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Exploring factors influencing the use of internet in the household by women small-scale farmers in rural South Africa: evidence from GHS 2019

F. S. Mbamba[1*] and P. Nsengiyumva[1]

Abstract

This study adds to the empirical evidence of information and communication technology (ICT) use by women smallholder farmers in South Africa. The study draws on quantitative data collected by Statistics South Africa. The General Household Survey (GHS) for 2019 was manipulated to meet study objectives. The GHS questionnaire was used to sample households, and special attention was given to women farmers who have access to buyers of agricultural products through internet access in the household. A stratified design was used for primary units, and systematic sampling for dwelling units. The Statistical Package for the Social Sciences (IBM SPSS Statistics 30.0.0) was used for analysis of statistical data. Findings indicated that rural farmers from Free State largely access internet to reach formal and international agricultural markets. Whilst, in other provinces farmers access internet mostly to reach local buyers from the district. Yet, gaining access to the internet access remains a predicament considering it is accessed by limited number of farmers. The Whites predominantly access internet to reach all agricultural market over other racial groups. The farmers with secondary education largely use internet and tend to access both local, formal, and international agricultural markets. To test association amongst variables, Chi-square tests showed a significant association. The Phi and Cramer's V tests showed a moderate and strong relationship amongst the variables. Logistic regression reveals that all variables, age; race; education; just to name a few, are leading factors that explain internet accessibility by women farmers. The study fundamentally recommended that the government should establish internet access platforms that can be accessed by farmers for free or that which will charge affordable rates to attain agricultural and market information.

Keywords Livelihoods, Women's empowerment, ICT, Rural development, Subsistence

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Introduction

The importance of internet access by women in small-scale agriculture cannot be overemphasized. Agriculture has a direct influence on the rural livelihoods of rural farmers of South Africa, more especially women farmers as they are mostly predisposed to smallholdings. In the Sub-Saharan Africa, as elsewhere in the developing world and in the developed world, the information communication technologies (ICTs) are transforming the manner in which people interrelate, unlocking exhilarating and unexplored opportunities in support of trade [42, 43], and transforming all facets of life [19, 43, 48, 72]. The small-scale farming sector remains struggling owing to that most of the population does not have internet coverage within their household, and a remarkable population in the rural communities remains poor.

According to Mdlalose [37], the agricultural sector remains the mainstay for most developing countries on the African continent. Along these lines, South African agriculture is strongly dualistic, determined by a limited number of commercial agricultural activities, largely operated by existing agribusinesses and many small-scale agricultural enter-prises, consisting of black and poor farmers [45, 69]. Moreover, the agricultural sector plays a vital role in poverty alleviation and human development and contributes significantly to the Gross Domestic Product (GDP) of these countries [68]. The proliferation of ICTs has transformed markets, governments, and households. Access to and use of ICTs has increased considerably in recent decades in rural areas of developing and transition countries [32]. Owing to that farming has changed to become more technology-intensive, and that many small-scale farmers live in rural areas with low literacy rates, they lack the intellectual capacity to utilize readily available resources [36]. This article will explore the factors associated with the use of internet in the household by women rural farmers to access buyers of agricultural products sold in South Africa.

Access to information is the foundation for agricultural development [57]. Adequate access to agricultural information enables efficient farming practices. Typically, small-scale farmers have limited access to agricultural knowledge. Information Communication Technologies (ICTs) have been recognised globally as a beneficial set of technologies that can be used to develop agriculture [49]. In this regard, the widespread use of ICTs over the past 20 years has been a positive development, especially in remote rural areas where the dependency on agriculture is high, but access to amenities remains limited [6].

Knowledge is crucial and enables women farmers to become more self-reliant to raise their level of living and agricultural output. information on new agricultural innovations and technology is therefore crucial to involve women farmers in remote areas in the development of new technologies and the research process at all levels. The reality is that many vulnerable farmers complain about meeting the quality and quantity requirements of formal market (Ncube, 2017). Therefore, internet access is of priority to obtain market information and standards demanded by formal markets of South Africa, buyers from neighbouring cities and towns, and export agencies in international buyers.

The benefits that come with ICT tools in the South African small-scale farming sector are like those across other African countries. ICT facilitates farmers' market participation, however, the extent of access of ICT for market participation is influenced by farmers' socioeconomic factors [47]. Therefore, this study was conducted to fill this gap by sharing robust empirical evidence on determinants of internet access to contact buyers of agricultural products sold by women farmers located in rural areas of South Africa. The result of this study is intended to be useful for policymakers, stakeholders, and rural development practitioners in South Africa in particular, who are seeking to understand how best to respond to the problems of lack of internet access within the household by identifying their major determinants. Consequently, the findings will allow them to redesign better ICT access policies that could motivate women farmers to utilize to access agricultural markets.

Literature review

Theory of planned behaviour (TPB)

A wide range of models have been put forth in recent years to study behavioural intention and the psychosocial connections it has to actual behaviours . Research on a wide range of behaviours has long been based on the theory of planned behaviour (TPB), which was first put forth by Ajzen as displayed in Fig. 1 to explain the mechanics behind human behaviour [5]. According to the theory, behavioural performance is indirectly influenced by the factors that make up behavioural intention [4]. Accordingly, it clarifies why an individual act in a particular manner, considers the information at hand, and evaluates the outcome of their choices [3, 50].

Moreover, the conceptual model acknowledges and incorporates additional factors that influence behaviour to explain attitudes, subjective norms, and perceived behavioural control [7, 74, 76]. "Attitude" in this study refers to how women farmers feel about ICTs, whether positively or negatively. The external pressure that women farmers may experience when selecting and adjusting to information and communication technologies is referred to as "subjective norms." "Perceived behavioural control" describes the barriers resulting from the individual experiences and expectations of women farmers. The aspirations of female farmers to use ICTs for agricultural operations and market their stored agricultural products

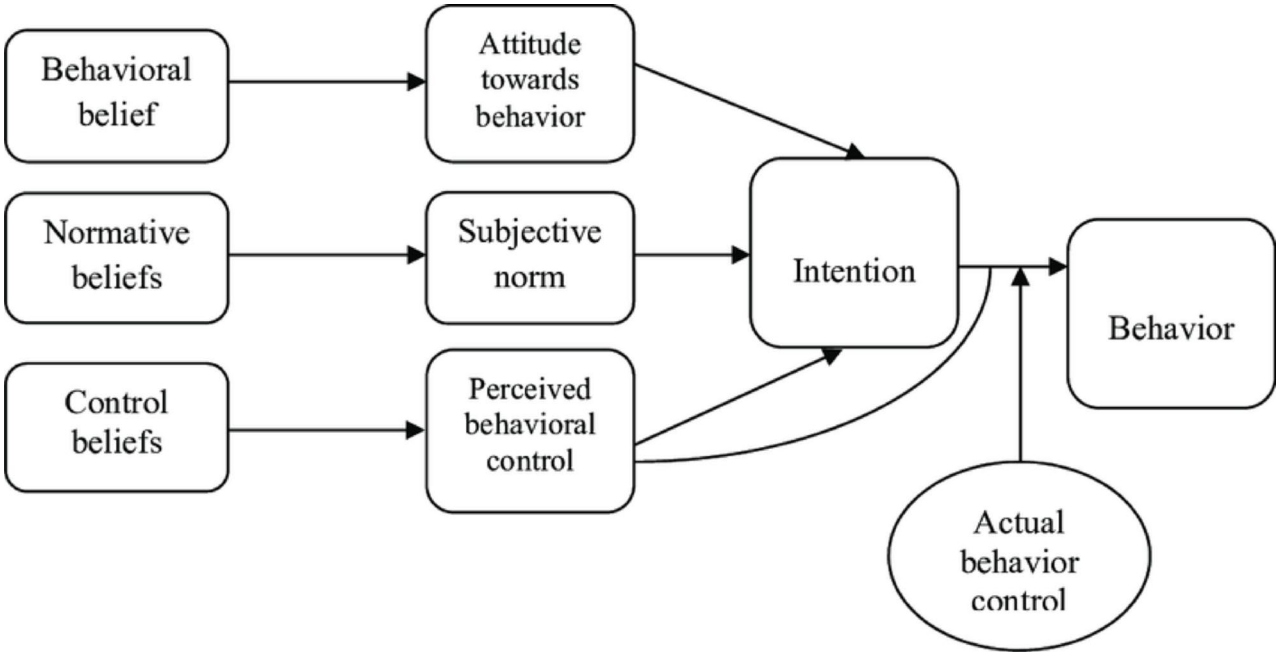

Fig. 1 Theory of planned behaviour (Ajzen, 2005)

to both local and distant markets may also be influenced by behavioural factors. Thus, among other theoretical and conceptual models, the study's design considered the notion of planned behaviour. Furthermore, researchers are incorporating constructs into the Theory of Planned Behaviour (TPB) to enhance its predictive power and explain why well-intentioned actions do not always materialize. This is a response to the need to comprehend behavioural intention in various contexts [11, 12, 31].

Furthermore, it should be mentioned that the TPB model gave rise to other technological acceptance models in accordance with its use by different researchers in diverse contexts [2, 12, 13, 67, 71]. However, each model and theory of technology acceptance has advantages and disadvantages of its own, thus none of them could be universally acknowledged as accurate [5, 7]. Despite this, the Theory of Planned Behaviour is useful for explaining and forecasting farmers' technology adoption behaviour. However, it explicitly ignores eccentric behaviour and the complex relationships that exist between agricultural workers, their families, and other stakeholders [50, 70] (Fig. 1).

Sustainable livelihoods framework (SLF)

A wide range of factors can be considered when defining sustainability [17, 21, 40, 63, 64]. Assisting the most disadvantaged households was the main goal of the SLF model. According to Morse and McNamara [40], many people find it hard to connect to the concept of sustainability because it has a minimal impact on their daily life. In recognition of these phenomena, academics suggest replacing the term sustainability with something more relatable to people's everyday lives, like "quality of life" or "well-being." (Conway & Chambers [15]). A consequence of this, women perform domestic duties, and male farmers occasionally complain that they feel too "tied to the farm/land" and find it difficult to allocate time to their families and being caregivers, even though agricultural employment can be flexible. Nonetheless, women typically take on employment outside the farm, although those with more rigorous schedules.

The Sustainable Livelihoods Framework (SLF) was developed in 1992 by Gordon Conway and Robert Chambers. It describes which capital assets are important to consider when analysing assets that can be used to improve peoples' livelihoods and the welfare of society [17, 29, 66, 77]). According to Morse and McNamara [40], the definition of "livelihood" in SLF goes beyond simple survival; it also includes providing tools that people can use to improve their lives and the way they live. Information and communication technologies (ICTs) have become a leading force in this regard, with great potential to assist South African rural households in their development by enabling them to join in official markets to sell their produce. Therefore, adopting a feminist viewpoint raises questions of justice and equality in respect to farms and other agents in the larger system as well as inside the farm and at home. As a result, feminist perspectives emphasize aspects of farm viability that have historically been disregarded, such as relationships in the family units, gender parity, or general wellbeing [14, 33, 62].

The author also argues that a "western" reader can find various aspects of livelihood in SLF. A person's means of subsistence can take many different forms; for example, it could involve working for family members for little pay or being largely dependent on the revenues from agriculture, which is very cyclical and highly dependent on environmental and market variables. The idea of SLF itself offers one way to practice sustainability in a more human-centred way [59]. According to Morse and McNamara [40], it stands for five crucial capital assets that must be considered to achieve a sustainable way of living. It focuses on how different aspects of livelihoods are interrelated and how individuals can preserve the sustainability of multiple forms of capital (natural, human, social, physical, and financial) as well as a variety of livelihood strategies within a specific framework of fragile policies and environments [77].

According to Scoones [58], there are some critical voices that can help people live better, healthier lives. Women who produce food in non-metropolitan areas are found to be appropriate candidates for integration into development. This study sets forth the factors that are crucial for women in rural South African provinces to lead healthy lives. SLF is regarded as one of the most important network systems because it recognizes the true problems facing individuals and their ability to survive. It not only facilitates communication between people but also imparts knowledge concerning the necessities. For example, a study carried out by the International Telecommunication Union (ITU) found an apparent relationship between the pronounced disparities in mobile phone ownership across genders and the relatively low Internet adoption rates among women. In 2020, just 19% of women in least developed countries (LDCs) and 86% of women in developed nations used the Internet (ITU [27]). ICTs therefore serve as resources that come in as critical to benefit women in farm value chains, and according to SLF, women ought to be taken into consideration anytime financial security and the distribution of monetary assets are being executed.

Furthermore, women play a supportive role in relation to the primary productive farm work in two ways: initially, through taking on unappreciated side or secondary tasks, where their contribution to maintaining and growing the farm and household is frequently disregarded [23]; secondly, by bearing primary responsibility for the labour and duties that are necessary to maintain the farm and household, make productive or farm work bearable, and enable tasks that contribute both materially and symbolically to the farm [8, 55], such as direct sales of agricultural products, manufacturing-related sectors, or diversifying their revenue [33]. Therefore, the study emphasizes how rural women are undervalued in development since they do not utilize ICTs to fully engage in South Africa's agricultural markets possible. However, it must be acknowledged that while the sustainable livelihoods approach helps identify realistic priorities for activities based on the opinions and interests of individuals involved, it is by no means an instant fix. It is not a substitute for other instruments, including integrated rural development, sector-wide approaches, or participatory development. Nonetheless, it establishes the link between individuals and the general supportive environment that affects livelihood strategy outcomes. It draws emphasis to people's innate potential in terms of their abilities, social networks, financial and material resources, and capacity to impact important institutions [59].

Materials and methods

Description of study area

This cross-sectional study was conducted across nine provinces of South Africa. In the center of Africa, South Africa is the southernmost country. It's more than 3,000 km of coastline connects Africa's east and west coastlines. South Africa covers an area of 1.22 million km^2, extending roughly 1 600 km from east to west and north to south [34]. Based on United Nations figures, the population is estimated to be 61 million at present. There are eleven official languages in the nation, while there are roughly fourteen different ethnic groups overall. Christianity is the most common religion. To the north are Botswana and Zimbabwe, and to the northeast and east are Mozambique and Swaziland. Namibia lies to the northwest, the Atlantic Ocean to the southwest and west, and the Indian Ocean to the southeast and south. In the southeast of the nation, Lesotho is surrounded by South Africa and is a legitimate monarchy with self-government (FAO [25]).

Study design & source of population

The research design was quantitative in nature. Furthermore, the study employed a multi-stage design, which was established on a stratified design with probability proportional to the size selection of primary sampling units (PSUs) at the first stage and sampling of dwelling units (DUs) with systematic sampling at the second stage. After assigning the sample to the provinces, it was further stratified by geography (primary stratification) and population attributes using data from the 2011 census (secondary stratification). The study filtered the non-rural population of women farmers by 'metro-coding' as they were not befitting for the study objective. Only the rural farmers were considered as a considered population.

Variables identification

The dependent variable of this study is "access to internet in the household" which has two binary outcomes if

a women smallholder has access is coded as 1, and "Otherwise" is coded as 0. The predictor variables include Age Group, Population Group, Marital Status, Highest Level of education, Income Source, and Metro-Coding. The market variable was "Buyers of Agricultural Products Sold" which was employed as a control variable to observe farmers who access local buyers from the district, and buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers.

Household internet access

This is a dummy variable which was aimed to find out whether members of the household have access to the internet or not. The question asked in this regard was "*Do members of this household use internet connection in the household*?". The final code list was 0 = No; and 1 = Yes. However, only females who are agriculturally involved were considered.

Use of internet for agricultural purposes

The impact of internet in the household is thus far to be felt in most households owing to inadequacy of communicating and sharing agricultural knowledge. Internet has grown more commonly accessible and has become better integrated into other segments of the economy. In the study context, internet connection in the household is deemed as an intermediary between women farmers and accessibility to agricultural information.

Buyers of agricultural products sold (market participation)

This is a market variable which was used to control for group of women farmers pursuing local marketing and those trading-off agricultural products beyond local markets. The question asked in this regard was "*To whom does your household sell most of its produce*?" The initial code list was 1 = Local buyers from this district; 2 = Buyers from neighbouring cities and towns; 3 = Formal markets in South Africa; 4 = Export agencies in international buyers; and 5 = Other. The "Other" category was removed because the author believes that the category does not give any significant results and may misrepresent the study findings and conclusions. Notably, the second subcategory was merged with the remaining subcategories as one to make interpretation of results easier. Therein, this question was to determine if the households sell any of the agricultural products they produce and establishes the buyers of the agricultural products produced.

Data collection methods

The data analysed in this study is secondary data obtained from Statistics South Africa (Stats SA). The sampling weights for the data collected from the sampled households were constructed so that the responses could be suitably stretched to embody the whole national population of South Africa. The design weights, which are the inverse sampling rate (ISR) for the province, were assigned to each of the households in each province. The enumerators were trained by Statistics South Africa (Stats SA) to embark on data collection route. The data collection technique employed was face to face interviews using questionnaire. Regarding interviews, the GHS data also indicates that the interviews were conducted in various languages. Moreover, the sample size for GHS 2019 ($N = 372190$).

Data entry and analysis

Data entry and cleaning were carried out using statistical software package for social science SPSS version 29.0.2.0 for the analysis. Descriptive statistics analysis was used to show the frequency distribution by using tables. The bivariate analysis to observe the disparities in terms of internet accessibility by women rural farmers to reach agricultural markets. Binary logistic regression model was used to assess and identify the leading factors on the access to the internet in the household.

Informed consent

This study used secondary data collected primarily by Statistics South Africa. Statistics South Africa covered all the ethical requirements. Therefore, there was no need for informed consent when writing this paper.

Results

Characteristics of the sampled farmers

Sociodemographic and socioeconomic characteristics were key in determining the decisions made by women smallholder farmers about access to internet within the households in rural areas of South Africa. Results in Table 1 presents the characteristics of the respondents in this research. Of the total sample of 372,190 participants, majority of the respondents were between 12 and 22 years (27.5%), followed by those between 23 and 33 years (21.0%), 34–44 years (18.6%) and the least of the population were between 56 and 66 years (10.1%). This means that most of the women who are in smallholdings are youth and middle-aged. Most of the respondents were Black (87.6%), Whites (11.2%), and Coloured (1.2%). About 70.6% of the respondents were found to be not married with the remaining 29.4% married. The study findings contradict with the study done by Rathnachandra and Malkanthi [54] in Sri Lanka, whereby about 91% of the women farmers were married.

Regarding education levels, very low number of respondents had no education (7.3%), while 21.4% had primary education. Most of the respondents had completed secondary education (59.7%), and the remaining 11.6% had completed tertiary education. These results

Table 1 Sociodemographic and socioeconomic factors of respondents N = (372190)

Characteristics	Frequency (*n*)	Percentage (%)
Age groups		
12–22	102,214	27,5
23–33	78,284	21,0
34–44	69,206	18,6
45–55	44,190	11,9
56–66	37,503	10,1
67+	40,793	11,0
Population group		
Black	325,986	87,6
Coloured	4535	1,2
Whites	41,669	11,2
Marital status		
Married	109,588	29,4
Not married	262,602	70,6
Highest level of education		
No education	27,221	7,3
Primary	79,698	21,4
Secondary	222,217	59,7
Tertiary	43,054	11,6
Income Sources		
Salaries/wages/commission	102,869	27,6
Income from a business	66,842	18,0
Remittances	28,660	7,7
Pensions	8434	2,2
Grants (include old age grant here)	165,684	44,5
Metro-coding		
Western cape	13,268	3,6
Eastern cape	56,579	15,2
Northern cape	10,960	2,9
Free state	3587	1,0
Kwa-Zulu Natal	91,505	24,6
North West	41,989	11,3
Gauteng	3789	1,0
Mpumalanga	44,779	12,0
Limpopo	105,734	28,4
Overall	372,190	100,0%

Author's computations from South Africa GHS data, 2019

conform to the findings by Churi et al. [16] and this implies that majority of farmers in rural areas have not gone for higher level education. Thereto, low education among the farming communities affects women's ability to adopt different technologies.

With respect to their income sources, the results further reviewed that majority (44.5%) have access to grants (inclusive of old age grant), while about 27.6% have salaries, wages, and commission. Moreover, about 18.5% have income from the business while others are getting their income from remittances (7.7%), and only a few (2.2%) are receiving pension funds. The findings suggest that most of the farmers are not earning sustainable levels of income as most of the grant recipients are not earning much money to sustain their families, therefore affording day-to-day internet connection may be expensive to afford. It was also reported that most of the farmers were from rural areas of Limpopo (28.4%), followed by those from Kwa-Zulu Natal (24.6%), Eastern Cape (15.2%), and the least of the women rural farmers were from Gauteng and Free State with 1.0%.

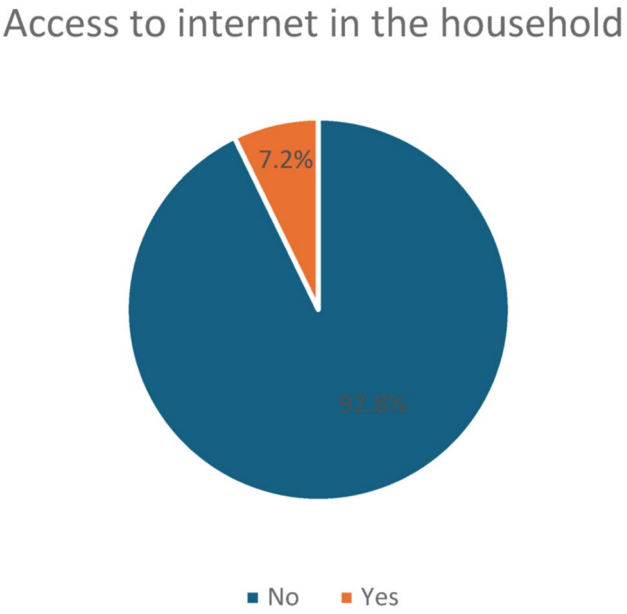

Fig. 2 Internet accessibility within the household

Access to internet in the household

It was inquired if respondents have access to the internet within the household. Figure 2 illustrates that 92.8% (345518) of the population indicated that they have no access to the internet in the household while 7.2% (26672) mentioned that they had access to the internet in the household. In rural areas, 90% of farmers own working mobile phones and 31% of businesses have access to functional landline telephones, but internet connectivity is limited [38].

The 7.2% access rate was a clear demonstration that the female farmers in rural areas have a very low in-house internet access rate. There is a possibility that most of the can use telephones to get agricultural information instead of having an in-house internet connection. Rural women might show a lack of interest or knowledge of ICTs, in part owing to a lack of digital skills and confidence [28], but also due to the absence of relevant content in local languages [60]. English is the primary language of the internet, so this could predominantly pose a predicament if farmers have low literacy levels, thus failing to comprehend and utilize the information as provided by the internet.

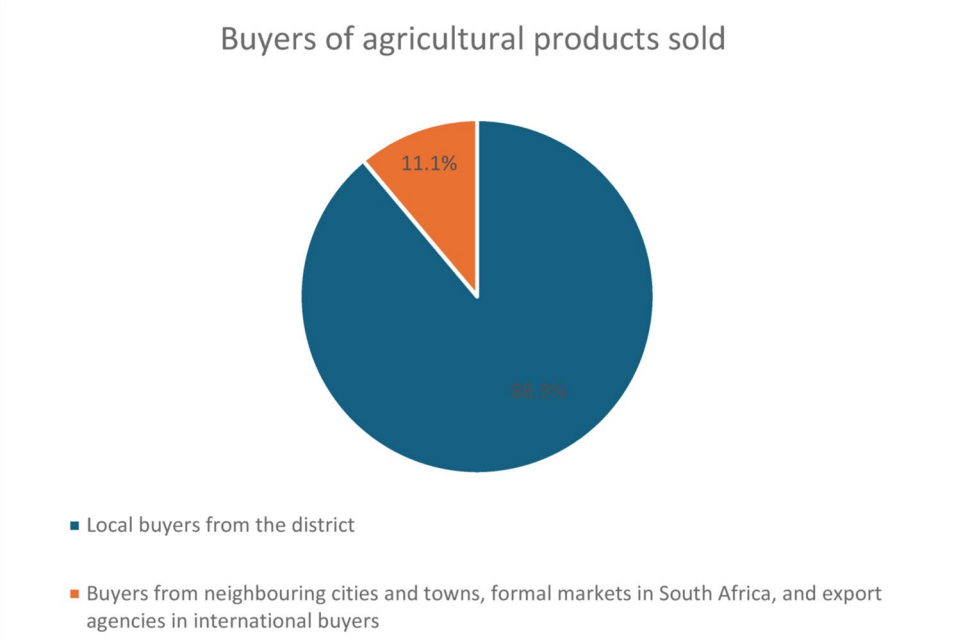

Fig. 3 Buyers of agricultural products sold by women farmers

Table 2 Access to internet by age groups to reach buyers of agricultural products

Buyers of agricultural products		Access to internet in the household						
		12–22	23–33	34–44	45–55	56–66	67+	Total
Local buyers from this district	No	86,470	67,208	51,602	36,627	31,411	38,681	311,999
		27,7%	21,5%	16,5%	11,7%	10,1%	12,4%	100,0%
	Yes	7097	2179	8197	1239	0	0	18,712
		37,9%	11,6%	43,8%	6,6%	0,0%	0,0%	100,0%
	Total	93,567	69,387	59,799	37,866	31,411	38,681	330,711
		28,3%	21,0%	18,1%	11,4%	9,5%	11,7%	100,0%
Buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers	No	8648	6405	6498	4965	4891	2112	33,519
		25,8%	19,1%	19,4%	14,8%	14,6%	6,3%	100,0%
	Yes	0	2492	2909	1358	1201	0	7960
		0,0%	31,3%	36,5%	17,1%	15,1%	0,0%	100,0%
	Total	8648	8897	9407	6323	6092	2112	41,479
		20,8%	21,4%	22,7%	15,2%	14,7%	5,1%	100,0%

Buyers of agricultural products sold

This question was aimed at ascertaining the markets that small-scale farmers are most likely to access to trade-off agricultural products. Figure 3 depicts that about 330,711 (88.9%) access local buyers from the district, while 41,479 (11.1) access buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers. The study findings suggest that accessing buyers that are beyond local remains a challenge in rural areas of South Africa, whilst selling farm products locally is prevalent. In a discussion with the farmers, it was noted that lack of market information makes them to sell their agricultural produce at farm gate price to the middlemen or in their local market hence continuation of poverty among the farming communities [30].

Access to internet for market accessibility by characteristics

Access to internet and age groups by buyers of agricultural products sold

From Table 2, results depict about 44% of smallholders aged between 34 and 44 years, followed by a 38% aged between 12 and 22 years, and the least of the population were about 7% aged between 45 and 55 years of age who had access to the internet within the household to reach local buyers of farm products. Table 2 further depicts the population of smallholders who did not have access

to the internet, a majority (27.7%) were aged between 12 and 22 years, few (21.5%) between 23 and 33 years, and the fewer (10.1%) between 56 and 66 years and had access to local buyers from the district for agricultural products.

Therefore, the study findings suggest that those aged 56 years and older did not have access to the internet due to that it might not be easy to use it to obtain market information concerning buyers of farm products, as such they would rather resort to traditional ways of trading off agricultural products to passing-by customers in local areas.

Moreover, study further indicates a 36.5% (34–44), 31.3% (23–33), and 15.1% (56–66) who had access to the internet in the household could contact buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers (p-value < 0.05). Comparably, amongst women farmers who could not access internet in the household, close to 26% were aged between 12 and 22 years, 19.4% between 34 and 44 years, and 19.1% between 23 and 33 years. Quite eye-catching, 6.3% aged 67 years and older who were without in-house internet made means to contact buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers.

Furthermore, results showed a significant association between women farmer's age groups and access to agricultural information through internet connection within the household. This implies that access to information using in-house internet is dependent of respondent's age. According to findings, both the youth and old farmers accessed internet in varying magnitudes and that could also suggest knowledge gaps on how to surf and operate internet.

Table 3 Access to internet by population group to reach buyers of agricultural products

Buyers of agricultural products		Access to internet in the household			
		African/black	Coloured	White	Total
Local buyers from this district	No	291,177	4535	16,287	311,999
		93,3%	1,5%	5,2%	100,0%
	Yes	7970	0	10,742	18,712
		42,6%	0,0%	57,4%	100,0%
	Total	299,147	4535	27,029	330,711
		90,5%	1,4%	8,2%	100,0%
Buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers	No	26,389		7130	33,519
		78,7%		21,3%	100,0%
	Yes	451		7509	7960
		5,7%		94,3%	100,0%
	Total	26,840		14,639	41,479
		64,7%		35,3%	100,0%

The Phi and Cramer's V tests (0.183) depicted a strong correlation relationship between age and internet access in the household. Along these lines, albeit women rural farmers struggled to secure active internet in the household but made means to reach buyers of agricultural products both locally and beyond to formal and international markets.

Access to internet and population group by buyers of agricultural products sold

The results in Table 3 show that White farmers (57.4%) had more access to the internet over Black farmers (42.6%) to access local buyers form the district, whilst the Coloured did not have access to the internet. On the other hand, a majority (93.3%) of farmers without internet were Blacks trading-off agricultural products locally, followed by the Whites (5.2%), and the Coloured (1.5%). The study results concur with Pesci et al. [52] whereby most of the farmers who identified as white had an online presence and sold products online. It is visible that having internet is an essential tool to reach direct agricultural markets.

Moreover, Whites who had an in-house internet (94.3%) accessed buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in other countries. Whilst the Blacks (5.7%) remained a minority. Into the bargain, about 78.7% and 21.3%, respectively Black and White farmers who did not have internet in the household made means to reach buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies (p-value < 0.05). Even though the data encompassing of Coloured women smallholders in this regard was missing. Additionally, the Phi and Cramer's V tests (0.504) denoted a very strong relationship between race and internet access in the household.

Access to internet and marital status by buyers of agricultural products sold

From Table 4, large proportion of the unmarried women farmers (67.0%) had access to the internet to access market information, and their counterparts (33.0%) also had access to the internet to reach potential buyers from the district. Quite the contrary, the farmers without internet connection within the household, 73.2% were unmarried women farmers and the remaining 26.8% were married who accessed local buyers from the district. However, only the married farmers (100%) who had an in-house internet could attain buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers. In some instances, it could be due to the cooperation by household members whereby the other spouse has off-farm financial engagements to gain more income that will help them to improve farming

Table 4 Access to internet by marital status to reach buyers of agricultural products

Buyers of agricultural products		Access to internet in the household		
		Married	Not married	Total
Local buyers from this district	No	83,616	228,383	311,999
		26,8%	73,2%	100,0%
	Yes	6168	12,544	18,712
		33,0%	67,0%	100,0%
	Total	89,784	240,927	330,711
		27,1%	72,9%	100,0%
Buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers	No	11,844	21,676	33,520
		35,3%	64,7%	100,0%
	Yes	7960	0	7960
		100,0%	0,0%	100,0%
	Total	19,804	21,676	41,480
		47,7%	52,3%	100,0%

activities and their living standard. Such a household can at least afford internet within household premises, such as having a router and data contracts to access market information.

More so, a noticeable proportion (64.7%) of unmarried farmers who were without internet access considered market information as very important agricultural information that can help them secure a reliable market to sell their agricultural produce to neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers. Whilst the married farmers (35.3%) who had no internet access also reached farm products buyers from neighbouring areas, formal markets in South Africa, and international markets (p-value < 0.05). The Phi's test (-0.143) showed a negative moderate relationship between marital status and access to the internet in the household. On the other hand, Cramer's V (0.143) test showed a positive moderate correlation.

Access to internet and highest level of education by buyers of agricultural products sold

Farmers with secondary education (58.0%) are in the majority pertaining to internet use to access local buyers from the district, few farmers have tertiary (31.3%) and fewer farmers (10.7%) have primary education as indicated in Table 5. In contrast, to smallholders who had no internet access, a majority (59.7%) was reported amongst farmers with secondary education. About 22.7% had primary education, 9.6% had tertiary, and the least (8.0%) had no education. Pertaining to digital literacy, rural women tend to lack the ability to use a mobile device and tend to be less literate than urban women [18, 73]. However, the study found that none of the women farmers were found to have no schooling who had internet in the household. Then again, it is not literacy alone that constrains women from using the mobile internet [75]. Broader misunderstandings about what they are accessing, how to access it, and what it is used for are also constraints. However, more of farmers had secondary education which is adequate and favourable in technology adoption.

There was a statistically significant difference between the highest level of education and internet access within the household as determined by Chi-square test estimates (p-value < 0.05), and Phi and Cramer's V tests = 0.195 denoting a strong relationship between highest level of education and access to the internet to reach agricultural markets. The findings further indicate that only women farmers who had secondary (69.6%) and tertiary (30,4%) education accessed buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers by means of internet accessibility. Whilst, among farmers who had no internet access, 58.1% had secondary, 20.8% had primary, 14,6% had tertiary education, and the 6.5% had no schooling.

Table 5 Access to internet by highest level of education to reach buyers of agricultural products

Buyers of agricultural products		Access to internet in the household				
		No education	Primary	Secondary	Tertiary	Total
Local buyers from this district	No	25,035	70,728	186,338	29,898	311,999
		8,0%	22,7%	59,7%	9,6%	100,0%
	Yes	0	2002	10,860	5850	18,712
		0,0%	10,7%	58,0%	31,3%	100,0%
	Total	25,035	72,730	197,198	35,748	330,711
		7,6%	22,0%	59,6%	10,8%	100,0%
Buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers	No	2186	6968	19,481	4885	33,520
		6,5%	20,8%	58,1%	14,6%	100,0%
	Yes	0	0	5539	2421	7960
		0,0%	0,0%	69,6%	30,4%	100,0%
	Total	2186	6968	25,020	7306	41,480
		5,3%	16,8%	60,3%	17,6%	100,0%

Table 6 Access to internet by income sources to reach buyers of agricultural products

Buyers of agricultural products		Access to internet in the household					
		Salaries/wages/commission	Income from a business	Remittances	Pensions	Grants (include old age grant here)	Total
Local buyers from this district	No	83,535	43,305	27,596	4740	152,824	312,000
		26,8%	13,9%	8,8%	1,5%	49,0%	100,0%
	Yes	9249	2927	0	0	6536	18,712
		49,4%	15,6%	0,0%	0,0%	34,9%	100,0%
	Total	92,784	46,232	27,596	4740	159,360	330,712
		28,1%	14,0%	8,3%	1,4%	48,2%	100,0%
Buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers	No	10,085	12,651	1064	3395	6324	33,519
		30,1%	37,7%	3,2%	10,1%	18,9%	100,0%
	Yes	0	7960	0	0	0	7960
		0,0%	100,0%	0,0%	0,0%	0,0%	100,0%
	Total	10,085	20,611	1064	3395	6324	41,479
		24,3%	49,7%	2,6%	8,2%	15,2%	100,0%

Table 7 Access to internet by metro-coding to reach buyers of agricultural products

Buyers of agricultural products		Access to internet in the household									
		WP	EC	NC	FS	KZN	NW	GP	MP	LP	Total
Local buyers from this district	No	3045	49,011	4946	591	77,776	35,583	3138	38,948	98,962	312,000
		1,0%	15,7%	1,6%	0,2%	24,9%	11,4%	1,0%	12,5%	31,7%	100,0%
	Yes	8010	0	588	0	7970	0	651	1493	0	18,712
		42,8%	0,0%	3,1%	0,0%	42,6%	0,0%	3,5%	8,0%	0,0%	100,0%
	Total	11,055	49,011	5534	591	85,746	35,583	3789	40,441	98,962	330,712
		3,3%	14,8%	1,7%	0,2%	25,9%	10,8%	1,1%	12,2%	29,9%	100,0%
Buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers	No	1384	5527	4363	0	5760	6406		4338	5741	33,519
		4,1%	16,5%	13,0%	0,0%	17,2%	19,1%		12,9%	17,1%	100,0%
	Yes	829	2042	1062	2996	0	0		0	1031	7960
		10,4%	25,7%	13,3%	37,6%	0,0%	0,0%		0,0%	13,0%	100,0%
	Total	2213	7569	5425	2996	5760	6406		4338	6772	41,479
		5,3%	18,2%	13,1%	7,2%	13,9%	15,4%		10,5%	16,3%	100,0%

NB: **WC**- Western cape; **EC**- Eastern cape; **NC**- Northern cape; **FS**- Free state; **KZN**- Kwa-Zulu Natal; **NW**- North West; **GP**- Gauteng; **MP**- Mpumalanga; & **LP**- Limpopo

Access to internet and income sources by buyers of agricultural products sold

From Table 6, close to a half (49.4%) of farmers who had internet access had salaries, wages, or commission, 34.9% were grant recipients (including old age grant), and close to 16% had income from a business, reached local buyers from the district. On the other hand, considering farmers that had no internet access who somewhat accessed local buyers, 49.0% were grant earners, 26.8% had salaries, wages, or commission, and the least of the farmers were pensioners (1.5%).

The study findings further indicate farmers who had accumulated income from a business (100%) to have accessed internet to reach buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in other countries Whereas, farmers who had no internet in the household, a noticeable 37.7% had income from a business, 30.1% had salaries, wages or commission, and the least of farmers were pensioners (10.1%). Moreover, a statistical significance difference among the income sources regarding access of internet to reach buyers of agricultural products sold as determined by Phi and Cramer's V = 0.196 denoting a strong correlation amongst the cofactors, and $p < 0.05$.

Access to internet and metro-coding by buyers of agricultural products sold

This variable geo-filtered all the metropolitan or urban areas and only selected the rural areas across all the nine provinces of South Africa to befit the study objective. The majority (42.8%) are women farmers from Western Cape, followed by Kwa-Zulu Natal (42.6%), Mpumalanga (8.0%), and the least (3.1%) were farmers from Northern Cape who had access to the internet within the household to reach local buyers from the district (Table 7). Analogously, amongst farmers who had no internet access, 31.7% were from Limpopo, 24.9% were from Kwa-Zulu Natal, 15.7% were from Eastern Cape, and the least were from Free State with 0.2%. The study results indicate

Table 8 Model summary

Step	-2Log likelihood	Cox & snell *R* square	Nagelkerke *R* square
1	79290,157[a]	0,261	0,648

Table 9 Goodness of fit (model diagnostic)

Hosmer-lemeshow test			
Step	**Chi-square**	**df**	**Sig.**
1	1046,943	8	0,000

that having an in-house internet access remains a predicament in the rural areas of South Africa.

Moreover, (37.6%) were farmers from Free State, (25.7%) from Eastern Cape, and the least (10.4%) were farmers from Western Cape who had access in the household to reach buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers. The study findings show that Kwa-Zulu Natal, North West, and Mpumalanga farmers had internet but none of the farmers had access to the internet to reach buyers from neighbouring cities and towns, formal markets in South Africa, and export agencies in international buyers. On the other hand, in rural Gauteng there was no noticeable statistics of women smallholders who have internet connection within their households.

Furthermore, the results show a sampled population of women farmers who had no internet access who rather reached for buyers from nearby cities and towns, formal markets in the country, and export agencies in remote countries. Nearby 19.1% were rural farmers from North West, 17.1% from Limpopo, 17.2% from Kwa-Zulu Natal, and only a few (4.1%) were rural farmers from Western Cape. There was a positive correlation between Metro-Coding and internet access for contacting buyers of agricultural products sold ($p < 0.005$). The Phi and Cramer's V tests = 0.556, denoted a very strong correlation between the variables (Table 7).

Binary logistic regression

Model summary

In this section, the model summary is discussed. The most common assessment of overall model fit in logistic regression is the likelihood ratio test, which is simply the chi-square difference between the null model (i.e., with the constant only) and the model containing the predictors. Under Model Summary we see that the − 2 Log Likelihood statistics are 79290,157. This statistic measures how poorly the model predicts the access to internet by women smallholders, the smaller the statistic the better the model.

As per Table 8, Cox and Snell's R^2 (0.261) denotes a weak level of correlation between the respondents" internet use within the household for agricultural purposes (accounting for 26.1% of the total variation in the dependent variable explained by the independent variable). However, the result of Nagelkerke R Square value is 0.648 (accounting for 64.8% which denotes a strong correlation between the dependent variable and the co-factors). This means that access to the internet in the household variable can be explained by the variables of age group, population group, marital status, highest level of education, income sources and metro-coding (Table 8). In this case, these values indicate that the variation in the dependent variable as explained by the predictor variable is assumed to be good enough (Table 8).

The Hosmer-Lemeshow test shown in Table 9 explores whether the predicted probabilities are the same as the observed probabilities. An overall goodness of fit of the model is indicated by p-values > 0.05 [26, 41]. As is observed from the table below, P-value is 0.000 which falls within the cut-off level of significance at 5%. The $P < 0.05$ value indicates a significant relationship between the respondents" internet access in the household by women farmers and predictor variables. We can also conclude that the data does not fit the model well.

The finding from logistic regression show that age was significant with internet usage. Age was one of the contributing factors to internet accessibility. The findings indicate that all age groups were significant except those aged 67 years and older. Along these lines, results depict that being a women smallholder aged between 12 and 22 years increases the chances of having access to the internet within the household 1,00 times likely than being aged between 23 years older. From Table 10, it is observed that being population group was also significant. The findings reveal that being White increases the chances of accessing internet within the household 11,575 times likely than being African/Black.

The findings depict that farmers who are not married are 0,457 times less likely to use internet within the household than those who are married. The highest level of education was also significant, but all the educational categories were insignificant. This denotes that educational level variable as an overall contributes to explaining the phenomenon of internet access in the household. However, the statistical differences between its subgroups and the reference group are not strong enough to meet the threshold $p < 0.05$ as a cut-off point individually.

Whithersoever, it can be underscored that women small-scale farmers who are tertiary education holders are 7,141 times likely to use internet within the household than those with no education. Moreover, being a women farmer dwelling in the rural areas of Free State increases the chances of using internet within the household 6,033 times likely than those from Western Cape or dwelling in either of the rural areas across all the South African provinces.

Table 10 The likelihood of accessing internet within the household

Characteristics	B	Wald	Sig.	Exp(B)
Age group		4951,128	0,000	
23–33	-0,328	130,779	0,000	0,720
34–44	-0,576	292,641	0,000	0,562
45–55	-2,880	3161,013	0,000	0,056
56–66	-3,816	3212,539	0,000	0,022
67+	-20,959	0,019	0,891	0,000
Population group		11781,415	0,000	
Coloured	-17,439	0,001	0,972	0,000
White	4,715	11781,4	0,000	11,575
Marital status	-0,783	390,740	0,000	0,457
Highest level of education		5611,969	0,000	
Primary education	14,748	0,008	0,930	0,667
Secondary education	15,652	0,009	0,925	3,776
Tertiary education	17,721	0,011	0,916	7,141
Income sources		1990,058	0,596	
Income from a business	1,00	919,233	0,000	2,711
Remittances	-16,292	0,006	0,936	0,000
Pensions	-15,353	0,002	0,968	0,000
Grants (include old age grant here)	1,427	1891,224	0,000	4,165
Metro-coding		13711,575	0,000	
Eastern cape	-2,267	2386,036	0,000	0,104
Northern cape	-0,362	42,831	0,000	0,697
Free state	1,797	547,317	0,000	6,033
KwaZulu-Natal	0,335	49,418	0,000	1,398
North West	-20,283	0,017	0,898	0,000
Gauteng	-3,385	3411,356	0,000	0,034
Mpumalanga	-3,490	3773,504	0,000	0,030
Limpopo	-2,747586103	3134,363114	0,000	0,064
Constant	**-18,298**	**0,012**	**0,913**	**0,000**

Discussion

The study results are in line with the indications from of Shaik et al. [61], Mwakaje [43], Maumbe and Okello [35], Anju and Barclay [10] who have found the relevance of ICTs in accessing farm-related information. In the present study, the association between the independent variables Age, Population Group, Marital Status, Highest level of Education, Income Source, and Metro-coding and the dependent variable Access of Internet Within the Household was tested. All the variables were found to be strongly correlated with the dependent variable, except for marital status that was found to have a moderate relationship with internet access within the household.

Study results show that middle-aged and younger people used internet within the household more than their elder counterparts. The farmers who are middle-aged predominantly could access markets for agricultural products from local buyers from the districts, expanding to buyers of agricultural products from nearby cities and towns, formal markets, and buyers in export agencies in international buyers. Though, younger farmers could also access local buyers for farm products and buyers in international spaces, it was only a few of them. The study findings are in line with Musa et al. who found the older group to be unaccustomed with modern communication technologies and often, the youth are far more familiar with social networking and other recent advances in internet access and usage. Moreover, older farmers are assumed to have more farming expertise and, as a result, would place less value on information obtained from the Internet than younger farmers with less experience would [79]. Furthermore, because older people have less time available to them until they retire, they have less time in which to reap the benefits of their investment [38, 79]. Contrary to this premise, several studies conclude that younger farmers are more likely to participate in the markets than the old farmers, because they are innovative risk-takers, and are likely to be open to new and more progressive ideas; therefore, they may always be eager to try new things [22, 53].

Regarding population group, most of the Black women farmers access local buyers from the district. Noticeably, White predominantly use an in-house internet to access buyers in nearby cities and towns, formal markets, and export agencies in international buyers. This shows that a magnitude of Black farmers in the rural areas of South Africa is severely struggling to reach formal markets of farm products. Black farm worker families are among the most vulnerable groups in society [9] and are also subject to seasonal food insecurity and hunger caused by intra-annual fluctuations in agricultural employment and income that mirror agricultural production cycles (Devereux & Tavener-Smith, 2019 cited in [1]). This necessitates that policies that target rural development put Black farmers at the central point as the most affected minority in terms of technology adoption. Then again, the legacy of apartheid also did not make things easy for the country's agricultural system. The South African agriculture that was classed as a dual system with mostly white well-developed capital-intensive large-scale farmers on the one side and mostly black less-developed smallholder and subsistence farmers that lack resources on the other side [65], could be the reason that there are still pending hindrances that pose as a threat of rural development in South Africa, inclusive of the adoption of information technologies.

Moreover, for the most part of the unmarried women farmers use internet to access local buyers form the district, whilst the married farmers access formal markets and export agencies in international buyers from agricultural products. This finding is in harmony with Zhu et al. [78] who indicated that being married increases of

adopting the ICTs, as compared to unmarried counterparts. The study done by Nyamba [49] also found marital status to be significantly associated with the use of mobile phone internet to reach for agricultural information. This could be that married farmers have spouses and dependents who might be having adequate knowledge on how to operate ICTs and surfing the internet to obtain market information, and economic support to afford internet connectivity. According to Edin [20], being married is deemed as beneficial for people to earn more money, which means married farmers may receive financial assistance from some of the household members to afford internet in the household.

The educated farmers, who have at least completed secondary and tertiary education used the internet in the household than their less educated counterparts. The finding echoes with the result of Rogers [56], who showed that individuals with more educational years are more likely to adopt innovative technologies such as the Internet. Moreover, the secondary and tertiary education holders could access local buyers and formal markets, and buyers in international peripheries. Having secondary education is adequate to be knowledgeable on operating communication technologies to access market information. The amount of agricultural related information accessed was more among educated farmers. Better education can not only help farmers to be aware of the positive benefits associated with ICT adoption but also improve their knowledge and skills of adopting the ICTs [78].

The result shows that salary, wages, and commission earners recorded the highest access of internet in the household and in turn used to access local buyers from the district for agricultural products. This means that ICT adoption and income source are jointly determined. According to the findings, farmers are more likely to understand and apply information offered to them, particularly through ICT, based on income they have. The result of this variable is consistent with the study done by Michailidis et al. [39]. They indicated that internet access in rural Greece was influenced by income.

In addition, Mwombe et al. [44] showed that income was among determinants that influenced the use of ICT by as a source of obtaining agricultural information by banana farmers in Kenya. This means that lack of financial resources could pose a challenge to use internet within the household to obtain buyers of agricultural products sold. However, farmers who generated income from a business mainly were farmers who made entrance to formal markets and reached buyers in export agencies international buyers. There is evidence that off-farm income (that is income derived from wage paying activities and self-employment in commerce, manufacturing and other services) is an important resource for farm and other rural households among urban residents [46]. There is, therefore, a greater need for advancement in market orientation and market participation, to better link the farmers to the markets to have a suitable market for their agricultural produce and to receive a boost for their income generation [51]. It is an important strategy for increasing women's incomes through opportunities to diversify from low access of internet to enhance farm productivity and ensure food security.

This study indicates that small-scale farmers choose local buyers from the districts which are often informal markets to sell agricultural produce to secure their livelihoods and food security, despite the evolution of formal and restricted markets in South Africa, and those in international export agencies. The study results showed that farmers dwelling in rural areas of Western Cape and Kwa-Zulu Natal recorded highest to access internet in the household to reach local buyers from the district for agricultural products. While rural farmers from Free State and Eastern Cape could access the internet available within the household to reach buyers that were beyond local, advancing to formal markets, and export agencies in international buyers.

Conclusion

This paper examined factors affecting access to the internet in the household by women smallholder farmers. Existing empirical studies were done on a household level and have consistently highlighted that women have much lower observed rates of adoption of a wide range of technologies. Most of these studies conclude that it is there is a gendered digital divide in access to these technological innovations, information about these innovations, or corresponding inputs and services that explicate gender differences in ICT adoption. Women smallholders in the non-metropolitan areas still struggle to access markets for agricultural information. This is due to their inability and lack of capacity to access internet in the household. Consequently, it makes it difficult for them to enter formal markets and markets in export agencies for farm production.

As the study results show, internet access has a strong relevance in the small-scale subsistence food production sector. When a correlation test was performed on internet access versus all the other explanatory variables such as age, race, education; just to name a few and market-orientated information accessed by the farmers, positive correlations were observed, implying that internet access within the household plays a vital role in helping women farmers to gain market insights. There were also positive relationships among the independent variables and internet access variable indicating that there were common factors that influence the internet access behaviour of farmers. Logistic regression shows that age, population

group, marital status, and metro-coding were the leading factors influencing the adoption of internet within the household by women farmers to reach buyers of agricultural products sold. The study results are significant for the policymakers to launch necessary technological innovations. These policy interventions can include – but is not limited to – the development of ICT infrastructure targeting households with active women small-scale farmers; empowering women's employment in agriculture; supporting women's entrepreneurship in agriculture and identifying access priorities.

Recommendations

1. Governments at the national level must collaborate with groups like farmers. Designed to allow the exchange of agriculturally related knowledge, information, and experiences regarding various ICT initiatives and projects in Africa.
2. Strategies for training and building up people's, groups', and communities' capacity to be knowledgeable about using ICT to gain market information and links to new clients must be developed.
3. Government could also install public WIFI's given that data usage is limited and moderated for useful intentions; more especially in community halls where hired facilitators could ensure a proper usage of internet connectivity.
4. Because doing so speeds up the adoption of new technology, the organisation and other agriculturally focused organisations should encourage small-scale farmers to work in community groupings.

Limitations of the study

The results of this should be interpreted while noting some limitations of this study. SADHS data are cross-sectional in nature; this limits the drawing of causal inferences with proper reasoning and logic that can authenticate the findings. However, the study has some strengths; one of the strengths of this study is that SAGHS is a nationally representative data, conducted with assistance from Stats SA and uses consistent methodology which makes it simpler to analyse the data over different time points. Additionally, the sample size was big. With a larger sample size, there is a possibility of detecting diverse outcomes compared to those obtained in smaller sample sizes.

Areas for future research

To fully comprehend access to the internet in the household by women farmers, more research is required. For example, it is critical to quantify the amount of accessibility that small-scale farmers have experienced since accessing internet in the household. Knowing how farmers access internet in the household for agricultural market information is insufficient. Therefore, more recent and primary data is needed to observe structural changes over time. Furthermore, to determine whether the agricultural knowledge rural women farmers receive on internet also openly affects their farm returns and productivity, a thorough understanding is necessitated. It is also critical to look at the degree and extent to which employing internet in the household to obtain agricultural information results in profit gains. A recent study that might also analyse types of farming such as livestock production, poultry, fodder grazing etc. in relation to access to the internet in the household is needed to direct policy interventions, so that assistance may be directed towards the most affected minorities.

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Author contributions
"F.S. Wrote the main manuscript. P. Guided the whole manuscript and with co-wrote the literature review. p. Also helped with proofreading and advised for the presentation of the manuscript with Population Association of Southern Africa (PASA) conference of 2025".

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval
The study made use of the secondary data that was collected by Department of Statistics South Africa, which covered and followed all ethical procedures when collecting data.

Consent to Participate
The participants were interviewed by the Department of Statistics South Africa which ensured all ethical considerations. The GHSProgram warrants that all data are anonymised before being released to the public so that no analyst can be able to identify the survey respondents. The data can only be used for the registered project.

Competing interests
The authors declare no competing interests.

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