Research article

A case study of the relationship between smallholder farmers' ICT literacy levels and demographic data w.r.t. their use and adoption of ICT for weather forecasting

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A B S T R A C T

Food insecurity caused by climate change has become one of the main issues on the global agenda. Worldwide, the importance of digital tools as a means to enhance adaptive capacity and resilience of smallholder farmers (SHFs) in the face of climate variability has long been recognised. Technology-based systems in agriculture frequently neglect to consider the actual context of use and adoption by SHFs in rural and developing contexts. These conditions, as pointed out in the literature, range from high "illiteracy" rates to poor technology infrastructure to a requirement for smartphone-based technology of which very few SHFs in the developing world can take advantage. However, very little is known about the information and communication technology (ICT) literacy levels of SHFs in general in terms of supporting them in their farming decisions. This paper, therefore, explores the ICT literacy levels of Msinga SHFs in order to understand what could enhance their use and adoption of ICT for weather forecasting. Msinga is a hotspot for climate change. Consequently, the means of livelihood of the SHFs in this municipality have been negatively impacted.

Volunteering sampling was used, in which 35 SHFs were purposively selected from a population of 100 SHFs who belong to the Asisukume Msinga Agricultural Cooperative (AMAC) – all irrigation farmers. A sequential transformative mixed method design, embedded in an Indigenous research framework, was employed. This paper reports on the quantitative aspects of the study which addressed the following two research questions: (i) What are Msinga SHFs ICT literacy capability levels? and (ii) What is the relationship between SHFs ICT levels and their demographic data w.r.t. their adoption of ICT tools in their agricultural practices? Data were collected using a demographic details questionnaire (examining age, marriage, educational level, and years of farming experience) and an assessment of ICT literacy (assessing 5 ICT literacy skills which included mobile phone symbol identification to advanced ICT literacy). Data were analysed using descriptive and inferential statistics, specifically the use of Spearman rank-order correlation using IBM® Statistical Package for the Social Science (SPSS®), version 20.

The results suggest that for the ICT literacy levels, SHFs were not able to display use of the various ICT related skills, with the exception of ICT levels 1 and 2 where satisfactory display of ICT literacy were displayed among most of the SHFs. When examining the associations between ICT literacy levels and the demographic variables, significant negative associations were found between the ICT literacy levels and age as well as years of experience, while significant positive associations were found between ICT literacy levels and educational level. The results, furthermore, suggest that marital status has no correlation with ICT literacy proficiency.

The findings arising from this study highlight the "importance of context" in helping SHFs to mitigate the threats of climate change on food production, an issue that is completely ignored in curriculum policies and policies aimed at integrated national adaptation responses to climate change impact and vulnerability.

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1. Introduction

1.1. Background to the study

Globally, the importance of digital tools as a means to enhance adaptive capacity and resilience of smallholder farmers (SHFs) in the face of climate variability has long been recognised. It is for this reason that the World Summit on the Information Society (WSIS) took the decision to make e-agriculture a priority (International Telecommunication Union, 2009, p. 26). Digital technologies are believed to have the "potential to end global poverty and hunger faster, including in rural parts of developing countries, where the majority of people earn their living from agriculture" (Kremer and Houngbo, 2021, para. 4). The affordances offered by the use of "mobile phones and other digital technologies to access customized, actionable agricultural information in real time" are believed to have the potential to "revolutionize how rural communities secure and improve their livelihoods" (Kremer and Houngbo, 2021, para. 5). Notwithstanding the above affordances, Harris and Achora (2018, p. 1) caution that technology-based systems in agriculture oftentimes fail "to consider the actual context of use and adoption by smallholder farmers in rural and developing contexts". These conditions, the authors argue, range from "high illiteracy rates to poor technology infrastructure to a requirement for smartphone-based technology of which very few smallholder farmers in the developing world can take advantage". Emeana et al. (2020) highlight the uneven distribution of the impact of this digital revolution, which Harris and Achora (2018) argue could further exacerbate the "digital divide". It is in this regard that some studies, particularly in Africa, question the impact and sustainability of this digital revolution (Emeana et al., 2020).

This study arose from a collaborative community research project which aimed at enhancing the ability of SHFs to adapt and mitigate the impacts of climate change in a rural area in Msinga[1], KwaZulu-Natal (KZN), South Africa. SHFs, community members, university researchers, and extension workers came together to reflect on this problem that was plaguing the farmers. The preliminary phase of the study identified SHFs' existing agricultural practices in relation to climate change adaptation. The second phase gathered the communities' perceptions regarding the possible integration of information and communication technology (ICT) into their agricultural practices. The results from the preliminary phase were encouraging because they clearly demonstrated that these SHFs were already using climate smart agricultural (CSA) practices in their farming. Thus, the next question explored how we can interface these CSA practices with ICT. In order to do this, it was imperative to ascertain the ICT literacy levels of the SHFs. This exploration enabled us to better understand the actual context of use and adoption of ICT by SHFs. The paper explores the ICT literacy levels of SHFs in Msinga, thereby elucidating factors that could enhance their capability to use ICT in weather forecasting to lessen the impacts of climate change and improve food production in their region.

All farmers, whether local or global, large or small, need reliable information about historic, current, and forecasted weather data to improve crop growth and earn sufficient income to support their families (Kroese, 2019). A variety of new digital applications, such as Connected Farmer[2] and Esoko or Tigo Kilimo (Tanzania) are now accelerating interventions that have been shown to improve productivity and growth in the agricultural sector (Warshauer, 2016). In South Africa, the AgriCloud Application (2019) by Rain for Africa (R4A) provides "agricultural

advisory services to farmers based on the best available weather and climate information at their specific location to help improve the quality and quantity of food production in a sustainable manner" (R4A, 2021, para. 1). Various types of weather-related data are available, including "manual observations, automatic weather stations, weather radars, satellite and weather forecast modelling output" (Kroese, 2019, para. 4). However, as Kroese (2019) argues, these data sources are often not accessible to or understood by a large majority of SHFs due to their low levels of ICT literacy.

The six main ICT tools available in the agricultural sector include mobile phones, television, radio, DVD/CD, Internet, and landline phones (Subashini and Fernando, 2017). Although the first three are easily accessed by farmers for agricultural related information and knowledge, mobile phones are the most widely used for social communication, marketing of produce, and contacting experts on a real-time basis for getting agricultural advice (Syiem and Raj, 2015).

"Food production is risky due, in part, to limited information about weather patterns, soil characteristics, future market demand, and other variables" (World Bank, 2011, p. vii). With limited information, farmers' decisions based on intuition are often less efficient than they could be. Many traditional methods of predicting and adapting to the changing climate are now inadequate and unreliable due to climate variability (Ackom, 2014). Several studies (Aleke and Nhamo, 2016; Ospina and Heeks, 2010; Shabajee et al., 2014) have therefore explored the various uses of ICT in farming:

- providing early warning systems for climate change;
- sharing knowledge of adaptation among concerned people;
- raising awareness of climate-related risks;
- coordinating disaster recovery information;
- supporting consultation and participation in developing adaptation policies;
- providing training in flood and risks management;
- providing data to aid adaptation decision-making; and
- collecting and analysing information for vulnerability assessments.

Additional key roles played by ICT in farming include the adaptation, monitoring, mitigating, and strategising of climate change related matters in Africa, Asia, and Latin America (Aleke and Nhamo, 2016; Ospina and Heeks, 2010; Shabajee et al., 2014); agro-information dissemination in Tanzania and India (Churi et al., 2013); and gaining access to markets (Beza et al., 2017). Nevertheless, the deployment of ICT alone is unlikely to combat the menace of climate change among SHFs (Yohannis et al., 2019). For this reason, Subashini and Fernando (2017) argue that integrating ICT with agriculture, particularly CSA, is pivotal to achieve sustainable development in the agricultural sector.

A number of studies (Chikaire et al., 2017; Nzonzo and Mogambi, 2016) reveal SHFs inadequate ICT literacy skills to integrate ICT into their farming practices. This was confirmed in Botswana (Lekopanye and Sundaram, 2017); Nigeria (Chikaire et al., 2017); Tanzania (Angello, 2015); and the Eastern Cape in South Africa (Chisango and Lesame, 2014). Yet the literature fails to specify how to develop SHFs ICT literacy levels (Chikaire et al., 2017). The low levels of ICT literacy skills invariably result in a digital divide and poverty among the rural communities, and is a possible barrier to the adoption of ICT in their agricultural practices. At present, there is a gap in the literature on SHFs' levels of ICT literacy capability and the acquisition thereof. Determining the ICT literacy levels of SHFs was therefore considered necessary for future construction of an innovative intervention aimed at their development.

2. Conceptual framework

2.1. ICT literacy defined

'ICT' is described by the World Bank's Agriculture and Rural Development division as an "umbrella term that includes anything ranging

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[1] The name means a current in the sea where air movement causes ripples on top of the water surface and ends up influencing the nearby climatic conditions through its breeze (Msinga Local Municipality, 2019).

[2] This is a mobile product which started in East Africa from a public-private partnership between Vodafone, USAID, and TechnoServe to help farmers work with agribusiness and better manage their crops and finances (Warshauer, 2016).

from radio to satellite imagery to mobile phones or electronic money transfers" (Salampasis and Theodoridis, 2013, p. 2). In this regard, ICTs are regarded as any device, tool, or application that permits the exchange or collection of data through interaction or transmission. The International ICT Literacy Panel defines 'ICT literacy' as using "digital technology, communication tools, and or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (Educational Testing Service, 2002, p. 2). This involves a continuum of skills and abilities "from daily life skills to the transformative benefits of ICT proficiency" (Educational Testing Service, 2002, p. 2), ranging from: (1) the ability to *access* information, which refers to "knowing about and knowing how to collect and/or retrieve" information; (2) the ability to *manage* information, which relates to applying an existing organisational or classification scheme (p. 2); (3) the ability to *integrate* information, which encompasses the ability to "interpret and represent information" (p. 2); (4) the ability to *evaluate* information, which entails "making judgments about the quality, relevance, usefulness, or efficiency of information"; and (5) the ability to *create,* which relates to "generating information by adapting, applying, designing, inventing, or authoring information" (p. 3). "These five components represent a set of skills and knowledge presented in a sequence that suggests increasing cognitive complexity" (p. 3).

A number of hinderances to the success and effectiveness of technology as a transformative tool are observed, including poor general literacy and limited skills in areas such as reading, numeracy, and problem solving.

2.2. The use of the ICT literacy definition to develop the 5 levels of the ICT literacy assessment tool (ILAT)

The study focused on the use of mobile phones – smartphones (SPs) and basic mobile phones (BMPs) – as mobile phones have been shown to be the most widely used form of ICT by farmers. In addition, in an attempt to understand the factors guided by the above five components, the following literacy levels were formulated:

- First level of ICT literacy – mobile phone symbol identification literacy (*access* component)
  Foregrounds SHFs' ability to recognise or *know* BMP symbols, e.g., ON and OFF button, charging, network, and Wi-Fi signals.
- Second level of ICT literacy – basic ICT literacy (*integrate* component)
  Requires skills to *perform* common BMP operations: Cognitive skill – to **interpret** the moment when the mobile phone is ready to disseminate information; technical skills – to press the ON, OFF, CALL, pick calls, and terminate calls buttons.
- Third level of ICT literacy – semi-medium-level ICT literacy (*manage* component)
  Requires skills to *document* caller contacts, type, and read text messages. SHFs must be able to **apply an existing classification scheme** on their BMP to carry out tasks involving the documentation of information.
- Fourth level of ICT literacy – medium-level ICT literacy (*evaluate* component)
  Skills to use a SP to perform tasks such as *sending* as well as *accessing* received audio and video messages. Cognitive and technical skills are required to make judgments about the "quality, relevance, usefulness, or efficiency" of the audio and video messages to be sent out or received from other farmers.
- Fifth level of ICT literacy – advanced ICT literacy (*create* component)
  Skills to use a SP to *access* Internet facilities. Requires high cognitive proficiency to **generate** or **create** information for the farmer.

These ICT literacy levels, like the five components discussed above, resemble a range of skills and abilities – from simple to complex uses of ICT devices – to perform relevant and needed agricultural tasks.

3. Methodology

3.1. Research method and design

Case study methodologies provide tools for researchers to study complex phenomena within their contexts (Baxter and Jack, 2008). This is a case study of SHFs in Msinga in KZN, South Africa, whose means of livelihood have been negatively impacted by climate change. Ethical clearance[3] was sought from the gatekeepers, which included the University of KwaZulu-Natal; the Asisukume Msinga Agricultural Cooperative (AMAC), and the Traditional Leadership. Informed consent was signed by the SHFs as well as the extension workers that participated in the study. Our aim was to come together as a collective: SHFs, AMAC members, university researchers, and extension workers to reflect on the ways in which we can enhance the ability of SHFs to adapt and mitigate the impacts of climate change in this particular rural area. To put it in Snow et al.'s (2016, p. 360) words: "[It was] a process of coming together to contribute to the welfare of a community, a moral and political activity", a process for which, according to them, conventional methods are still inadequate when researching Indigenous communities. Conventional research is often accused of using the "Indigenous communities" to further specific agendas outside the needs, benefits, or guidance of these particular communities, and of employing oppressive and colonising practices. Snow et al. (2016) therefore argue for a move towards a more Indigenous research practice which decolonises research methods.

In line with this view, the study was cautious in its integration of conventional methods in its research practice. Indigenous methods, such as storytelling and community forums (Deacon-Crouch, 2016), were foregrounded, with particular attention given to the latter option. A 'community forum' is an organised platform that permits the participation of interested parties in addressing a concern (Duenpen et al., 2016). It affords the opportunity to capture the general ideas of a community within a short period by providing space for their voices to be heard (Blyden, 1995). A community forum allowed for the collaboration between Msinga SHFs, extension workers, and university researchers to examine the SHFs' ICT literacy levels in order to explore the potential of ICTs in supporting them in their farming decisions. Most importantly, it allowed the majority of the SHFs who have limited levels of education to express themselves in their own language – Zulu[4] – without fear of having their reading or writing ability challenged.

A sequential transformative mixed method design (Creswell, 2013) embedded in the Indigenous research framework was adopted to generate data. The paper reports on the quantitative analysis of the study which addresses the following two questions:

1. *What level of ICT literacy do SHFs in Msinga have?*
2. *What is the relationship between SHFs ICT levels and demographic data w.r.t. their adoption of ICT tools in their agricultural practices?*

The dataset for the above research questions was produced by the ILAT protocol which sought to ascertain the demographic data and the levels of ICT literacy. The instrument consisted of six sections, namely:

- SHFs' demographic data – gender, age, levels of education, etcetera;
- First level of ICT literacy – mobile phone symbol identification literacy;
- Second level of ICT literacy – basic ICT literacy;
- Third level of ICT literacy – semi-medium-level ICT literacy;
- Fourth level of ICT literacy – medium-level ICT literacy; and

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[3] The Ethical Clearance No. HSS/1648/017D was granted by the University of KwaZulu-Natal's Humanities and Social Sciences Research Ethics Committee (HSSREC) to conduct the study.

[4] Zulu or isiZulu is a Southern Bantu language of the Nguni branch spoken in Southern Africa. It is one of the 11 official languages spoken in South Africa.

- Fifth level of ICT literacy – advanced ICT literacy.

The collection of data was done orally. It was interesting to note that when the SHFs were asked about their familiarity with ICTs and whether they could use them, they all chorused *"yebo"* (meaning, "yes"), and laughed. The ILAT protocol, which was translated into Zulu, was handed out to each SHF. The research assistant read out each question to the SHFs who responded by raising their hands. The extension workers and the researchers were responsible for the counting of the raised hands. The SHFs responded to the first level of ICT literacy by identifying symbols on a mobile phone. We proceeded to the second level, the SHFs could use their mobile phones to *perform* common BMP operations. However, as we moved to the third level (which requires skills to *document* caller contacts, type, and read text messages), only a few of the SHFs responded to the items. Similarly, at levels four (which requires skills to use a SP to perform tasks such as *sending* as well as *accessing* received audio and video messages) and five (which requires skills to use a SP to *access* Internet facilities), most of the SHFs barely attempted any of the items.

For the analysis, at each level of ICT literacy, the ICT scores of the component questions were generated and summed up for the levels. The total score of each SHF out of the maximum possible score at each level were expressed in percentages. The percentage scores were divided into three tertiles (Ko et al., 2019) as follows: scores of 33.3% or lower were categorised as "low", scores of 33.4–66.6% were categorised as "moderate"; and scores of 66.7% and above were regarded as "high". The ILAT protocol was used as a rubric to gather the responses for analysis. The SHFs' responses on the utilisation of ICT for operations at each level were scored and recorded by three people – the researcher, the research assistant, and the extension worker. The scores of the SHFs were first triangulated for validity and thereafter related to the three tertiles categorisation of "low", "moderate" and "high" in order to determine where their ICT literacy capability scores lay on the scale.

To explore the relationship between the SHFs ICT levels and their demographic data w.r.t. their adoption of ICT tools, the Spearman rank-order correlation was employed using IBM® Statistical Package for the Social Science (SPSS®), version 20. The Spearman rank-order correlation is used to calculate the interrelationship between the level of scores on two variables (Hwang et al., 2009). It measures monotonic (Lv et al., 2018) and nonparametric (Farber et al., 2011) relationships between two variables. In addition, the Spearman rank-order correlation is represented using *rho* (Henriksen et al., 2018) with its values.

3.2. Sample

'SHFs' are defined broadly as farmers owning small plots of land (less than 2.0 ha) on which they grow subsistence crops and one or two cash crops, and who rely almost exclusively on family labour (Republic of South Africa, 2012). Volunteer sampling was used, in which a sample of 35 SHFs were purposively selected from a population of 100 SHFs. It came as no surprise that all of the SHFs were women. As Harris and Achora (2018, p. 6) have shown, in many parts of the developing world women play an important role in the agricultural sector, both in production and marketing, as compared to their counterparts in developed countries. They all belong to the AMAC – all irrigation farmers in Msinga. Agricultural cooperatives[5] play a significant role in enabling farmers to improve product and service quality, reduce risks, and empower members economically and socially.

After explaining the objectives and timeline at a community meeting, all 35 SHF volunteered to participate in this study. A non-parametric test was opted for as it prevents making untrue assumptions about the study's parameters (Abramo et al., 2008). Therefore, a Spearman rank

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[5] "An agricultural cooperative is a formal form of farmer collective action for the marketing and processing of farm products and or for the purchase and production of farm inputs" (Agriculture for Impact, 2020, n.p.).

correlation was adopted, using a correlation coefficient (r) as well as p-value at both 0.05 and 0.01.

3.3. Study context

Msinga is a local municipality in the Mzinyathi District in KZN, South Africa, located at 28°10′S 30°15′E. It is characterised by hot and dry weather. With a mean annual precipitation of 600–700 mm and high summer temperatures soaring to 44 °C (Cousins, 2012). Msinga is vulnerable to the elements of climate change, such as the high rise in temperature, pests and diseases, decrease in the volume of water bodies, and an increase in drought and flood. This was established by several studies highlighting Msinga's prolonged drought spells in the years 1992, 1999, 2001, 2003, 2004 (Drought Information Bulletin, 2004), 2007, 2008, 2010 (Hitayezu, 2016), 2014, and 2015 (Vanderhaeghen and Hornby, 2016). Consequently, the livelihoods of SHFs, who rely mostly on subsistence farming activities, are severely impacted (Sinyolo et al., 2014). Irrigation farming, exacerbated by the drought years, is restricted to the banks of the uThukela River (Cousins, 2012, 2013), leaving large parts of the land unfarmed. However, irrigation farming is insufficient to eradicate poverty (Sinyolo et al., 2014), highlighting the need for the integration of other practices into farming, such as ICT and CSA.

4. Results

We begin this section by examining the demographic details of the SHFs. This is followed by a presentation of the SHF ICT literacy results.

4.1. SHFs demographic data

The results presented in Tables 1 and 2 above show that most of the SHF participants were between 40–49 years of age (n = 17; 48.6%), with a mean age of 48.23 and SD = 11.944. All of the SHFs (n = 35; 100%) identified themselves as female. Those with no formal education were the most prevalent (n = 20; 57.1%), while those with a higher education were the least prevalent (n = 1; 2.9%).

4.2. SHFs ICT literacy levels

When examining the prevalence of the various ICT literacy levels of the SHFs, the following was found (see Figures 1, 2, 3, 4, and 5). On the first level, all SHFs (n = 35) were able to accurately recognise (AR) the 7 mobile symbols presented to them (AR% = 100%), thus achieving a 100% AR score for all of them (see Figure 1). On the second level, all SHFs (n = 35) were able to satisfactorily demonstrate (SD) the ability to (i) receive and terminate a call (n = 35; 100%), (ii) receive a call and terminate it without (w/o) assistance (n = 35; 100%), (iii) make a call and terminate it w/o assistance (n = 35; 100%), as well as (iv) turn the mobile phone on and off w/o assistance (n = 35; 100%). However, the results also suggest that only 74% (n = 26) of the SHFs were able to SD the ability to (v) identify missed calls using the call log, and (vi) identify a caller (see Figure 2). When examining the display of the third level of ICT literacy, 49% of the SHFs (n = 17) were not able to display (NAD) the ability to save contacts and retrieve caller contacts of calls. Furthermore, 63% of SHFs (n = 22) were NAD sending text messages, accessing and reading text messages, and deleting text messages (see Figure 3).

When using a SP for the fifth level of ICT literacy, the prevalence of NAD use of sending audio messages (n = 31) and video messages (n = 31) w/o assistance was seen in 89% of SHFs, while 91% of the SHFs were NAD accessing received audio messages (n = 32) and video messages (n = 32), respectively (see Figure 4). The more advanced use of SPs, suggested as not being able to display complete use of these functions among SHFs (see Figure 5), were seen among 89% of the SHFs who were NAD the following: (i) activate mobile Internet access (n = 31), (ii) browse the Internet using their mobile phone (n = 31), and (iii) send and check emails on their mobile phone (n = 31). However, 34 of the SHFs were

Table 1. Participant demographic details.

Variable	Category	n	%
Age group	<40	5	14.3%
	40–49	17	48.6
	50–59	9	25.7
	≥60	4	11.4
Gender	Male	0	0
	Female	35	100
Education level	None	20	57.1
	Primary	10	28.6
	Secondary	2	5.7
	National Senior Certificate	2	5.7
	Higher Education	1	2.9

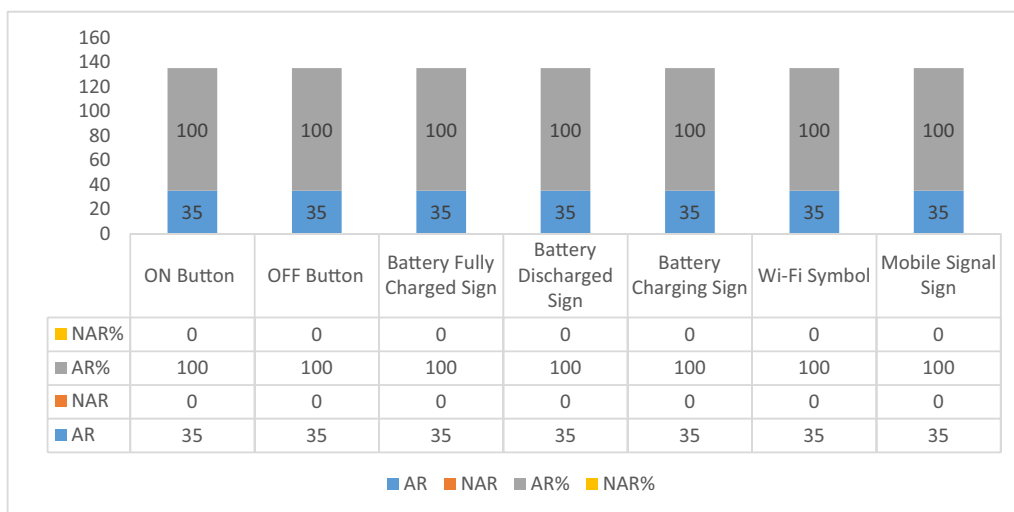**Table 2.** SHFs mean and standard deviation for age group and education level.

Variable	N	Mean	Std. Deviation (SD)
Age	35	48.23	11.944
Educational Background	35	.71	1.100

NAD the use of Google Play Store™ (97%) and download mobile applications (97%) (see Figure 5). Overall, for the fifth level of ICT literacy, all SHFs (n = 35; 100%) were not able to display the ability to use their mobile phones to set their global positioning system (GPS) and to check the weather forecasting (see Figure 5).

When taking into consideration all the ICT literacy levels of the SHFs (as displayed in Figures 1, 2, 3, 4, and 5), the overall examination of ICT literacy levels, as presented in Figure 6, suggests that the SHFs' ICT proficiency curve displays a downward decline from the first to the fifth level of the graph. The slope shows a gentle downward decline from the first to the second level but a sharp decline from the second to the fifth level.

The associations between the variables are examined in Table 3 using Spearman's correlation for the SHFs. The results suggest that ICT literacy level 3 was significantly correlated with ICT literacy level 2 (ρ = .422; p < 0.05), while ICT literacy level 4 was significantly correlated with ICT literacy level 3 (ρ = .569; p < 0.01). The results in Table 2 also suggest that ICT literacy level 5 was significantly associated with ICT literacy level 3 (ρ = .569; p < 0.01) and ICT literacy level 4 (ρ = .998; p < 0.01), respectively. Age was significantly negatively associated with ICT literacy level 2 (ρ = -.572; p < 0.01), ICT literacy level 3 (ρ = -.930; p < 0.01), ICT literacy level 4 (ρ = -.553; p < 0.01), and ICT literacy level 5 (ρ = -.551; p < 0.01), respectively. Education level was significantly correlated with ICT literacy level 3 (ρ = .753; p < 0.01), ICT literacy level 4 (ρ = .616; p < 0.01), and ICT literacy level 5 (ρ = .729; p < 0.01); however, education level was significantly negatively correlated with age (ρ = -.729; p < 0.01). When examining the associations between years of experience in farming, significant negative relationships were found between years of experience in farming and ICT literacy level 2 (ρ = -.380; p < 0.01), ICT literacy level 3 (ρ = -.741; p < 0.01), ICT literacy level 4 (ρ = -.560; p < 0.01), ICT literacy level 5 (ρ = -.559; p < 0.01), and educational level (ρ = -.584; p < 0.01), respectively, although a significant relationship was found between years of experience in farming and age (ρ = .729; p < 0.01).

	ON Button	OFF Button	Battery Fully Charged Sign	Battery Discharged Sign	Battery Charging Sign	Wi-Fi Symbol	Mobile Signal Sign
NAR%	0	0	0	0	0	0	0
AR%	100	100	100	100	100	100	100
NAR	0	0	0	0	0	0	0
AR	35	35	35	35	35	35	35

■ AR ■ NAR ■ AR% ■ NAR%

Figure 1. First Level of ICT Literacy (Identifying the Seven Selected Symbols on a Mobile Device). Note: AR = able to recognise; NAR = not able to recognise.
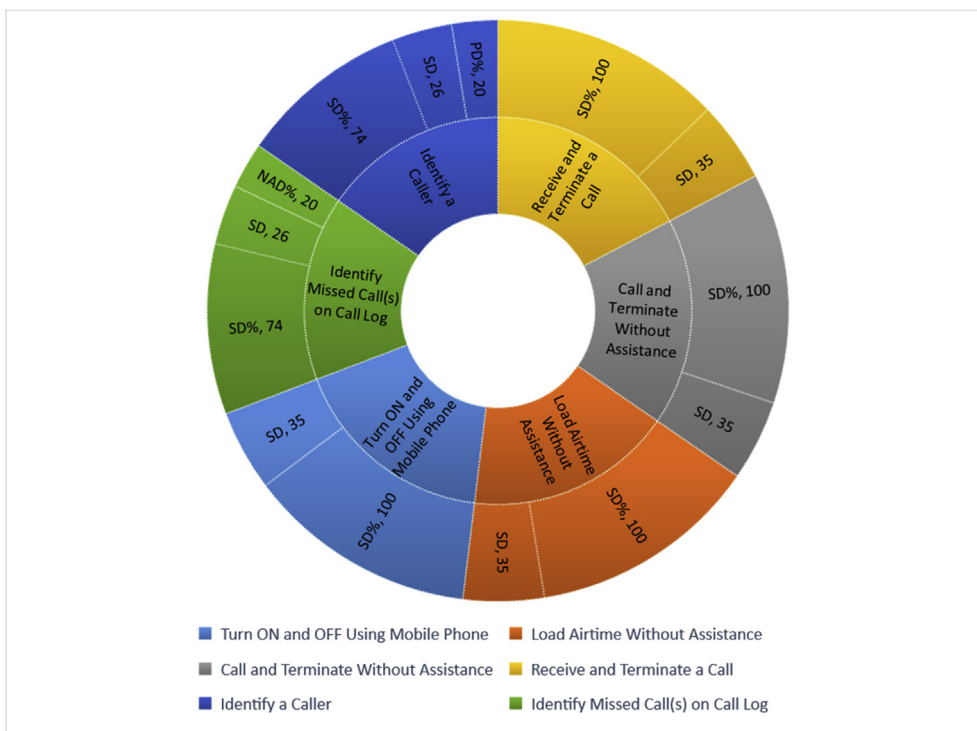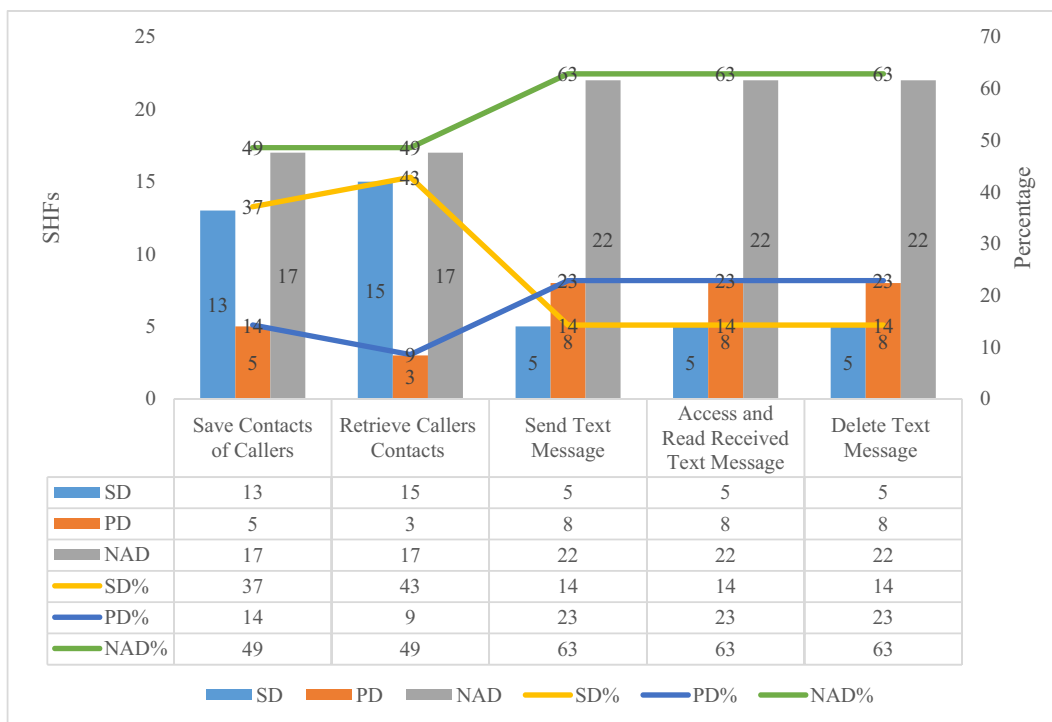
Figure 2. Second Level of ICT Literacy: SHFs' Basic Level of ICT Literacy. Note: SD = satisfactorily demonstrated; PD = partially demonstrated; NAD = not able to demonstrate.

The relationship between the SHFs' ICT proficiency at each level and their demographic data is explored next to illuminate the factors that may inform the above trends.

The Spearman rank-order correlation was employed. The results are presented in Table 3 below.

5. Discussion and conclusion

In general, we set out to examine *the ICT literacy levels SHFs with the aim of supporting them in their farming decisions*. More specifically, we examined the interrelationship between the SHFs ICT literacy levels and

	Save Contacts of Callers	Retrieve Callers Contacts	Send Text Message	Access and Read Received Text Message	Delete Text Message
SD	13	15	5	5	5
PD	5	3	8	8	8
NAD	17	17	22	22	22
SD%	37	43	14	14	14
PD%	14	9	23	23	23
NAD%	49	49	63	63	63

Figure 3. Third Level of ICT Literacy: SHFs' Capacity to Use a BMP. Note: SD = satisfactorily demonstrated; PD = partially demonstrated; NAD = not able to demonstrate.
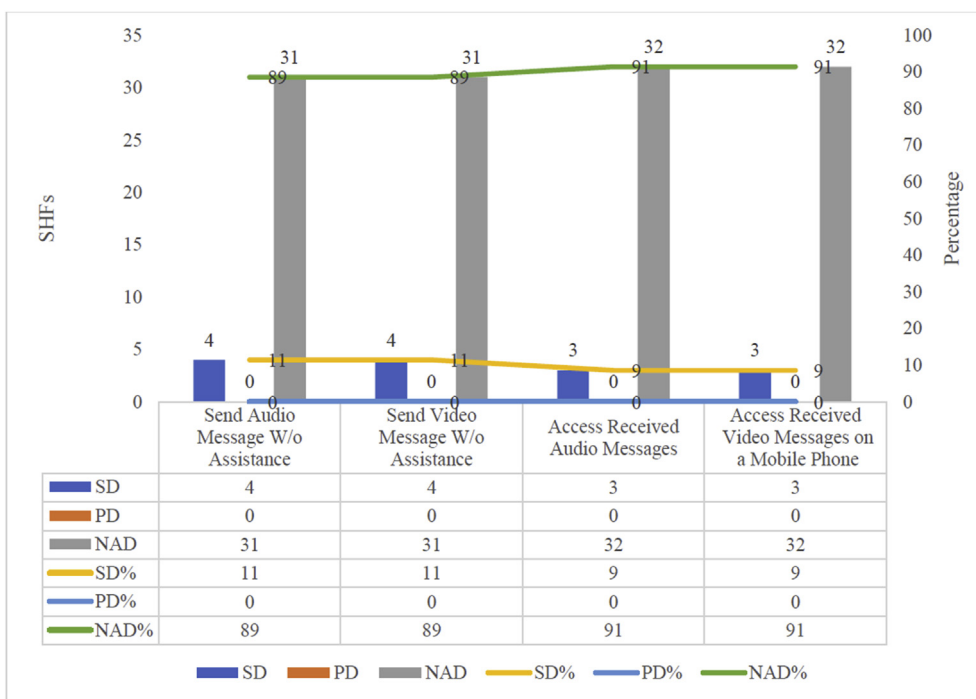
Figure 4. Fourth Level of ICT Literacy: SHFs' Medium ICT Literacy Level. Note: SD = satisfactorily demonstrated; PD = partially demonstrated; NAD = not able to demonstrate; w/o = without.

demographic variables, such as age, marriage, educational level, and years of farming experience. The results suggest that for all the ICT literacy levels explored, SHFs were not able to display use of the various ICT related skills, with the exception of ICT levels 1 and 2, where the satisfactory display of ICT literacy in these levels was evident among most of the SHFs. In other words, as the SHFs progressed from the third to the fifth level, the proportion of low ICT literacy proficiency for that level increased. This trend clearly reveals that the Msinga SHFs have insufficient ICT literacy capability to viably include ICT in their agricultural practices.

When examining the relation between ICT literacy levels and the demographic variables, significant negative associations were found between the ICT literacy levels and age as well as years of experience, while significant positive associations were found between ICT literacy levels and educational level. This means that the SHFs' age and years of farming experience are negatively and inversely proportional to their ICT literacy proficiency, whilst their educational level is directly proportional to their ICT literacy proficiency.

In our study, the age factor can be classified as a moderating variable that negatively and significantly informs Msinga SHFs' ICT literacy needs. Educational level can be classified as a moderating variable that
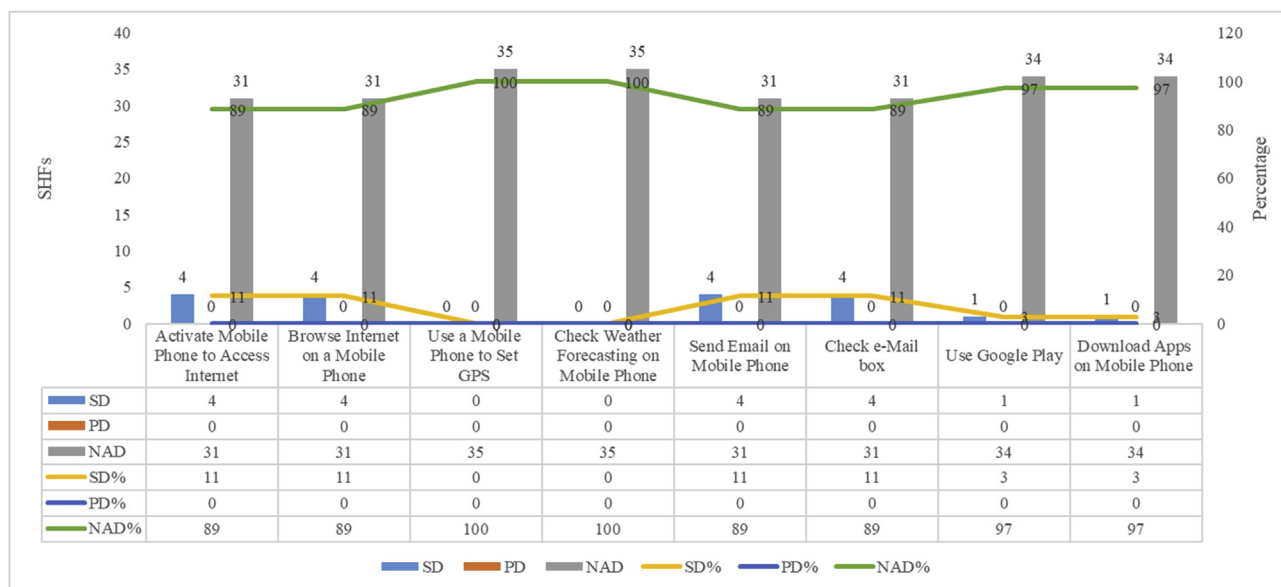

Figure 5. Fifth Level of ICT Literacy: SHFs' Advanced ICT Literacy Level. Note: SD = satisfactorily demonstrated; PD = partially demonstrated; NAD = not able to demonstrate.
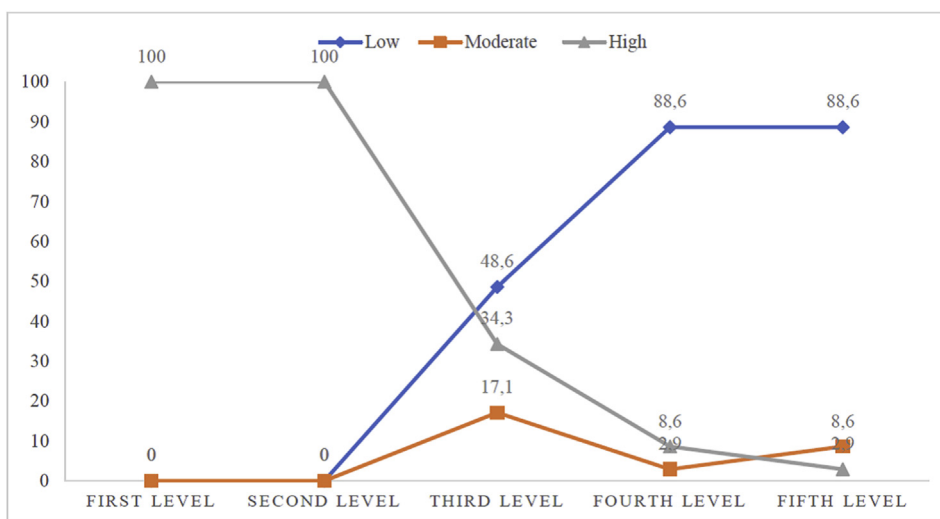
Figure 6. The trends based on the five levels of ICT literacy.

Table 3. Spearman correlation amongst the variables.

	1	2	3	4	5	6	7	8
1. ICT score at Basic level (Level 2)	1							
2. ICT score at semi-moderate level (Level 3)	.422*	1						
3. ICT score at moderate level (Level 4)	.042	.569**	1					
4. ICT score at advanced level (Level 5)	.051	.569**	.998**	1				
5. Age	-.572**	-.930**	-.553**	-.551**	1			
6. Current marital status (in marriage or not)	-.032	-.223	-.179	-.179	.159	1		
7. Educational level	.224	.752**	.616**	.616**	-.729**	-.179	1	
8. Years of Farming Experience	-.380*	-.741**	-.560**	-.559**	.729**	.258	-.584**	1

*P < 0.05.
**P < 0.01.

positively and significantly informs Msinga SHFs' ICT literacy needs. The results of this study have confirmed that the lack of certain ICT skills could greatly affect the adoption of ICT by farmers, which relies largely on the practical ICT knowledge of the users (Wawire et al., 2017). The findings of this study corroborate the findings of Subashini and Fernando (2017) who observed a downward trend in Sri Lankan farmers in the use of ICT with the increase of age and a very strong relationship between the usage of ICT and level of education. However, 99% of the farmers in their study had completed at least their secondary education, whilst in our study, only 9% had completed secondary education. Of course, the question lingers; would the results have been the same if male SHFs participated?

How do the above findings talk to the actual context of ICT use and adoption by SHFs in rural and developing contexts?

The findings arising from this study highlight the "importance of context" in helping SHFs to mitigate the threats of climate change on food production, an issue that is completely ignored in curriculum policies and policies aimed at integrated national adaptation responses to climate change impact and vulnerability. We fully agree with the assertions by Kremer and Houngbo (2021, para. 5) that agriculture is central to every rural and developing context's socio-economic development and that digital technologies have the opportunity to "revolutionise how rural communities secure and improve their livelihoods". However, like Harris and Achora (2018, p. 1), we would argue for the serious consideration of "the actual context of use and adoption by smallholder farmers in rural and developing contexts". We need to change the narrative around ICT innovation for development and acknowledge that just as much as digital

technologies and SPs offer "richer user interfaces and better user experiences", they could also pose serious "usability challenges" at various levels of the community, particularly for users with low income and low levels of ICT literacy (Harris and Achora, 2018). Three challenges that come to mind relate to: the financial burden that comes with owning a SP in low-income communities; the disruption to traditional modes of information exchange and knowledge sharing in these communities; and the dearth of training and access to quality education, interventions, and research that will be sensitive to the SHFs' particular context of use. Indeed, as Emeana et al., (2020, p. 1) assert, interventions "are highly likely to fail to achieve their intended purpose or be abandoned when implementers ignore the literacy, skills, culture, and demands of the target users".

What we take away from our study is that to truly facilitate transformative, impactful, and sustainable agricultural development that is cognisant of "the context of use", we will need to engage in innovative collaborative agricultural knowledge exchange and learning. This means going beyond the rhetoric of the affordances of digital innovation and being informed by real, concrete data from the ground – the context of use.

Declarations

Author contribution statement

Busisiwe P. Alant; Olusegun O. Bakare: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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