copy, cut, paste and undo skills online | 0.754 | | | |
| CR2 | Ability to create agricultural information and post it online | 0.871 | | | |
| CR3 | Ability to produce simple digital content in at least one format using digital tools | 0.917 | | | |
| CR4 | Ability to make basic editing to content produced by others | 0.883 | | | |
| Evaluate (EVL) | | | 0.889 | 0.895 | 0.633 |
| EV1 | Ability to critically assess agricultural information found online | 0.653 | | | |
| EV2 | Ability to compare agricultural information accessed online with that from other sources | 0.832 | | | |
| EV3 | Ability to check usefulness of agricultural information accessed online based on prescribed criteria and standards | 0.916 | | | |
| EV4 | Ability to assess the validity and credibility of agricultural information accessed online using a range of criteria | 0.840 | | | |
| EV5 | Ability to judge the quality and relevance of agricultural information accessed online | 0.708 | | | |

CA **—Cronbach's Alpha, LD *—Loading.

However, once the requirements of the measurement model fit had been met, it was necessary to inspect the construct reliability and validity of the model [64]. The construct reliability was assessed using Cronbach's Alpha and composite reliability; convergent validity and discriminant validity were used to assess the validity of the model. Cronbach's Alpha assesses the extent to which indicators measuring the same construct are associated with each other [65]. The value of Cronbach's Alpha for an item should exceed the required limit of 0.7 [66]. The values of Cronbach's Alpha obtained were between 0.861 and 0.927. The composite reliability (CR) assesses the contribution of an item and is estimated based on the factor loading analysis of every item in the construct. The minimum recommended value of CR is 0.7 [65], and the values obtained were between 0.866 and 0.928. Thus, CR was derived for the model. Hence, as presented in Table 5, construct reliability was established for each factor in the model.

The convergent validity refers to the correlation between the responses of different variables in assessing the same construct and is assessed through computing the average variance extracted (AVE) [67]. The AVE values are required to be over the threshold value of 0.5 [65]. As presented in Table 5, the model has convergent validity.

Discriminant validity refers to the extent to which the constructs actually differ from one another empirically [67]. Discriminant validity contributes toward demonstrating the distinction of one construct from another and is assessed through developing the Discriminant Validity Index Summary. Discriminant validity exists if the correlation value between the two constructs is less than the square root of the AVE value [68]. Thus, this measurement model for digital literacy constructs achieved the discriminant validity values depicted in Table 6.

**Table 6.** Discriminant validity in confirmatory factor analysis model.

| Factor | AVE | MSV | MaxR(H) | CRT | ACC | MNG | INT | EVL | COM |
|---|---|---|---|---|---|---|---|---|---|
| Create | 0.737 | 0.498 | 0.930 | 0.858 | | | | | |
| Access | 0.721 | 0.689 | 0.920 | 0.281 | 0.849 | | | | |
| Manage | 0.731 | 0.689 | 0.893 | 0.322 | 0.830 | 0.855 | | | |
| Integrate | 0.683 | 0.417 | 0.876 | 0.502 | 0.579 | 0.646 | 0.826 | | |
| Evaluate | 0.633 | 0.258 | 0.921 | 0.393 | 0.419 | 0.350 | 0.508 | 0.796 | |
| Communicate | 0.763 | 0.498 | 0.929 | 0.706 | 0.373 | 0.369 | 0.502 | 0.377 | 0.874 |

Hence, with the fulfilment of all reliability and validity conditions, the confirmatory factor analysis model is effective for assessing the contribution of the factors when measuring digital literacy levels. The Digital Literacy Scale has 6 factors and 23 items measured on a 5-point Likert-type scale.

### 3.2.2. Digital Literacy Level

Figure 1 presents the digital literacy levels of smallholder farmers based on the six factors. The figure shows that one can distinguish the digital literacy skill levels of smallholder farmers. As per Schreiber and Schmitz [69], this measure of the digital literacy of smallholder farmers has discrimination power due to its ability to distinguish between factors being assessed. The level "High" has the highest value for every factor, and the level "Very low" has the lowest value for each factor.

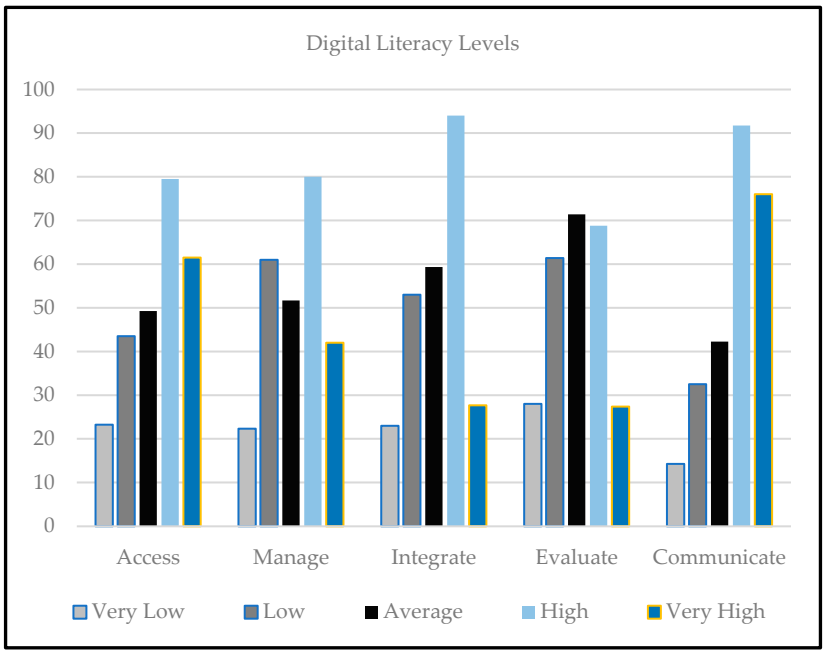


**Figure 1.** Digital literacy levels of smallholder farmers.

Table 7 presents the descriptive statistics for the 23 items of the 6 factors measuring the DL levels of smallholder farmers. The results reveal that DL levels vary per factor, items of the same factor have different values. An individual smallholder farmer demonstrates a high level of digital literacy when s/he scores "High" or "Very high" levels; the farmer demonstrates a low level of digital literacy when they achieve the levels "Low" or "Very low". Then, the results revealed that smallholder farmers have high DL levels related to two factors, i.e., their ability to communicate digital information (the score for every item was above 60%), followed by ability to access digital information (the score for every item was above 50%). For these two factors, knowledge related to one factor leads to the other, i.e., someone who knows how to communicate digital information is likely to understand

how to access digital information. Knowledge of the two factors is also influenced by the ownership of digital devices, as presented in Table 3.

**Table 7.** The levels of digital literacy skills of smallholder farmers.

| | N (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Factor-Item** | **Very Low (1)** | | **Low (2)** | | **Average (3)** | | **High (4)** | | **Very High (5)** | |
| **Access** | | | | | | | | | | |
| AC1 | 35 | 13.6 | 43 | 16.7 | 46 | 17.9 | 80 | 31.1 | 53 | 20.6 |
| AC2 | 17 | 6.6 | 46 | 17.9 | 46 | 17.9 | 93 | 36.2 | 55 | 21.4 |
| AC3 | 18 | 7.0 | 42 | 16.3 | 46 | 17.9 | 86 | 33.5 | 65 | 25.3 |
| AC4 | 23 | 8.9 | 43 | 16.7 | 59 | 23.0 | 59 | 23.0 | 73 | 28.4 |
| Manage | | | | | | | | | | |
| MN1 | 22 | 8.6 | 67 | 26.1 | 44 | 17.1 | 84 | 32.7 | 40 | 15.6 |
| MN2 | 25 | 9.7 | 64 | 24.9 | 54 | 21.0 | 79 | 30.7 | 35 | 13.6 |
| MN3 | 20 | 7.8 | 52 | 20.2 | 57 | 22.2 | 77 | 30.0 | 51 | 19.8 |
| Integrate | | | | | | | | | | |
| IT1 | 20 | 7.8 | 64 | 24.9 | 50 | 19.5 | 89 | 34.6 | 34 | 13.2 |
| IT2 | 26 | 10.1 | 51 | 19.8 | 62 | 24.1 | 99 | 38.5 | 19 | 7.4 |
| IT3 | 23 | 8.9 | 44 | 17.1 | 66 | 25.7 | 94 | 36.6 | 30 | 11.7 |
| Evaluate | | | | | | | | | | |
| EV1 | 27 | 10.5 | 43 | 16.7 | 72 | 28 | 79 | 30.7 | 36 | 14 |
| EV2 | 26 | 10.1 | 58 | 22.6 | 79 | 30.7 | 70 | 27.2 | 24 | 9.3 |
| EV3 | 29 | 11.3 | 68 | 26.5 | 72 | 28.0 | 67 | 26.1 | 21 | 8.2 |
| EV4 | 30 | 11.7 | 72 | 28.0 | 70 | 27.2 | 61 | 23.7 | 24 | 9.3 |
| EV5 | 28 | 10.9 | 66 | 25.7 | 64 | 24.9 | 67 | 26.1 | 32 | 12.5 |
| Create | | | | | | | | | | |
| CR1 | 37 | 14.4 | 60 | 23.3 | 52 | 20.2 | 71 | 27.6 | 37 | 14.4 |
| CR2 | 33 | 12.8 | 65 | 25.3 | 49 | 19.1 | 76 | 29.6 | 34 | 13.2 |
| CR3 | 38 | 14.8 | 61 | 23.7 | 50 | 19.5 | 75 | 29.2 | 33 | 12.8 |
| CR4 | 33 | 12.8 | 60 | 23.3 | 52 | 20.2 | 76 | 29.6 | 36 | 14.0 |
| Communicate | | | | | | | | | | |
| CM1 | 16 | 6.2 | 45 | 17.5 | 40 | 15.6 | 93 | 36.2 | 63 | 24.5 |
| CM2 | 15 | 5.8 | 37 | 14.4 | 42 | 16.3 | 103 | 40.1 | 60 | 23.3 |
| CM3 | 14 | 5.4 | 27 | 10.5 | 52 | 20.2 | 92 | 35.8 | 72 | 28.0 |
| CM4 | 12 | 4.7 | 21 | 8.2 | 35 | 13.6 | 80 | 31.1 | 109 | 42.4 |

The score for the level average in different items was between 13.6% and 30.7%. Thirteen items (i.e., over a half) were rated average by over 20% of respondents. The average level for the factor Evaluate was between 24.9% and 30.7%, while for the factor Create it was between 18.7% and 20.2%. The range for the level average for other factors is not large, signifying that nearly the same number of respondents rated the items the same in the factor. In general, some smallholders had average level of digital literacy.

The low level of digital literacy ranged between 12.8% and 39.7%, and over 20% rated low for 21 items. The low level was significant in all factors: in the factor ability to create digital information, it ranged between 36.2% and 39.3%; in the factor ability to evaluate information, it ranged between 27.2% and 39.7%; in the factor ability to manage digital information, it ranged between 28.0% and 34.6%; and in the factor access to digital information, it ranged between 24.9% and 32.3%. The results show that smallholder farmers had low digital literacy in four factors: Manage, Integrate, Evaluate, and Create. The four factors require digital competencies and skills for executing them. For example, to interpret information accessed online, to judge the quality of online information based on criteria and standards, and to contrast and explain online information, some knowledge is required. As most smallholders had primary and secondary education (Table 2), they might lack knowledge of the four factors. Furthermore, Table 3 shows that the majority of smallholders had not attended training related to computers, thus they lacked skills related to the four factors. Low ratings of digital literacy were greater in the ability to

evaluate digital information factor; for example, 39.7%% had no ability to assess the validity and credibility of online agricultural information, and 37.7% had no ability to assess the usefulness of agricultural information accessed online. Based on the ability to create digital information, 39.3% had no 'copy', 'cut', 'paste' and 'undo' skills, and 38.1% had no ability to create agricultural information and post it online.

The overall mean score to various items, as represented in Table 8, reveals that most of the responses were average. Mean responses for all items in the factors Access and Integrate, and in most items of other factors, were average. On the other hand, a few items in the factors Manage, Evaluate and Create had low mean responses, while six items in the factor Communicate had high mean responses. A mean item score comparison based on demographic variables showed a significant difference for EV4, EV5, CR3, CM1 and CM2 items under the gender variable. Educational level showed a significant difference for all items in the factor Communicate and items AC2, AC3, MN1, MN2, EV1, EV3, EV4 and CR4. Age group only revealed a significant difference for items AC3, AC4 and CR4. All items in the factor Integrate did not show any significant difference under all the three demographic variables.

One can ask why do the smallholder farmers demonstrate different levels of skills in the six factors studied? Usually, digital device owners, including smallholder farmers, use digital devices for accessing and communicating digital information. In doing so, they learn how to use digital devices to access and communicate information and thus improve their experience. Factors such as create, integrate, manage and evaluate digital content require more analytical skills, which can allow individuals to observe, collect, interpret and use the information accessed. Analytical skills can enable an individual to identify the source of information, analyze information, make decisions, and use the solution to solve the prevailing problems. Analyzing and evaluating information can enable an individual to spot trends in the data. In this respect, the majority of smallholder farmers have no ability to find and access online agricultural information and assess its usefulness. Additionally, they cannot assess the validity and credibility of online agricultural information and judge its quality and relevance. The majority have no skills to create and post agricultural content online. Thus, low digital literacy may be a barrier to online participation for some smallholder farmers.

Based on the demographic characteristics gender, age group and level of education level, digital literacy was categorized as low and high (Table 9). A significantly higher number of respondents reported high digital literacy (58.0%). The overall mean score for the 23 items was 75.17 $\pm$ 5.79, with variables such as male, 31–50 years age group, and primary education level having significantly low mean score. Variables such as university education and age <30 years have a significantly higher mean score. The results show that females outperformed males in digital literacy. While studying the ICT literacy of students, Inan Karagul et al. [70] related digital literacy with gender, and Kim et al. [71] found that female students outperformed male students at the ICT level. Another study by Rizal et al. [72] concluded that there was a difference in digital literacy between male and female prospective physics teachers, and males had higher digital literacy than females. Interestingly, Anzak and Sultana [73] argued that the digital literacy skills of women enabled them to be active members of the digital world and improved their participation in social and economic life. One can say 'the more one is educated the more digital literate s/he becomes', as the mean score based on age increased with educational level. Furthermore, youths (i.e., lower age group) are more digitally literate as they work more with digital devices. To be successful in their activities, youths need to competently use digital devices and define, access, understand, create, communicate and evaluate digital information. They also need to respect online norms and values and work online without compromising their own privacy and safety. Peng and Yu [74] argued that parents who possess a higher level of education can guide their children to use digital devices.

**Table 8.** Item-wise mean score comparison based on demographic variables.

| | Gender | | | Education | | | | Age | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item** | **Male** | **Female** | | **Primary** | **Secondary** | **University** | | **<=30** | **31–50** | **>50** | |
| | **Mean ± SD** | **Mean ± SD** | **Sign** | **Mean ± SD** | **Mean ± SD** | **Mean ± SD** | **Sign.** | **Mean ± SD** | **Mean ± SD** | **Mean ± SD** | **Sign.** |
| AC1 | 3.43 ± 1.36 | 3.09 ± 1.23 | 0.11 | 3.05 ± 1.37 | 3.44 ± 1.28 | 3.61 ± 1.09 | 0.09 | 3.57 ± 1.24 | 3.22 ± 1.33 | 3.02 ± 1.31 | 0.45 |
| AC2 | 3.61 ± 1.22 | 3.28 ± 1.10 | 0.26 | 3.27 ± 1.25 | 3.64 ± 1.09 | 3.70 ± 1.13 | 0.05 * | 3.61 ± 1.13 | 3.42 ± 1.24 | 3.42 ± 1.12 | 0.23 |
| AC3 | 3.66 ± 1.24 | 3.34 ± 1.21 | 0.92 | 3.42 ± 1.36 | 3.61 ± 1.17 | 3.64 ± 0.90 | 0.00 * | 3.75 ± 1.10 | 3.44 ± 1.31 | 3.38 ± 1.21 | 0.01 * |
| AC4 | 3.60 ± 1.34 | 3.24 ± 1.24 | 0.11 | 3.24 ± 1.37 | 3.56 ± 1.26 | 3.82 ± 1.07 | 0.15 | 3.65 ± 1.16 | 3.46 ± 1.42 | 3.13 ± 1.20 | 0.00 * |
| MN1 | 3.43 ± 1.26 | 2.89 ± 1.13 | 0.16 | 2.98 ± 1.31 | 3.40 ± 1.20 | 3.33 ± 0.92 | 0.01 * | 3.45 ± 1.11 | 3.13 ± 1.26 | 3.00 ± 1.29 | 0.22 |
| MN2 | 3.29 ± 1.24 | 2.93 ± 1.16 | 0.21 | 2.95 ± 1.33 | 3.30 ± 1.12 | 3.24 ± 1.06 | 0.04 * | 3.35 ± 1.15 | 3.13 ± 1.20 | 2.84 ± 1.30 | 0.46 |
| MN3 | 3.53 ± 1.26 | 3.08 ± 1.12 | 0.07 | 3.18 ± 1.30 | 3.54 ± 1.17 | 3.21 ± 1.05 | 0.21 | 3.52 ± 1.09 | 3.25 ± 1.29 | 3.25 ± 1.25 | 0.11 |
| IT1 | 3.15 ± 1.19 | 3.28 ± 1.18 | 0.55 | 3.15 ± 1.26 | 3.23 ± 1.14 | 3.30 ± 1.07 | 0.41 | 3.21 ± 1.10 | 3.20 ± 1.24 | 3.20 ± 1.21 | 0.54 |
| IT2 | 3.12 ± 1.16 | 3.14 ± 1.09 | 0.30 | 3.00 ± 1.22 | 3.20 ± 1.09 | 3.36 ± 0.90 | 0.12 | 3.12 ± 1.08 | 3.12 ± 1.19 | 3.18 ± 1.09 | 0.66 |
| IT3 | 3.23 ± 1.17 | 3.28 ± 1.12 | 0.24 | 3.08 ± 1.23 | 3.36 ± 1.08 | 3.45 ± 1.00 | 0.20 | 3.44 ± 1.07 | 3.11 ± 1.20 | 3.25 ± 1.11 | 0.64 |
| EV1 | 3.19 ± 1.24 | 3.23 ± 1.13 | 0.14 | 3.14 ± 1.33 | 3.20 ± 1.11 | 3.48 ± 0.91 | 0.01 * | 3.33 ± 1.10 | 3.14 ± 1.23 | 3.18 ± 1.25 | 0.56 |
| EV2 | 2.86 ± 1.15 | 3.27 ± 1.07 | 0.39 | 2.98 ± 1.22 | 3.01 ± 1.05 | 3.27 ± 1.10 | 0.32 | 3.31 ± 1.10 | 2.82 ± 1.11 | 3.05 ± 1.15 | 0.84 |
| EV3 | 2.75 ± 1.16 | 3.17 ± 1.08 | 0.10 | 2.80 ± 1.26 | 2.99 ± 1.04 | 3.21 ± 0.99 | 0.01 * | 3.10 ± 1.14 | 2.77 ± 1.10 | 3.04 ± 1.22 | 0.40 |
| EV4 | 2.83 ± 1.22 | 3.02 ± 1.09 | 0.01 * | 2.81 ± 1.28 | 2.94 ± 1.09 | 3.18 ± 0.95 | 0.03 * | 3.00 ± 1.11 | 2.81 ± 1.17 | 2.98 ± 1.24 | 0.67 |
| EV5 | 2.90 ± 1.29 | 3.23 ± 1.06 | 0.00 * | 3.06 ± 1.30 | 2.94 ± 1.15 | 3.27 ± 1.04 | 0.17 | 3.12 ± 1.10 | 2.81 ± 1.28 | 3.40 ± 1.12 | 0.27 |
| CR1 | 2.98 ± 1.32 | 3.08 ± 1.28 | 0.40 | 2.95 ± 1.34 | 3.05 ± 1.30 | 3.18 ± 1.18 | 0.72 | 3.02 ± 1.30 | 2.94 ± 1.32 | 3.20 ± 1.28 | 0.90 |
| CR2 | 2.94 ± 1.29 | 3.21 ± 1.22 | 0.17 | 2.94 ± 1.33 | 3.11 ± 1.19 | 3.24 ± 1.25 | 0.30 | 3.02 ± 1.28 | 3.00 ± 1.26 | 3.20 ± 1.25 | 0.99 |
| CR3 | 2.90 ± 1.35 | 3.19 ± 1.15 | 0.00 * | 2.90 ± 1.36 | 3.04 ± 1.24 | 3.33 ± 1.14 | 0.19 | 3.01 ± 1.19 | 2.89 ± 1.30 | 3.29 ± 1.36 | 0.09 |
| CR4 | 3.01 ± 1.29 | 3.20 ± 1.23 | 0.37 | 3.00 ± 1.38 | 3.13 ± 1.23 | 3.24 ± 0.94 | 0.02 * | 3.11 ± 1.10 | 2.99 ± 1.36 | 3.25 ± 1.29 | 0.01 * |
| CM1 | 3.41 ± 1.26 | 3.75 ± 1.12 | 0.01 * | 3.35 ± 1.38 | 3.68 ± 1.10 | 3.82 ± 0.85 | 0.00 * | 3.48 ± 1.11 | 3.62 ± 1.24 | 3.53 ± 1.30 | 0.28 |
| CM2 | 3.47 ± 1.19 | 3.79 ± 1.10 | 0.05 * | 3.43 ± 1.33 | 3.68 ± 1.05 | 3.97 ± 0.73 | 0.00 * | 3.51 ± 1.11 | 3.60 ± 1.21 | 3.76 ± 1.14 | 0.65 |
| CM3 | 3.64 ± 1.19 | 3.79 ± 1.09 | 0.18 | 3.50 ± 1.28 | 3.81 ± 1.05 | 4.06 ± 0.83 | 0.00 * | 3.61 ± 1.13 | 3.72 ± 1.18 | 3.82 ± 1.09 | 0.49 |
| CM4 | 3.95 ± 1.17 | 4.03 ± 1.13 | 0.26 | 3.83 ± 1.32 | 4.08 ± 1.04 | 4.18 ± 0.77 | 0.00 * | 3.86 ± 1.13 | 4.06 ± 1.19 | 4.02 ± 1.08 | 0.76 |

* $p < 0.05$ statistically significant.

**Table 9.** Levels of DL and mean score comparison based on demographic variables.

| Variable | | n (%) | | Mean ± SD |
|---|---|---|---|---|
| | | Low | High | |
| Gender | Male | 63 (42.0) | 87 (58.0) | 74.87 ± 5.96 |
| | Female | 45 (43.3) | 59 (56.7) | 75.51 ± 5.13 |
| Age | <30 years | 34 (40.5) | 50 (59.5) | 77.15 ± 5.45 |
| | 31–50 years | 50 (42.4) | 68 (57.6) | 73.64 ± 5.82 |
| | >50 years | 24 (43.6) | 31 (56.4) | 75.40 ± 5.79 |
| Education | Primary | 55 (48.7) | 58 (51.3) | 72.00 ± 6.28 |
| | Secondary | 44 (39.6) | 67 (60.4) | 76.92 ± 5.48 |
| | University | 9 (27.3) | 24 (72.7) | 80.12 ± 4.81 |
| Total | | 108 (42.0) | 149 (58.0) | 75.17 ± 5.79 |

## 4. Discussion

Digital literacy can be considered to represent the quality of being a member of a digital community. Digital communities rely on digital technologies such as mobile phones, the Internet and e-mail to communicate, network and disseminate information. Digital communities enable individuals to connect with more people across different geographical regions, thus increasing the potential for them to come across individuals with whom they have something in common. Traditionally, people form community connections based on geographical proximity. The Internet eradicates this reliance on physical space and distance, as time and location no longer matter in this digital community. One can work wherever s/he is, as a digital community removes logistical barriers of connectivity.

Among the many elements of digital literacy, the ability to create and communicate digital information, as well as interpret and judge its quality, is particularly important in this digital community. Knowledge of them enables an individual to investigate, create, and communicate digital information in order to participate effectively in daily dealings [46], including in agriculture. Sarbadhikari and Pradhan [75] insisted on using digital media ethically and safely to avoid the risk of many dangerous situations, such as losing important data, devices being hacked, incurring damage to one's reputation, financial losses, and many others. In this digital era, Gleason and Von Gillern [76] insisted that one should act "in ways that are safe, legal, and ethical". Considering the average age of respondent smallholders and the majority's educational level, there is a dilemma about whether they can act healthily online, consume safe and credible online information and create relevant content.

This research has revealed some observations. The majority of smallholder farmers do not have the literacy to create, manage and evaluate digital information, and their ability to interpret and judge the quality of digital information is poor. However, the majority of farmers can access and communicate digital information—a common phenomenon among owners of digital devices. It is evident that smallholder farmers require intervention in order to improve their digital literacy and to enable them to live in the current digital era. The factors Manage, Integrate, Evaluate and Create digital information were at unsatisfactory levels, and this presents the challenge of improving them. Low informational capabilities [77] and dependence on traditional methods of accessing agricultural information [78,79] may contribute to low digital literacy in this area. Common sources of agricultural information include interpersonal communication, farmer's groups/associations, input suppliers/agro-dealers and extension officers [79]. Barriers to online access like language constraints [80,81] may lower the confidence of smallholders when accessing digital information. In Tanzania, e-services are not much provided, and smallholders in rural areas may have no access to such services. Improved access to e-services may motivate more people, including smallholders, to adopt e-services in service deliveries.

A detailed analysis of the results yielded several discoveries. The vast majority of the smallholder farmers surveyed could make an evaluation of their digital literacy.

However, there were some that either overestimated or underestimated their literacy. The actual evaluation of digital literacy itself is made more difficult by the fact that there is no fixed framework by which to determine digital literacy level [82]. An underestimated or overestimated sense of digital literacy is a disadvantage as it may lead to inadequate or even false intervention strategies.

We noticed several factors that can hinder both the development and improvement of digital literacy in rural areas. The lack of communication infrastructure in some rural areas discourages the adoption of digital services. A lack of local content and use of foreign languages, predominantly English, which are not accessible to many, do not promote the available e-services. A thorough analysis reveals that digital literacy is a complex concept covering both social and technical aspects. Users are participating in social media, online forums and discussions. Technically, online users should understand how to use digital applications and services and should be aware of the safe, legal, and ethical issues while online. Knowledge in one area does not guarantee understanding in other areas. However, there is a positive correlation between all of the factors analyzed. Thus, when dealing with this digital literacy concept, we should understand its complex nature and, as per Tondeur et al. [83], we should understand that there is no exhaustive repository of digital literacy indicators at present.

Some strategies can motivate smallholder farmers to own and use digital devices. Increasing the use of digital devices in rural areas holds the potential to strengthen the informed participation of smallholder farmers by enabling them to use digital devices to access agricultural-related information. In this respect, in its national ICT policy, The United Republic of Tanzania [84] claimed that the use of electronic services to facilitate provision of social and economic services has significantly increased. The national ICT policy also encourages productive sectors like agriculture to incorporate ICTs in their development plans; the government is also committed to promoting and supporting the implementation of nationwide ICT systems for rural development and agriculture sector development activities [84]. In its national agricultural policy statement, The United Republic of Tanzania [85] acknowledged the need to strengthen the mechanisms for the collection, analysis and dissemination of agricultural information and data to various actors in the sector. The implementation of these plans will encourage smallholder farmers to adopt ICTs when accessing and delivering services, and thus help to develop their digital literacy. Improving the supporting infrastructure for the digital environment [82] is also a factor as it can influence more people to own digital devices. For example, providing electricity [86], mobile phone companies extending infrastructure to rural areas [87], and improving rural roads can influence digital device ownership, even in the rural areas where smallholder farmers live. Establishing electronic services, providing agricultural-related information to smallholder farmers, and encouraging farmers to use it can also be a strategy.

Some areas investigated require educational support and training. The results have indicated that smallholders are not provided with training to enable them to be active in this digital age. The ability to access, interpret, classify, share and manage information requires knowledge and skills that can be obtained through training. In addition to creating and sharing information online, the ability to assess the usefulness of online information, the ability to assess the validity and credibility of online information and the ability to judge the quality and relevance of online information need to be strengthened. Vulnerability to viruses, fake news, hoaxes, and manipulation have become challenges that every Internet user needs to be aware of [82]. With low digital literacy, smallholders are at risk of violating copyrights, for example, while using software, videos, and music during their agricultural activities. Thus, smallholder farmers need to improve their digital literacy through self-learning and self-education, or even by attending organized training.

## 5. Conclusions

This study provides an empirical component in the analysis of the digital literacy of smallholder farmers in their agricultural activities and aims to improve the use of ICTs in delivering agricultural services. During the research, we gathered new data regarding the digital literacy of smallholder farmers. Smallholders, with different demographic characteristics, have different levels of digital literacy. Scholars have acknowledged that education can improve digital literacy. One way of implementing this is by mainstreaming ICT curricula in primary and secondary education; the majority of smallholder farmers have these educational levels. As a strategy for ICT human capital development, the Tanzania government in its national ICT policy proposed the introduction of ICT as a subject in primary and secondary school curricula; however, its implementation is yet to be assessed.

Digital literacy consists of a dynamic combination of mindset, behaviors, and skills that are employed to enhance the literacies of smallholder farmers. The definition of digital literacy encompasses the ability to utilize and be aware of digital information, technology, and media for accessing, managing, integrating, evaluating, creating, and communicating as needed. An assessment of these factors indicated some difficulties with managing, integrating, evaluating, and creating digital information. Strategies to improve digital literacy can begin with these factors.

As the 2013 agricultural policy acknowledged the use of ICT in collecting, analyzing and disseminating agricultural-related information to actors in the sector, it is the right time for this to happen now. The responsible ministry can establish these mechanisms and also ensure that actors such as extension officers and smallholder farmers are equipped and are literate enough to utilize ICTs in their agricultural dealings. Information systems providing extension services, climate information, and agricultural market information can be very useful for rural smallholder farmers. With information systems, farmers can get advice on agricultural-related matters and can even change their practices from traditional to modern agriculture. Farmers can access good markets for their agricultural produce, for increased income. In this way, farmers can increase agricultural productivity and income, and the agricultural sector can employ more people and contribute to national growth.

The discussions we have outlined and the conclusions we have drawn from them may be used as the basis for further research into the digital literacy of smallholder farmers, especially their behaviors and the way they act while online; identifying the needs of smallholders in order to improve their digital literacy; and for motivating smallholders to develop their literacy in the use of digital technologies. This paper has been an attempt to measure digital literacy; on the other hand, it was intended to highlight the many contexts that can help to assess the concept of the digital literacy of smallholder farmers. The challenge of developing a standardized instrument to measure the digital literacy of farmers remains. Regardless of the approach and the results, the importance of improving the digital literacy of smallholder farmers in this era is clear.

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