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Factors Influencing the Perceptions of Smallholder Farmers towards Adoption of Digital Technologies in Eastern Cape Province, South Africa

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Abstract: The objective of the study was to determine the factors that influence the perceptions of smallholder farmers towards the adoption of digital technologies. A purposively selected sample of 250 smallholder farmers who were cross-sectionally surveyed from Port St Johns and Ingquza Hill Local Municipalities in South Africa was used in the study. The Technology Acceptance Model (TAM) and the Attention, Desire, and Action (AIDA) model were used to analyse the data. The results showed that digital technologies were perceived to be expensive, cause a digital divide, and discouraged the use of Indigenous Knowledge even though they increased production. Positive perception towards digital technologies was associated with cattle rearing, with extreme negative perception for sheep and goat rearing. Educational level, employment status, monthly income, household size, being part of a cooperative (1% level), age, and source of income (10% level) were significant factors affecting smallholder farmers' perceptions of digital technologies. In conclusion, there are economic, social justice, and traditional perceptions towards digital technologies by smallholder farmers, with socio-economic factors affecting the perceptions. The study recommends providing low-cost digital technologies that promote Indigenous Knowledge, which should target the youth and young farmers with less education in small households who are full-time farmers with moderate-to-high incomes and are part of farmer groups/organisations.

Keywords: attention, interest, desire, and action (AIDA) model; digital technologies; perceptive index; technology acceptance model (TAM)

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1. Introduction

Sustainable agricultural development can be achieved through the use of digital technologies, which can lead to achievement of Sustainable Development Goals (SDGs) 1, 2, 6, 8, 12, 14, and 15 [1]. Agriculture is an essential livelihood sector in Sub-Saharan Africa (SSA), accounting for 54% of the working population [2] and contributing 15% to Gross Domestic Product, even though highs of 50% in Chad and lows of 2% in South Africa have been recorded [3]. The OECD/FAO [3] highlighted that the agricultural sector in SSA has been currently increasing at 2.6% per year, fuelled by an increasing local and international interest in the farm land, the rise of a middle class, rural to urban migration, urbanisation, and population growth. Despite a steady increase, agricultural growth has not been ideal, with low productivity [4] fuelled by lack of use in appropriate technologies [3].

Digital technologies have been identified as a solution to transform the agricultural sector in SSA and livelihoods of the 250 million smallholder farmers in the region [2]. In South Africa, agriculture contributes USD 21 billion, employing 5.3% of the population [2]. Relative to the rest of SSA, South Arica has advanced utilisation of digital technologies in the agricultural sector, mainly focusing on precision agriculture, Agri-e-commerce, digital procurement, Agri-digital financial services, and digital advisory services [2]. This has been backed by advanced telecommunication infrastructure and digital penetration. Due to various reasons, such as costs, economies of scale, and lack of integration with Indigenous systems, there had been little usage of digital technologies by the 2.4 million farmers in the smallholder sector compared to the commercial sector [5,6]. Some of the constraints to the utilisation of digital technologies by smallholder farmers in South Africa has been due to the perceptions towards digital technologies. However, openness to digital technologies is determined by the combination of perception and socio-economic characteristics [7]. Caffaro et al. [8] identified that perceptions towards digital technologies relate to usefulness, increased productivity, cost reduction, efficiency, and workload reduction. A negative perception towards digital technology offers a barrier to its adoption. Despite the aforementioned issues, there is still limited understanding of the drivers of digital technologies which is itself driven by perceptions. The objective of this study was therefore to identify the drivers of digital technology perception in a country such as South Africa, hypothesising various socio-economic and institutional factors affecting this perception. The underlying question that this study seeks to answer is: What are the factors affecting digital technology perceptions by smallholder farmers in South Africa?

2. Literature Review

There are various determinants on the level of perception towards digital technologies which include demographics and socio-economic factors. A study by Pishnyak and Khalina [7] and Caffaro et al. [8] highlighted that perceived ease of use, usefulness, safety, reliability, and socio-economic characteristics had a positive impact on the propensity to use innovations. In particular, gender, age, educational level, and household income had an effect on perceptions towards digital technologies [7]. Pishnyak and Khalina [7] and Thomas et al. [9] highlighted that perceptions towards digital technologies are influenced by informal social networks through social capital. Some of the sources of information include other farmers and farmer organisations. A qualitative study by Reissig et al. [10] highlighted that there are farm and farmer characteristics affecting the perceived usefulness of digital technologies. Farm structure, including size and enterprise type, had an indirect impact on the usefulness of digital technology. Furthermore, there was a relationship between perceptions towards digital technologies and the user competences [10]. Perceptive usefulness is affected by digital technology characteristics relating to improved performance, effectiveness, productivity, control, and quality [11].

Kaur and Singh [12] found that factors such as farmers' age, education, and farming experience determined their perceptions towards digital technologies. However, gender, household size, land size, and income did not determine perceptions towards digital technology. These characteristics have an effect on the information received through the use of digital technologies [13]. Factors such as age, gender, marital status, education, and income were some of the socio-economic factors affecting perceptions towards digital technologies identified by Meijer et al. [14] and Pfeiffer [15]. According to Dissanayake [16], subjective norms affect the perceptions of farmers to technologies. In this instance, the relevance of how other farmers or neighbours feel about the technology and their attitude can help shape individual perceptions towards a technology. Technology usefulness and skills to be formed also help in shaping the perception towards a technology [16].

Even though various studies on the use of digital technologies have been conducted in South Africa, most have been adoption studies [5,17,18] with very few highlighting the factors affecting smallholder farmers' perceptions towards digital technologies. Some of these studies have also taken qualitative approaches, lacking in statistical rigour [19–22]. It is essential to acknowledge the perceptions of digital technologies by farmers to enable development of appropriate technologies [23]. This is informative to digital technology developers, extension officers, and research centres. This allows efficient budget and time allocations. It becomes imperative to also acknowledge the socio-economic circumstances of the farmers and how they shape their perception complex so that they can be taken on board in designing and disseminating digital technologies. According to Gerli et al. [24], transforming the perceptions towards digital technologies is more essential than the technology itself if there is going to be sustained adoption. Perception of digital technology is a barrier to its adoption [9]. The perceived characteristic of a digital technology determines its adoption. It is essential to understand farmer perceptions for effective development and dissemination. Farmer perceptions also help shape behaviour [16]. It is therefore against this background that this paper sought to determine the factors that influence the perceptions of smallholder farmers towards adoption of digital technologies in Port St Johns and Ingquza Hill Local Municipalities. In this study, empirical analysis will be used to analyse the factors that influence the perceptions of smallholder farmers towards adoption of digital technologies in the study area.

3. Materials and Methods

3.1. Description of Study Area

Port St Johns (PSJ) and Ingquza Hill (IH) Local Municipalities located in OR Tambo District Municipality of South Africa were the study sites that were used. Both Local Municipalities are Category B rural, having high poverty levels with reliance on social grants [25,26]. Agriculture accounts for 2.0% of Gross Value Added (GVA) in IH Local Municipality compared to 1.4% in PSJ. There are 53.9% of households engaged in agriculture in IH compared to 47.0% in PSJ, with PSJ also having a higher employment rate within agriculture at 5.4% compared to 4.1% in IH [25,26]. Port St Johns (PSJ) Local Municipality has a population of 166,779, with 18.9% having completed high school in 33,951 households on 1292.2 km^2 [27]. The median age of the population in PSJ is 17, with 54% of the population under the age of 18. Around 54.0% of the population in PSJ are female, with 59.0% of the households being female-headed [28]. The Local Municipality has 20 ward areas and 130 rural areas/villages [29]. Port St Johns (PSJ) has high smallholder maize production mainly through smallholder subsistence farmers with some using irrigation [30–32]. Ingquza Hill (IH) Local Municipality sits on 2479 km^2, housing 60,697 households with a population of 303,379 [33]. About 19.6% of the population in IH have completed secondary school and 14.0% are unemployed, with 31.0% of households having less than ZAR 10,000 annual income. The Local Municipality also has 54.0% of the population under the age of 18, with a mean age of 17, with 58.0% of the households being female-headed and 78.0% living in poverty [25,33]. The study areas were ideal because they are agro-based and characterised by the rural poor exhibiting high poverty rates.

3.2. Conceptual Framework

The study combined the Technology Acceptance Model (TAM) and the Attention, Interest, Desire, and Action (AIDA) model (Figure 1) [34]. The TAM investigates adoption decisions which are driven by behaviour, itself a construct of attitude towards the use of that technology. Attitude is a direct reflection of beliefs and perceptions in usefulness and ease of use. The AIDA model is one of the information-based rational choice models which show that users of digital technologies go through a series of cognitive and emotional steps in making a purchase and adoption decisions, or in a behaviour change process [34,35]. The steps involve attracting attention through creating interest (cognitive level), with the second step turning this interest into strong desire (affective level). The final step is taking action to move to that behaviour (behavioural level) [36,37]. The AIDA model prescribes agricultural digital technology provider behaviour in promoting their use by smallholder farmers. Greater competition amongst service providers, utilisation of multi-lingual, customised value-added services, and integration of Indigenous Knowledge were some of the service provider activities advocated by Maumbe [6] to enhance adoption of digital technologies by smallholder farmers in South Africa. In the current study, the cognitive and affective levels of the AIDA conceptual framework will shape the perceptions that smallholder farmers have towards digital technologies in the TAM. In conjunction with the socio-economic circumstances of the smallholder farmers, the perceptions will shape the behavioural level of the AIDA conceptual framework, enabling adoption of digital technologies. The current study was focused on the perceptions towards digital technologies, thereby focusing on the initial parts of the conceptual framework relating to perceived usefulness and perceived ease of use. This was inquired from the users of digital technologies from which an overall index was formulated, as will be indicated in Section 3.3.

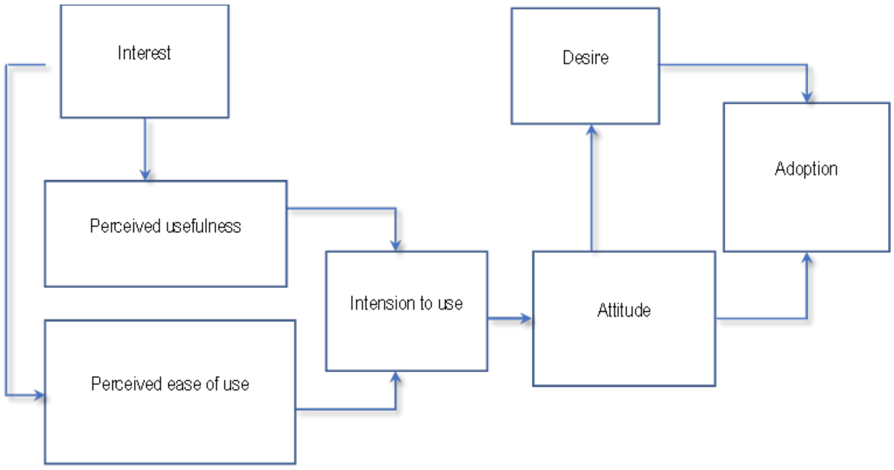

Figure 1. Conceptual framework combining the Technology Acceptance Model (TAM) and the Attention, Interest, Desire, and Action (AIDA) model. Source: Geng [34].

3.3. Study Design

A cross-sectional survey of a purposively selected sample of 250 smallholder farmers was used in the study. A Likert scale, Perceptive Index, and Tobit regression were used to analyse the data. The study used a Likert scale to measure the level of awareness and perception towards digital technologies by smallholder farmers. The 5-point scaled items that were used in the study are shown in Table 1. The respondents were asked to what extent they agreed with the perceptive questions. Internal validity was improved by pre-testing the questionnaire so that the questions measured what was intended, which was the perception, and any ambiguity in the questions was rectified. This reduced confusion and skip patterns.

Table 1. Perceptions of respondents towards digital technologies.

Perceptions of Adoption of Digital Technologies
Adoption of digital technologies can make farming easier
I have adequate knowledge of digital technologies
Use of digital technologies will be labour-saving
Use of digital technologies improves agricultural production
Through digital technologies smallholder farmers access information on time
Through digital technologies farmers access extension services easily
The use of digital technologies helps smallholder farmers to access the market
It is easy to access farm loans through digital technologies
Digital technologies are expensive compared to other agricultural innovations
The use of agricultural digital technologies improved household income
Digital technologies are user-friendly
Digital technologies are complicated
Digital technologies are the cause of the digital divide between smallholder and commercial farmers
Unequal access to digital technologies exists among smallholders
Digital technologies will discourage the use of Indigenous Knowledge and skills
All the digital technologies are suitable for smallholder farms
Use of digital technology will increase smallholder farmers' farming output
Use of digital technologies requires specific skills

Source: Authors own conceptualisation informed by the literature.

The Min-Max Normalisation as used by Ngarava [38] was used to standardise the perceptions towards digital technologies by smallholder farmers. The Min-Max Normalisation was used to produce an indicator which fell in the range of 0–1, using the following formula:

$$PI_{qi} = \frac{P_{qi(obs)} - P_{qi(min)}}{P_{qi(max)} - P_{qi(min)}}.$$

where PI_{qi} is the Perceptive Index of question i, $P_{qi(obs)}$ is the observed value of perceptive question i, $P_{qi(min)}$ is the global minimum value of question i (=1), and $P_{qi(max)}$ is the global maximum value of question i (=5). The overall PI_{qi} for each respondent was:

$$PI_{overall(j)} = \frac{\sum_{i=1}^{n} PI_{qi}}{n}$$

where n is the number of perception questions, which is 18.

The Tobit model used was modelled as follows [39–42]:

$$PI_i^* = x_i'\beta + \varepsilon_i,\ \varepsilon_i \sim N\left(0, \sigma^2\right)$$

$$PI_i^* = \begin{cases} PI_i^*, & if\ PI_i^* > 0 \\ 0, & if\ PI_i^* \leq 0 \end{cases}$$

where PI_i^* is the latent variable, which can only be observable when the values are greater than 0. Explanatory variables are depicted by x_i with a vector β and ε_i is the error term which is normally distributed. The following log-likelihood function L was maximised by estimating β and σ:

$$\max_{\beta,\sigma} \ln L = \sum_{PI_i > 0} \frac{1}{\sigma} \rho \left(\frac{PI_i - x_i'\beta}{\sigma} \right) + \sum_{PI_i = 0} \ln \left[1 - \tau \left(\frac{x_i'\beta}{\sigma} \right) \right]$$

where τ is the standard normal cumulative distribution function, ρ is the matching density function. The variables in Table 2 were used in the Tobit model.

Table 2. Variables used in the Tobit regression model for factors affecting the perceptions towards digital technologies by smallholder farmers in PSJ and IH Local Municipalities.

Variable	Explanation	Measurement	Expected Sign
Dependent PI	Perceptive Index	Truncated: 0 (negative)–1 (positive)	
Independent			
GEN	Gender	Nominal: 0—male, 1—female	−
AGE	Age (Years)	Nominal: 0—less than 40 years, 1—otherwise	−
MARST	Marital status	Nominal: 0—married, 1—not married	−
EDU	Education level	Nominal: 0—none, 1—otherwise	+
EMPL	Employment status	Nominal: 0—full-time farmer, 1—part-time farmer	−
SOUINC	Source of income	Nominal 0—social grant, 1—otherwise	+/−
MI	Monthly income (ZAR)	Nominal: 0—less than 1000, 1—otherwise	+
HHS	Household size	Nominal: 0—up to 5, 1—otherwise	+/−
FEN	Farming enterprise	Nominal: 0—crop production, 1—otherwise	+/−
TEN	Tenure	Nominal: 0—communal, 1—leased	+
FEX	Farming experience (Years)	Nominal: 0—less than 5 years, 1—otherwise	+
TR	Training	Nominal: 0—yes, 1—no	−
COOP	Part of cooperative member	Nominal: 0—yes, 1—no	−

The Tobit model was defined as follows:

$$PI = \beta_0 + \beta_1 GEN + \beta_2 AGE + \beta_3 MARST + \beta_4 EDU + \beta_5 SOUINC + \beta_6 MI + \beta_7 HHS + \beta_8 FEN + \beta_9 TEN \\ + \beta_{10} FEX + \beta_{11} TR + \beta_{12} COOP + \varepsilon$$

4. Results

Empirical Results

Figure 2 shows the perceptions towards digital technologies by smallholder farmers in Port St Johns (PSJ) and Ingquza Hill (IH) Local Municipalities. The Cronbach's alpha value of 0.70 shows that the Likert measures of perceptions were reliable and valid. There was strong agreement with digital technologies being expensive compared to other agricultural technologies (48.4%), improves agricultural production, (43.2%), they are a cause of a digital divide (37.6%), and discourage use of Indigenous Knowledge (33.2%). However, there was strong disagreement to smallholder farmers having knowledge about digital technologies (42.0%).

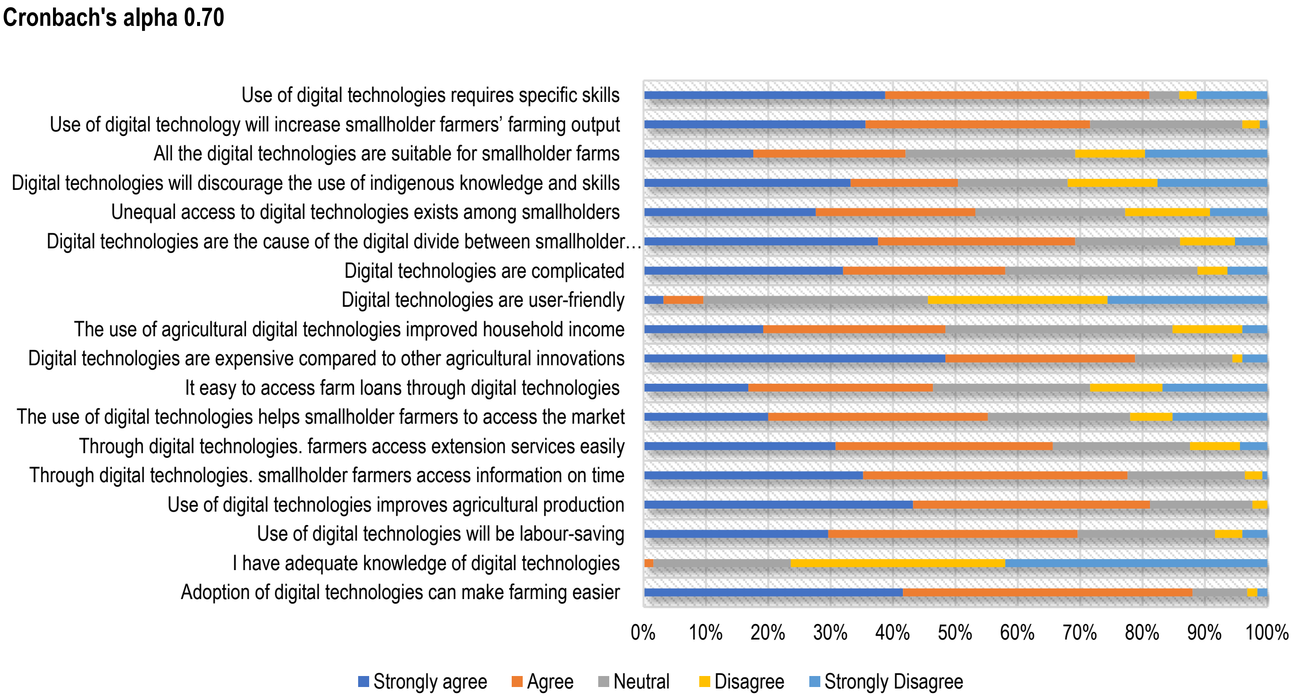

Figure 2. Perceptions towards digital technologies by smallholder farmers in Port St Johns and Ingquza Hill Local Municipalities.

The highest positive perception towards digital technologies for smallholder farmers in PSJ and IH Local Municipalities was associated with cattle rearing (23.53%), a combination of cattle and goat rearing (21.43%), and maize production (12.32%) (Figure A1). However, a certain level of negative perception was associated with all pig and chicken producers, as well as smallholder farmers involved with a combination of cattle and sheep rearing. In addition, extremely negative perceptions towards digital technologies by smallholder farmers had association with all farmers involved with rearing a combination of sheep and goats, a combination of cattle, sheep, and goats (44.0%), rearing goats (29.27%), and maize production (20.20%), respectively.

Extremely negative perceptions towards digital technologies by smallholder farmers in PSJ and IH Local Municipalities had association with 2–4 hectares of crop production (29.35%) and less than 1 hectare of animal rearing (25.66%) (Figure A2). Some level of positive perception towards digital technologies was associated with utilisation of less than 1 hectare of crop production (15.57%), 5–10 hectares (10.0%), and 2–4 hectares (7.61%). Positive perception was also associated with 2–4 hectares (13.33%) and less than 1 hectare (7.96%) of land use for animal rearing.

Figure A3 shows that extremely negative perceptions towards digital technologies by smallholder farmers in PSJ and IH Local Municipalities were associated with enterprises that sell less than 50 kg (42.86%), 150–200 kg (36.36%), and 250–300 kg (31.82%) of maize, respectively. Close to 23.08% of smallholder farmers who sell 150–200 kg and 15.15% of over 200 kg of cabbages have extremely negative perceptions towards digital technologies. Positive perception was exhibited by 27.27% of smallholder farmers that sell 150–200 kg of maize and 27.78% who sell less than 50 kg of cabbages.

There was association between positive perceptions of digital technologies and consumption of more than 200 kg (62.86%), 50–100 kg (9.80%), and 150–200 kg (9.38%) of maize, respectively (Figure A4). There was association with consumption of 50–100 kg (16.67%) and over 200 kg (12.50%) of cabbages. Most negative perceptions were associated with consumption of 50–100 kg of maize for 27.45% of smallholder farmers and consumption of less than 50 kg for 24.05%.

Table 3 shows the significance of the association between the perceptions towards digital technologies and the farming enterprise characteristics. There was a significant association between level of perception towards digital technologies and the type of livestock that are reared (1% level), land size that is devoted to crop and vegetable production (5% level), and land tenure (10% level). The low Spearman correlations (between 0.03 and 0.19) indicate very low levels of association.

Table 3. Cross tabulation of Port St Johns and Ingquza Hill Local Municipality farmers' perceptions towards digital technologies.

		Pearson χ^2	**Spearman Correlation**	**Cramer's V**	***p*-Value**
Maize	Production	2.61	0.09	0.11	0.27
	Land size	5.40	−0.10	0.11	0.49
	Sale	17.89	−0.25	0.26	0.12
	Consumption	6.86	−0.08	0.13	0.33
Cabbage	Production	4.02	0.15	0.17	0.13
	Land size	1.92	−0.04	0.08	0.75
	Sale	10.13	0.16	0.27	0.12
	Consumption	8.50	−0.16	0.17	0.20
Livestock kept		35.93 ***	0.19	0.36	0.00
Total land size for crop and vegetables		14.88 **	0.14	0.18	0.02
Total land size for livestock		2.48	−0.13	0.13	0.29
Tenure of agricultural land		5.51	−0.03	0.15	0.06

, * represents 0.05 and 0.01 levels.

Table 4 shows the factors affecting the perception towards digital technologies by smallholder farmers from PSJ and IH Local Municipalities. The model was significant at the 1% level; however, with a low R^2 value indicating that there were other variables that were excluded from the model that affect the level of perceptions towards digital technologies. The results show that educational level (1% level), age, employment status, being part of a cooperative (5% level), source of income, monthly income, and household size (10%) were significant factors affecting the perception towards digital technologies by smallholder farmers.

Table 4 shows that an increase in age is associated with an increase in negative perceptions towards digital technologies by smallholder farmers in PSJ and IH Local Municipalities. Surprisingly, an increase in the educational levels were associated with an increase in the negative perceptions. The employment status results indicate that part-time farmers from PSJ and IH Local Municipalities are associated with negative perceptions towards digital technologies. An increase in monthly income increases the positive perception towards digital technologies by smallholder farmers, while an increase in the household size is associated with negative perceptions towards digital technologies. If smallholder farmers from PSJ and IH are not part of a farming cooperative, they are likely to have a negative perception towards digital technologies as exhibited.

Table 4. Factors affecting perceptions towards digital technologies by smallholder farmers in Port St Johns and Ingquza Hill Local Municipalities.

Variable	β	*Std Err*	*t*	$p > \|t\|$
Gender	0.55	1.47	0.35	0.66
Age	−1.24 **	0.79	−1.65	0.03
Marital status	−0.59	0.90	−0.72	0.50
Education level	−3.22 ***	0.95	−3.13	0.01
Employment status	−1.74 **	0.54	−2.97	0.04
Source of income	0.93 *	0.50	1.96	0.09
Monthly income	2.99 *	1.13	2.83	0.07
Household size	−2.96 *	0.98	−2.79	0.08
Farming enterprise	0.74	0.71	1.00	0.26
Tenure	−5.21	3.26	−1.59	0.14
Farming experience	−1.03	1.28	−0.84	0.44
Training	−0.44	0.50	−0.70	0.45
Part of cooperative member	−4.14 **	1.42	−2.85	0.04
Constant	78.91	4.80	18.33	0.03
Summary statistics				
Sigma	15.43	0.62		
χ^2	45.45			
$p > \chi^2$	0.00			
Pseudo R^2	0.13			

*, **, *** represents 0.1, 0.05, and 0.01 levels, respectively.

5. Discussion

The results showed that digital technologies were regarded as expensive, cause a digital divide, and discourage use of Indigenous Knowledge, with farmers having little knowledge about them even though they improve agricultural production. Migiro and Kwake [43], Dlamini and Ocholla [5], as well as Mabaya and Porciello [20] concurred that the use of digital technologies was expensive. Strydom [44] attests that in developing countries, Africa included, the requirement of some digital technologies to access internet connectivity has increased their costs, making them unreachable to many. Thus, only 20% of the population in SSA have access to the internet [44]. This has been compounded by the profit-targeting private sector who have supplied and offered services to these digital technologies. This can work against smallholder farmers as big corporate takeovers consolidate the smaller farms [45,46]. However, this can be offset by the cost reductions that will be envisaged through using the digital technologies such as transaction costs, especially for profit-oriented small-scale farmers relative to subsistence-targeted farmers [47,48]. In addition, the expense of digital technologies has also been attributed to ancillary inputs, which are also expensive, such as electricity [44], servicing [49], and data [50,51]. However, authors such as McCampbell et al. [52] indicate that it is not the cost but rather the neglect of a bottom-up approach and social, political, and economic injustices in the design of the technologies. This will further exacerbate the digital divide.

Engås, Raja, and Neufang [53] indicated that the digital divide led to low adoption of digital technologies. In order to maximise the opportunities presented by digital technologies, there is a need to consider the digital divide in all three levels of capacities, competences, and inequality in access [54,55]. McCampbell, Schumann, and Klerkx [52] referred to the digital divide as a result of structural ethical issues, for example, limits in skills and access. According to Hackfort [56], the digital divide is deepened by digitalisation between small and large farms, as well as between farmers who are willing and unwilling to purchase digital technologies. Digital technologies need to be inclusive to reduce the risk of widening the digital divide through the exclusion of smallholder farmers based on their characteristics and circumstances [57]. However, according to Oosterlaken [58], the capability approach as prescribed by Sen [59,60] can inform the development and technologies that provide context in the form of human dignity and rights. In the current study, what appears as a digital divide might be informed by opportunities available for the smallholder farmers to value their way of doing things. This is based on their own capabilities.

Maumbe [6] highlighted that lack of integration with Indigenous Knowledge (IK) was a drawback in using digital technologies, with Dlamini and Ocholla [5] highlighting that instead of replacing Indigenous Knowledge, digital technologies can actually be used in conjunction, for instance, to record, store, and disseminate Indigenous Knowledge. Indigenous Knowledge management using digital technology is in its infancy in Africa, with language being costly and acting as a deterrent [61,62]. There should be prioritisation of improving food security through Indigenous Knowledge, which should be preserved, disseminated, and used. Kantiza et al. [63] highlighted the use of IK systems in Africa and that there is need to disseminate the good IK practices into areas where they are not currently available. This can be achieved through digital technologies. Franco et al. [64] go on to highlight that farmers themselves are able to adapt existing technologies to suit their contextual needs. This improves the appropriateness of technologies.

The results showed that livestock production on 2–4 hectares as well as maize crop production on less than 1 hectare were associated with positive perceptions towards the use of digital technologies. This was contrary to Pope and Sonka [65], who found economies of scale being associated with digital technology adoption. According to Bronson and Knezevic [66], various land sizes require different types of technologies. Farm sizes were highlighted by Annosi et al. [67] to have an effect on the use of digital technologies, with Tagarakis et al. [68] highlighting that utilisation of digital technology was limited by small farm sizes. Groher, Heitkämper, and Umstätter [69] indicated that new solutions that can be brought about by digital technologies are required for animal and environmentally friendly production systems, with adoption differing according to animal species. Furthermore, Kernecker et al. [70] found that crop farming systems had more adoption of digital technologies. Compared to the literature, this study reveals that there is a digital technology and farmer characteristic relationship, with small farms associated with low-tech technologies relative to large farms.

Smallholder farmers who sold 150–200 kg and consumed more than 200 kg of maize had positive perceptions towards the use of digital technologies. This was also true for smallholder farmers who sold less than 50 kg and consumed less than 50 kg of cabbages. According to Giua, Materia, and Camanz [71] as well as Omulo and Kumeh [72], digital technologies are useful when selling agricultural products, especially to obtain market and price information to increase their bargaining power. Expansion of the smallholder market will allow the use of more sophisticated digital technologies not just to market their produce but also to increase production to meet the market demand.

Increases in age, educational levels, household size, being part-time farmers, decreases in monthly income, and not being part of a farming cooperative were associated with negative perceptions towards digital technologies by smallholder farmers. da Silveira et al. [73] indicated that older farmers exhibit negative perceptions towards technologies due to resistance to change. They are sceptical due to lived experiences, including Indigenous Knowledge systems. Despite the fact that increases in age and educational levels improve digital technology literacy [74], surprisingly, an increase in education was associated with negative perceptions towards digital technologies. Firstly, it is worth noting that only 9.9% of the smallholder farmers in the study area had educational levels beyond secondary school. Secondly, the nature of the digital technologies used precludes the advantages of higher educational levels. Schulze Schwering, Bergmann, and Isabel Sonntag [75] attest that openness to technologies is related to educational levels. However, in the current study, the digital technologies being used are low tech and for everyday use, rendering higher education unnecessary. In fact, since the digital technologies are low tech, smallholder farmers with higher educational levels develop a negative perception. An increase in household size translates into an increase in digital technology-related costs such as data, especially given that most technologies being used in the study area include mobile phones. Thus, the smallholder farmers would develop a negative perception towards digital technologies as the household sizes increased with their associated costs. Gabriel and Gandorfer [76] indicated that practicing farming on a part-time basis is an exhibition and often results in less motivation, and reduced access to capital and time invested in the farming enterprise, which increases economic risk. Combined with the financial risk involved in digital technology investments, part-time smallholder farmers will be sceptical and have a negative perception towards digital technologies. The role of income in digital technology is a reinforcing one. An increase in disposable income allows access to digital technologies which results in positive perceptions towards digital technologies, and due to higher income allows access to improved digital technologies. Hence, there is a perpetual positive perception due to an increase in income. Farming cooperatives allow farmers to share ideas and information about digital technologies, thereby creating perceptions towards digital technologies. According to Kvam, Hårstad, and Stræte [77], farming cooperatives should play a central role in the adoption of digital technologies.

6. Conclusions

This study sought to determine the factors that influence the perceptions of smallholder farmers towards adoption of digital technologies. The conceptual framework used comprised a combination of the Technology Acceptance Model (TAM) and the Attention, Interest, Desire, and Action (AIDA) model. The Likert scale, Perceptive Index (PI), and a Tobit regression were used to analyse the data. The study showed that there were strong perceptions towards cost, inequality, and lack of adaptation to local knowledge exhibited by digital technologies, even though they increased production. Furthermore, a positive perception towards digital technologies was exhibited by smallholder farmers using small pieces of land for their agricultural enterprises, as well as those engaged in small-scale sales and marketing. This was informed and reinforced the use of low-tech digital technologies. Socio-economic factors such as age, educational levels, household size, being part-time farmers, monthly income, and being part of a farming cooperative affected the level of perception towards digital technologies by smallholder farmers in PSJ and IH Local Municipalities. This study concludes that there are socio-economic factors affecting the perception of digital technologies by smallholder farmers. All combined, these have influenced the use of low-tech digital technologies in PSJ and IH Local Municipalities.

7. Recommendations

Some of the recommendations that can be envisaged from this study include availing low-cost high-tech digital technologies for smallholder farmers in PSJ and IH Local Municipalities. The central government can subsidise the use of high-tech digital technologies for use by smallholder farmers. Lobbying for low-cost digital technologies from suppliers can also be used to avail low-cost technologies. This can also be a strategy used for ancillary and complementary services to access data, internet, and after-sales services. Another strategy that can be used to encourage the use of high-tech digital technologies is integrating the current low tech with high tech. Digital technology providers can be lobbied to take this route as the costs will be a compromise between the low and high ends. Availing cheaper options of digital technologies can avert the inequality that is associated with the use of digital technologies. Promotion of digital technology, especially to poor smallholder farmers, can also reduce the digital divide. Extension officers can play a significant role, as they are already embedded within the communities and have a database of not well-off farmers. In conjunction with traditional leaders and opinion leaders, as well as extension officers, there should be lobbying for technology developers to provide digital technologies that cater for Indigenous Knowledge. Central government funding can play a pivotal role in the development and dissemination of such technologies. Digital technologies that are promoted should also be cognisant of the small nature of the enterprises. In promoting the use of digital technologies, be it through print, electronic and social media, and even though extension, the target should be the youth and young farmers with less education in small households who are full-time farmers with moderate-to-high incomes and are part of farmer groups/organisations. This demographic already shows positive perceptions and thus will quickly embrace the use of digital technologies in PSJ and IH Local Municipalities. This however does not preclude the other demographics in the promotion of digital technologies. Areas of further study include focusing on the determinants of the component parts of interest, perceived usefulness, perceived ease of use, and intention to use as spelt out in the TAM and AIDA models.

8. Limitations of Study

The study had conceptual and methodological limitations. The perceptions could have been grouped according to the TAM and AIDA models to provide categorised factors affecting interest, perceived usefulness, perceived ease of use, and intention to use. Furthermore, external validity was limited because the study used a purposive design which was spatially and temporally limited. Any findings are difficult to extrapolate to other contexts.

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Appendix A

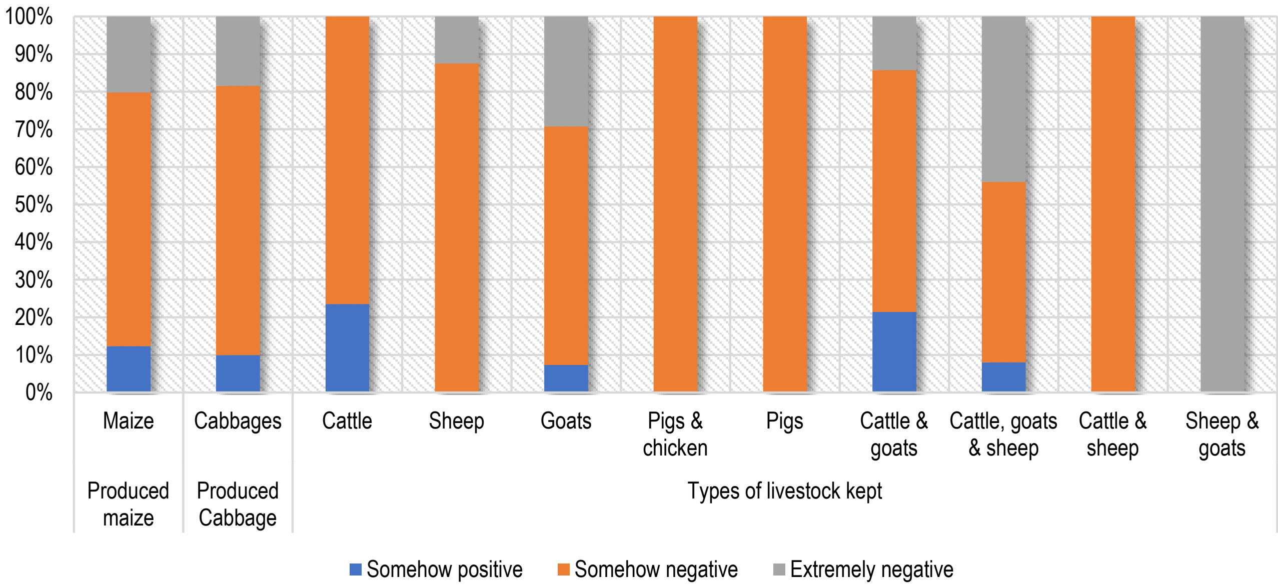

Figure A1. Perceptions towards digital technologies and the farming enterprises for smallholder farmers in Port St Johns and Ingquza Hill Local Municipalities.

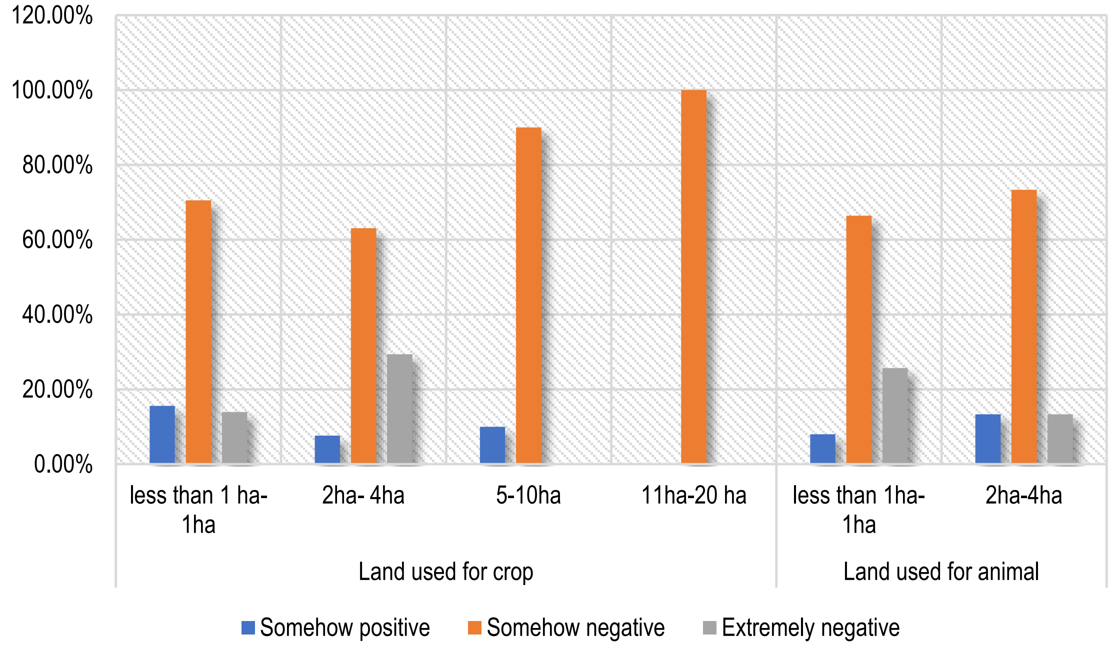

Figure A2. Perceptions towards digital technologies and farming land size for smallholder farmers in Port St Johns and Ingquza Hill Local Municipalities.

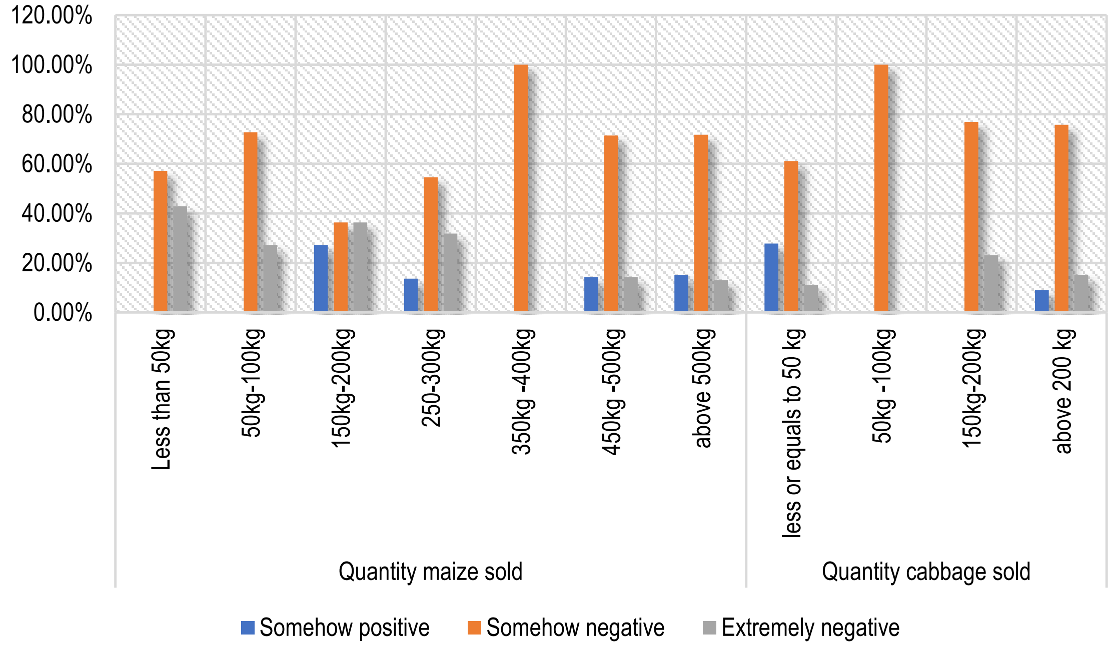

Figure A3. Perceptions towards digital technologies vis-à-vis propensity to sell maize and cabbage by smallholder farmers in Port St Johns and Ingquza Hill Local Municipalities.

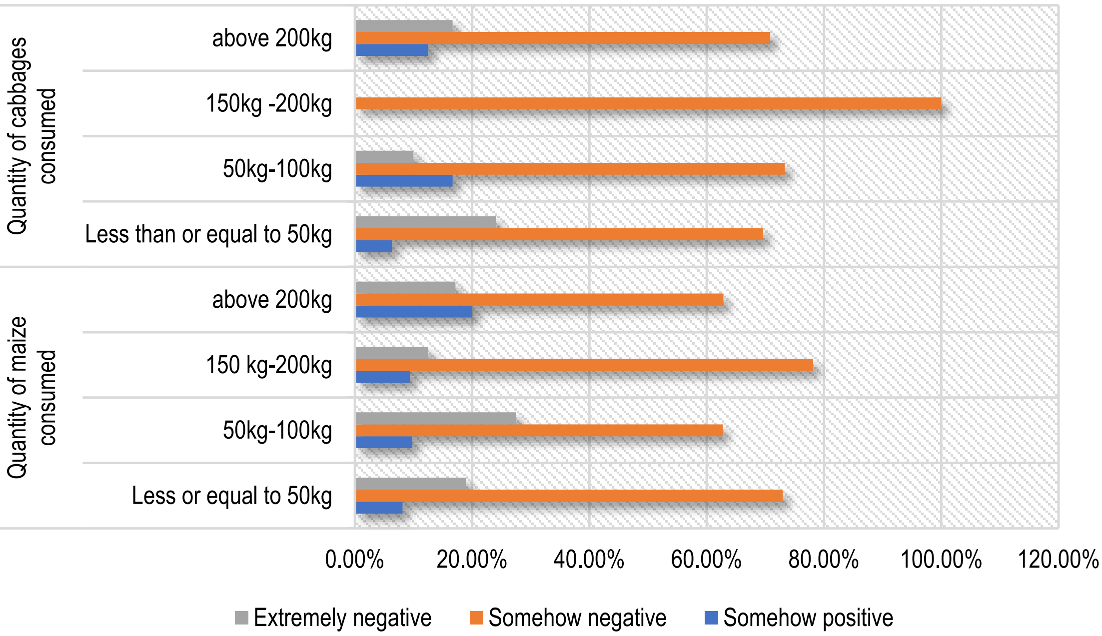

Figure A4. Perceptions towards digital technologies vis-à-vis propensity to consume maize and cabbage by smallholder farmers in Port St Johns and Ingquza Hill Local Municipalities.

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