

Emerging Black Women Agripreneurs' Experiences in the Digital Era: A South African Perspective

Nonceba Ntoyanto-Tyatyantsi

<https://orcid.org/0000-0002-1231-3755>

University of South Africa

ntoyan@unisa.ac.za

Sizile Zamandlovu Makola

<https://orcid.org/0000-0003-4311-6073>

University of South Africa

Babalwa Ceki

<https://orcid.org/0000-0002-9827-0732>

University of South Africa

Abstract

The purpose of this study was to investigate the challenges and opportunities experienced by emerging black women agripreneurs in using technologies in their farming operations. The study was situated within the interpretivism paradigm and employed the qualitative approach and an exploratory design. The data were collected using in-depth semi-structured interviews using the purposive snowballing sampling technique with 12 emerging black women agripreneurs in three provinces in South Africa. Content analysis was used to analyse the data. The findings indicate that emerging black women farmers face several challenges with acquiring and using technologies in their farming operations. In addition, the women agripreneurs acknowledged and understood the opportunities available in farming when technologies are adopted. The article concludes by proposing initiatives and programmes to enhance technology adoption and access, training and support for these women agripreneurs. These efforts aim to accelerate rural development, promote economic growth and contribute to sustainable agricultural practices.

Keywords: emerging farmers; black women; agripreneurs; digital technologies

Introduction

Food security is a growing problem worldwide. This is because it underpins human health, economic development and social stability. According to the Food and Agriculture Organization, the number of undernourished people rose to 828 million in 2021, an increase of over 160 million since 2019, driven largely by conflict, climate extremes and economic shocks (FAO 2022). In sub-Saharan Africa, more than one in five people remain chronically hungry, and the Global Hunger Index classifies hunger levels in several countries as “serious” or “alarming” (Von Grebmer et al. 2023). Dlamini et al. (2023) conducted a national study and found that 1 in 5 South African households is food insecure. This persistence of widespread hunger contributes to increased morbidity and mortality, undermines educational attainment, and perpetuates poverty cycles, which make the alleviation of food insecurity an urgent priority for global policy and intervention.

Much focus should therefore be placed on the agricultural sector with a view of equipping the sector for increased food production capabilities. The transformation of the agricultural sector is one of Africa’s difficult and urgent priorities to be addressed. If sub-Saharan Africa is to stave off food and nutrition insecurity, and meet the continental food demands, it needs to increase the current levels of agricultural productivity (Tsan et al. 2019). The South African National Development Plan (NDP) (National Planning Commission 2011) highlights the key challenges for rural development such as the lack of economic participation in rural areas, the lack of access to resources (land and water), high unemployment and lack of government services. These challenges necessitated the transformation of the agricultural sector to facilitate access to land, farming skills and clean water to the rural communities. The NDP views the agricultural sector as one of the key drivers for the significant growth of the country’s economy and job creation (National Planning Commission 2011).

The agricultural sector recorded the most substantial contribution to the gross domestic product (GDP) growth by 33.6%, which includes contribution from the small, medium and micro enterprises (seasonally adjusted and annualised) during the second quarter of 2017 when compared to other industries (DAFF 2017). This economic contribution assisted South Africa in recovering from a recession during that period and showed the significant role played by the agricultural sector in contributing to the GDP of the country. The agricultural sector showcased its potential of being the backbone of the country’s GDP growth and major contributor in achieving the aim of the NDP. The NDP aims to eliminate poverty and reduce inequality in accordance with the sustainable development goals (SDGs) of the UN 2030 Agenda for Sustainable Development (National Planning Commission 2011). The relationship between small, medium and micro enterprises (SMMEs) and a country’s GDP is strongly interconnected. The presence of a robust and thriving GDP indicates the significant role played by SMMEs in contributing to the overall economy of a nation, as highlighted by Pandya (2012).

Problem Statement

The use of digital technologies in agriculture can be a tipping point in fast-tracking the transformation of the agricultural sector in Africa (Tsan et al. 2019). According to Jakku et al. (2016), digital technologies can potentially deliver a step change in productivity and/or profitability across the value chain. The adoption of digital agriculture not only facilitates information dissemination and market access for farmers but also enhances their bargaining power in the agricultural sector (Mwangi and Kariuki 2015). This is exemplified by the use of mobile applications, which provide farmers with valuable insights into market prices, weather patterns and optimal crop cultivation techniques. Moreover, online marketplaces serve as direct conduits that link farmers with potential buyers, thereby diminishing the reliance on intermediaries and empowering farmers to engage in fair price negotiations (Mkentane 2019). Consequently, for black women agripreneurs¹ to attain a competitive edge, it becomes imperative to embrace digital agricultural strategies in their enterprises. Such measures enable farmers to leverage the benefits of enhanced information access, expanded market opportunities and strengthened bargaining positions.

The integration of technologies in agricultural practices not only mitigates the adverse environmental impact associated with farming but also fosters the advancement of sustainable development. By leveraging digital technologies, the agricultural sector stands to undergo a profound transformation characterised by heightened operational efficiency, diminished wastage and augmented decision-making capabilities (FAO 2022). Such technological interventions hold significant promise for promoting environmentally conscious and economically viable agricultural practices in pursuit of the SDGs. The digital technologies used in agriculture include smart farming systems, sensor technology, the internet of things (IoT), big data analytics, blockchain and drones. The South African agricultural sector is lagging behind in the use of these technologies compared to other developing countries such as Brazil, Russia, India and China (Jakku et al. 2016).

Sibanda and Simalenga (2010) suggest that South Africa still has a long way to go regarding these technologies. Incorporating these technologies into every facet of agriculture in South Africa is critical, because of the sector's role in the economic development and sustainable development of the country. Senyolo et al. (2018) add that it is important for South Africa to invest in digital agricultural technologies, particularly in climate-smart technologies, because the country is faced with severe droughts and water shortages. These technologies will mitigate climate change challenges. For example, when a climate control system is used in vertical farming, it helps in minimising water, land and nutrient usage. Furthermore, digital technologies will help increase agricultural productivity, improve efficiencies in the value chain, increase

1 Entrepreneurs who run businesses in the agricultural sector by combining farming with modern business strategies, technology and innovative thinking.

economic growth and contribute to achieving the SDGs. Agricultural rural development can be accelerated by supporting rural farmers in the adoption of digital technologies in their farming businesses.

Research Objectives

This study's objective was to investigate the challenges and opportunities experienced by emerging black women agripreneurs in using digital technologies in their farming operations. The study was guided by the question, "What are the experiences of emerging black women agripreneurs of using digital technologies in their farming businesses?"

There is no consensus on the definition of emerging farmer in South Africa. According to Khapayi and Celliers (2016), the term "emerging farmer" is used interchangeably with "subsistence farmer". Others such as Mohlatlole et al. (2015) and Xaba and Dlamini (2015) define emerging farmers as beneficiaries of land reform. Owing to the lack of consensus on the definition, Zantsi et al. (2018) provide the following definition in a bid to contribute towards a common understanding of the term "emerging farmer". The authors define an emerging farmer as black, making less than half a million rand turnover per annum, and selling more than the produce they use for their own consumption, a Commodity Chanel Index value of at least 0.6, given that they produce for the market and aspire to commercialise their farming fully (Zantsi et al. 2018). This definition is adopted in this study.

The structure of this article is as follows. The literature review provides a background of the South African agricultural sector, the role of emerging black women farmers in the sector, the challenges faced by emerging black women agripreneurs and the technologies that can enhance farming and opportunities brought by digital agriculture. This is followed by the research methodology used, after which the findings in relation to the challenges and opportunities are discussed. Following the findings, is the discussion of the findings with regard to the literature. Lastly, the conclusion of the findings is provided.

Literature Review

The agricultural sector can be divided into two major categories: subsistence and market-oriented farming. There are different farming scales within the broad umbrella of market-oriented agriculture, namely, small, medium-sized and large-scale/mega-scale farming. This study is situated in the small-scale market-oriented farmers. The Department of Agriculture, Forestry and Fisheries' (DAFF) draft National Policy on Comprehensive Producer Development Support is the guiding document for the agriculture, forestry and fisheries sectors in the country. It standardises and directs government interventions for various categories of producer, such as land ownership,

access to finance, access to markets and compliance with market standards (DAFF 2018). The policy document distinguishes between four groups of farmers: household producers/subsistence farmers, smallholder producers/farmers, medium-sized producers/farmers, and large-scale commercial producers/farmers. These categorisations are similar to those used by industry players such as the Bureau for Food and Agricultural Policy, and the Land and Agricultural Development Bank (Mtombeni et al. 2019).

In South Africa, the total agricultural land is about 93 million hectares, which represents 76.23% of the total land area (Sihlobo and Kirsten 2021). Large-scale commercial agricultural farming utilises 7.6 million hectares of this land. On the other hand, small-scale emerging farmers use approximately 25 million hectares of land and produce lower levels of the country's primary produce. Approximately 38.8 million hectares of agricultural land is not productive (Statistics South Africa 2020). The land usage shows the divide in the agricultural sector, inequality and marginalisation of the rural emerging black women agripreneurs.

Trend Analysis of the Agricultural Sector

The agricultural development in South Africa has, historically, been discriminatory based on gender and race (Sebola 2018). Even after democracy, farming in South Africa remains dominated by the white community, with the role of the black community limited to being the labour surplus and unsuccessful subsistence farmers (Sebola 2018). However, in the last few decades, women's participation in the economy, access to resources and their role in decision-making in agriculture have been the focus areas of research globally (Khatri-Chhetri et al. 2019). Black women in South Africa are one of the key marginalised groups to be brought into the fold in the agricultural sector. During apartheid, black women were regarded as minors and could not own land or property, therefore, could not participate in commercial farming (United Nations Centre Against Apartheid 1978).

Evidence suggests that empowering women can have economic benefits for the women themselves, as well as their households and communities. Sub-Saharan Africa experiences an annual cost of approximately USD95 billion because of gender inequality, as estimated by the 2016 Africa Human Development Report. In addition, a study by the McKinsey Global Institute in 2015 indicates that achieving gender parity in economic outcomes, where women achieve similar levels as men, could potentially add a substantial USD12–28 trillion to the global economy. However, there is a scarcity of research focused on examining the specific impacts of women's empowerment in agricultural settings (Anderson et al. 2021; Klasen 2018).

In South Africa, commercial farming is a sophisticated and highly complex business. Considering the technological revolution taking place in farming, emerging farmers are now forced to be well equipped to become the commercial producers of the future. Various studies have been conducted on the challenges faced by emerging farmers that

limit their ability to increase their produce. However, there is a gap in the scientific knowledge regarding the key challenges and opportunities that affect emerging black women farmers' use of digital technologies in their operations (Khapayi and Celliers 2016).

Importance of Emerging Black Women Farmers in South Africa

The South African agricultural sector is gradually transforming after many years of discrimination against all black farmers during colonisation and the apartheid periods. During these periods, the South African agricultural sector was characterised by dualism. On one end, there was a large-scale, white-owned, technologically advanced commercial agricultural sector that was thriving. On the other end, there was a small-scale sector in the former homelands, and it remained largely subsistent on communal lands (Greyling et al. 2015). Considering this conundrum, the democratic government has introduced agricultural and land reform transformation policies to address the injustices of the past. The aimed beneficiaries of these transformational policies included emerging black farmers (Greyling et al. 2015; Zantsi et al. 2018).

Job Creation Opportunities

The South African commercial agricultural sector has shown a growing trend of shedding jobs in recent decades. The number of individuals employed in the agricultural sector declined in the 1990s from an average of 1.04 million to approximately 775 000 recently in 2020 of which two-thirds were employed regularly and the remainder were seasonal or casual workers (Piek et al. 2023). Although efforts were made to create approximately 250 000 new jobs in export-led and high value industries (for example, citrus, tree nuts, avocados), unfortunately there has been a decline in jobs in the field crops and livestock production (Piek et al. 2023) and identified a trend away from the employment of permanent, regular workers to casual labour. According to the authors, this was a concern because casual jobs were less secure and inconsistent, and this trend would exacerbate the problem of rural unemployment in the country.

Several factors contributed to job shedding, including the intensive use of machinery which reduced the need for unskilled labour. Considering this trend, emerging black women farmers can contribute towards job creation because they are more labour intensive than commercial farmers (Zantsi et al. 2018). As they expand their farming operations or engage in agribusiness ventures, they often require assistance in various aspects, such as farm labour, agri-input suppliers, equipment maintenance and transportation. By doing so, they contribute to local job creation and income generation, particularly in rural areas where agriculture is a primary economic activity. This has been highlighted in the NDP, which has identified the agricultural sector as one of the sectors that has the greatest chance of creating jobs (National Planning Commission 2011). Engaging women in farming and job creation not only has economic implications but also contributes to their empowerment. Through their involvement in agriculture,

women gain financial independence, decision-making power and increased social status. These factors, in turn, have broader social and economic impacts by improving gender equality and promoting inclusive development.

Poverty Reduction

Internationally, it has been proven that small-scale emerging rural farmers generate income opportunities and employment in rural areas. In most developing countries, agriculture and agriculture-related activities provide most of the employment in rural areas. According to Diao et al. (2007), agricultural-led growth played a key role in alleviating poverty and transforming the economies of many Latin American and Asian countries, but the same has not occurred in Africa. The literature provides studies that have investigated the relationship between agriculture and poverty in different countries. The studies include countries such as Zimbabwe (Mbiba 1995), Malawi (Orr 2000), Kenya (Kimenyi 2002), Zambia (Siegel and Alwang 2005), Africa (Fan et al. 2008) and southern Africa (Victor and Akadiri 2019).

Engaging in agricultural activities allows women to generate income through various means such as selling agricultural produce, livestock or value-added products. This additional income plays a significant role in uplifting households out of poverty and improving their overall economic well-being. Women farmers contribute to poverty reduction by focusing on enhancing food security and nutrition in their households and communities. According to Mabaso (2014), the challenge in South Africa is to eradicate the structural constraints that limit the growth of emerging farmers. In South Africa, many emerging farmers live in rural areas characterised by unemployment and poverty (Zantsi et al. 2018). There is a large rural population, and a poorly educated and largely unskilled workforce. Agriculture is a promising strategy to combat rural poverty because many poor people reside in rural regions and many are already involved in some type of farming activity (Mabaso 2014; Zantsi et al. 2018).

Contribution to Economic Growth

There is a connection between the agricultural and non-agricultural sectors. In this regard, the development growth of the agricultural sector has the potential to promote growth in the non-agricultural sectors, which will have a poverty-reduction effect. Li et al. (2022) posit that an increase in the income of rural households has the potential to increase consumer expenditure on non-tradable goods and, consequently, lead to local economic development. Women actively engage in farming activities, which leads to the production of various agricultural goods. This, in turn, creates employment opportunities throughout the value chain, including processing, packaging, distribution and marketing of agricultural products. Studies have highlighted the positive correlation between women's involvement in agriculture and overall economic development, including job creation.

Agriculture has had a significant impact on rural development in nations where emerging farmers predominate. In this sense, improving emerging farmers' productivity would raise demand for agricultural inputs such as fertilisers, pesticides and labour – if the constraints they face are alleviated and well-developed government support is provided (Zantsi et al. 2018). The cultivation of diverse crops by women farmers has several positive outcomes, which contribute to food security, nutrition and, ultimately, poverty reduction. Women farmers ensure a consistent supply of nutritious food, which leads to improved health outcomes, reduced healthcare costs and increased productivity. In turn, this would reduce unemployment and increase the food supply, and, consequently, address the issue of rural food security, which is a major issue in South African rural areas. But, among other things, for this to happen, there is a need for emerging black women farmers to be capacitated and supported in adopting and effectively using the technological resources (Mwangi and Kariuki 2015).

Challenges Faced by Emerging Black Women Farmers

Access to Finance

In South Africa, 75% of emerging black women farmers have a turnover of less than R1 million; therefore, most farmers are unable to obtain digital technologies due to high costs and economies of scale (WCDoA and USB 2018). Most black women farmers do not have the necessary finances to fund their farming activities and cannot afford to access the necessary technologies and capacity to drive their farming into the digital era (Mkentane 2019). Women farmers might face difficulties in accessing credit or loans due to factors such as lack of collateral, limited land ownership rights and cultural biases. Financial institutions might have stringent requirements or discriminatory practices that restrict women's access to finance. Gender bias and discrimination can affect women farmers' ability to secure financial support. Traditional gender roles and stereotypes might result in unequal treatment, lower loan amounts, higher interest rates or exclusion from financial services tailored to the specific needs of women farmers (Li et al. 2019).

Limited financial literacy and knowledge of financial systems can pose challenges for women farmers. Understanding loan application processes, financial management and the requirements of financial institutions might be a barrier. In some cases, women farmers rely on informal financial systems, such as rotating savings and credit associations or community-based lending, because of limited access to formal financial institutions. Although these systems can provide some support, they might not offer the same level of financial stability or growth opportunities as formal financial channels. Black women farmers lack the tools they need to make informed decisions about their business' financial management, such as cost and profit margins and profitability analyses. Furthermore, these farmers do not have management systems for storing and analysing the farm-related data collected that would support decision-making in everyday farming activities and management (Paraforos et al. 2016). The technologies

require investment; owing to a lack of financial support and access to finance, these farmers are unable to participate fully in the economy. Government support is needed to reduce the costs of the technologies, and this can be achieved through subsidies and financing schemes.

Access to Information and Training

Limited access to extension services poses significant challenges for women farmers in accessing valuable agricultural information and training. Factors such as distance to extension offices, lack of awareness about available services and gender biases in extension systems contribute to the limited reach of extension services to women farmers (Drewry et al. 2022; Kiptot and Franzel 2012). Cultural norms, lack of representation and limited decision-making power further restrict women's participation in agricultural training programmes and hinder their ability to access relevant information. In addition, women farmers might face socio-economic constraints that limit their ability to access information and training. Household responsibilities, limited financial resources and lower education levels make it challenging for women to participate in training programmes or access information through formal channels. Language barriers and low literacy levels further compound the challenges faced by women farmers in accessing and understanding agricultural information. The lack of tailored training materials in local languages and the requirement of advanced literacy levels can further exclude women from accessing and benefiting from available resources (Ingutia and Sumelius 2022). Black women farmers are constrained by a lack of knowledge and education on the opportunities and benefits associated with agricultural technologies and innovations in the digital era. Stakeholders in the entire agricultural sector need to ensure that farmers are trained, developed and afforded support in technology adoption and usage (Ngwexana 2018). Advisory and mentorship initiatives are necessary to build farmers' capabilities to make use of data-driven information, knowledge and technologies.

Lack of Technological Skills and Access to Technologies

One significant challenge faced by black women farmers, especially in rural areas, is the limited use of digital technology owing to low capacity. This is exacerbated by the absence of digital technology infrastructure, which hampers their ability to effectively employ digital tools and technologies in their agricultural activities. As a result, these farmers are unable to fully leverage the potential benefits that digital advancements can offer to improve their agricultural practices. South African black women farmers face challenges in accessing stable internet connectivity and infrastructure, which limits their ability to leverage digital technologies for farming activities. The effective use of digital tools, such as data analytics that require internet access, is hindered by the lack of reliable internet connectivity. Owing to poor infrastructure and the high cost of internet services, it becomes challenging for these farmers to collect and analyse the data necessary for informed decision-making in their agricultural practices. The limited access to stable internet and infrastructure creates barriers to the adoption and use of

digital technologies, and impedes the potential benefits they can bring to improve farming efficiency and productivity. There is also a lack of technical skills among rural farmers, which is required to organise and integrate digital technologies in their farming activities to reap the full benefits (Freeman and Qin 2020; Goedde et al. 2020).

Digital Technologies that Can Enhance Farming

Digital innovation is a significant driver in enhancing agricultural production and improving the value chain, including post-harvest processes, transport and storage. It plays a crucial role in addressing various aspects of the agricultural sector. For instance, food traceability systems that use digital platforms have emerged as essential tools for managing risks related to food safety and ensuring consumer confidence. These systems enable the tracking and monitoring of food products throughout the supply chain, helping to contain safety issues and enhance transparency. In addition, digital-enabled marketing strategies contribute to increasing the efficiency and competitiveness of companies in the agricultural market (Corallo et al. 2018; Smidt and Jokonya 2022). By leveraging digital technologies, companies can streamline their operations, improve intra-company efficiency and gain a competitive edge. These advancements in digital innovation have far-reaching implications for the agriculture industry, transforming various stages of the value chain and promoting sustainable and secure food systems. The digital technologies are also changing the scope of farming globally regarding production and ecosystems. These tools are advancing farming, unlocking new innovations to improve farming, empowering farmers to be resilient against harsh weather conditions, and enhancing efficiencies in production. Agricultural technologies include smart farming systems, sensor technology, the IoT, big data analytics, blockchain and drones.

Artificial Intelligence

Artificial intelligence (AI) drives the development and implementation of various digital technologies in agriculture. AI involves the creation of computer systems capable of performing tasks that typically require human intelligence. In the realm of agriculture, AI is being utilised for tasks such as visual perception, speech recognition, decision-making and language translation. For instance, AI enables the analysis of images to monitor crop and soil growth, improves communication between farmers and automated machines through speech recognition, and supports decision-making by analysing data on soil conditions and weather patterns. In addition, AI's natural language-processing capabilities allow for the extraction, classification and machine translation of content from research studies and farming documents, which provide up-to-date information on trends and practices in the agricultural sector. In agriculture, AI systems leverage historical trends and patterns to optimise irrigation scheduling, fertigation management and cultivation planning (Lingireddy et al. 2023).

Sensor Technology

Sensor technology is used to detect changes in the field and to send information to other devices. When armed with data from soil sensors, GPS-equipped tractors and external sources, such as local weather channels, enable farmers to better manage key resources including seed, fertilisers and pesticides, while increasing productivity. Farmers can monitor crop health and yield predictions, control smart irrigation and improve data management (Fresco and Ferrari 2018). The use of sensors makes it possible to regulate water, nutrients and temperature in the smart greenhouse, pinpoint which plants need which quantities, consequently saving on costs and product use such as fertiliser. Sensors can assist farmers in fertilising or irrigating crops in such a way that crops are not overwatered and can also provide crucial information regarding the availability, condition, location, performance and product visibility (Ghoreishi and Happonen 2020).

Internet of Things

The IoT is about “things” which are capable of recognising, communicating and cooperating with their surroundings. The IoT provides flexible control mechanisms for large fields and can send information to the farmer in real time, which allows the farmer to make changes according to the produce (Fresco and Ferrari 2018, Sharma et al. 2023). It simplifies and streamlines the collection, inspection and distribution of farming materials and resources by using on-site equipment. In addition, the IoT affords the farmer the ability to remotely monitor animal movement, control and schedule pesticide sprays, control and schedule fertigation systems, detect leaks and control large water flows, and automate pest counting. The use of the IoT has improved productivity and efficiency, reduced water uses in irrigation and increased yields, while also reducing, energy consumption costs to produce clean energy for long-term sustainability (Ahmed et al. 2022; Ojha et al. 2015).

Big Data Analytics

Big data analytics are the techniques that are applied to find valuable and meaningful insight from large data that have hidden or unknown correlations and patterns. Using the analysis of data, farmers can predict the amount of rainfall that might occur in a given season and even the incidence of flooding (Lohmer and Lasch 2020). Accurate predictions can assist farmers regarding planning and deciding what to grow and when to grow it. With big data analytics, farmers can discover business trends and customer preferences, track supplies and increase yields. The availability of data provides farmers with information that will help in cost savings, enable the farmer to better manage risk, and increase production and efficiency (Kamble et al. 2019).

Blockchain

Blockchain is beneficial to farmers regarding data that relate to land and resource use records, fair pricing, overseeing farm inventory and financial flow across the entire value chain. Blockchain brings an opportunity for farmers that promotes data analytic

capabilities. These capabilities will provide technology infrastructure for digitisation, tracking and automation. All of these will help drive the farmers' sustainable initiatives (Kamble et al. 2019). Blockchain can also improve farm security and product traceability. In a blockchain-driven ecosystem where the whole value chain for agricultural products is entrenched, traceability from farm to fork can occur across supply chain partners who work in their own technological systems and export information into a private and centralised blockchain capability for shared use, which makes it easy for customers to validate the quality and authenticity of the products they purchase if farmers comply (Aldag and Eker 2018; Subramanian and Subramanian 2022).

Research Design and Methodology

A qualitative methodology within the interpretivism paradigm was used. The motivation for a qualitative study was that an in-depth study of a situated experience would provide a deeper understanding than gathering standardised quantitative data from a large sample of the population (Patton 2002). The interpretive perspective enabled the researchers to enhance their understanding of the key issues related to the experiences of emerging black women agripreneurs' use of Fourth Industrial Revolution (4IR) technologies in their farming operations. An exploratory research approach with multiple case studies was chosen as it is particularly useful to employ because there was a need to gain an in-depth appreciation of the phenomenon of interest in its natural real-life context (Crowe et al. 2011). The individual emerging black women farmers were regarded as individual cases. The interview questions were derived from two preconceived themes that emerged from the literature review. These were (1) the benefits of using technology in a farming business, and (2) the challenges of using technology in a farming business. The participants were drawn from the North West, Gauteng and Western Cape provinces of South Africa.

A non-probability purposive, snowballing sampling technique was used. Initial participants were identified and recruited using one of the researchers' contacts, as she had previously conducted research with farmers. After the initial contact with one participant, the researcher requested the individual to refer other women farmers. The researchers then used their judgement to select participants that best enabled them to answer the research question and meet the research objectives (Cohen et al. 2011). Snowballing was used and does not require a population number or sample size because the number of black women farmers is unknown (Johnson et al. 2014). The predicted sample size of the black women agripreneurs was 12 to 25. Creswell (2013) suggests that a sample of 12 to 25 in-depth interviews is adequate to answer qualitative research questions. A sample of 15 black women agripreneurs was therefore sought through referrals, however, saturation was reached at participant number 12 as no new data were being introduced by the participants. These participants met the inclusion criteria of being an emerging black farmer in line with the definition of emerging farmer adopted

in this study. Table 1 presents the participants' information regarding their farming activities, the number of hectares they own and use, and their geographic information.

Table 1: Participant information

Participant	Province	Size of farm ha	Farming activities
P1	Western Cape	2	Lavender
P2	Gauteng	1.3	Vegetables and poultry
P3	Western Cape	22	Ornamental, indigenous and agricultural crops, also orchards of plums grown, harvested and exported
P4	North West	126	Livestock farming (includes cattle, sheep, piggery and goats)
P5	Gauteng	3	Culinary and botanical herbs, and training development of indigenous knowledge systems
P6	Gauteng	2	Organic crops farming and agroprocessing
P7	Western Cape	4	Crops farming and livestock farming
P8	Gauteng	1	Crops farming and rabbit farming
P9	Western Cape	10	Crops farming and sheep farming
P10	North West	8	Crops farming and agroprocessing
P11	North West	2	Crops farming and vegetable farming
P12	North West	12	Crops farming and piggery farming

Semi-structured, telephonic interviews were conducted in English. Each interview lasted 50–60 minutes and was audio-recorded with the participants' consent. All three researchers conducted the interviews. The interviews were recorded and transcribed verbatim. The transcriptions were made by the researchers, who afterwards listened to all the recordings again to ascertain the quality and accuracy of the transcripts.

The interview data were analysed using content analysis. Content analysis is an inductive research approach that involves analysing various dimensions of a phenomenon (Roller 2019). Inductive coding was employed, and the codes were generated by open line-by-line coding. Recurring themes and patterns were therefore identified, categorised without any influence from preconceived perspectives, and explained (Owen et al. 2016). In the findings section, the verbatim quotes from the participants are used to support the themes. Ethics approval was obtained to conduct the study. All participants signed an informed consent form before participating in the interviews. They were also informed of the voluntariness of their participation and confidentiality of the information provided. Pseudonyms were assigned to each participant. To ensure trustworthiness, first, the participants were requested to verify the

credibility and accuracy of the transcribed documents. No changes were made by the participants. Second, the researchers coded the transcriptions independently and then developed a shared understanding of the emergent themes through critical discussions.

Findings

The findings are important at two levels. First, the findings indicate a lack of digital technologies in farming. None of the participants indicated that they used technologies such as smart farming systems, unmanned aerial vehicle's (UAV) big data analytics, drones, the IoT, automated fertigation systems, automatic irrigation, sensors and blockchain. Second, the findings point to limited access to and knowledge about these technologies. The key challenges that the participants faced with the use of digital technologies related to their skills deficiency in managing the use of technology, the lack of information and communications technology (ICT) literacy, and financial constraints.

Two themes were identified, namely, benefits of using technology and challenges of using technology.

Benefits of Using Digital Technologies in Farming Operations

Most participants were not using any digital technologies in their farming businesses. The technologies they did use included machinery, systems and ICT. The machinery used were distilling machines, water meters, moisture readers, spray carts, automatic irrigation, heat pumps, soil mixing machines and potting machines. The systems used were fogging systems, tunnel cooling and heating systems, hydroponic systems, drip irrigation systems, raised beds and growing towers. The ICT used included social media, printing machines, colour coders, computers and mobile phones.

The participants indicated that the benefits they gained from employing technology in their businesses included productivity relating to higher yield, better use of man-hours, reduced manual tasks, saving time and speeding up production. Product quality is linked to a higher standard of product. Profitability related to water cost savings and electricity/energy cost savings. Information and marketing related to business and product market visibility and research/information gathering.

Higher productivity and yield, better use of workers' time, and a higher standard of product delivery make a business more sustainable and provide more value for money.
(P1)

I believe that introducing technology, especially in this era of the Fourth Industrial Revolution, is crucial for survival and competitiveness. Without embracing technology, businesses risk stagnation or decline. To grow and succeed, adapting to digital technology is imperative. (P2)

The use of a mobile phone has actually been beneficial to me because I am able to research most of the things or cases that I come across in my line of work, be it health-related challenges, feed, or any other thing that I may need information about. (P3)

I have introduced new technology that has significantly improved our efficiencies. It has reduced our bird mortality rate to about 3 to 7% (reduced from 20%) per cycle, which is a significant improvement from our previous methods. This new technology has positively impacted our efficiency and overall performance in poultry farming. (P4)

I can do many activities without manual hard labour of soil treatment. We have also saved water and electricity by following a watering schedule. (P5)

We opened our shop doors to the public in 2012 but did not have a big clientele until we created a Facebook page in 2013. Then my business started gaining momentum. I do not spend money on marketing. (P6)

The sensors on the ground ensure that resources like water and fertiliser are being used as efficiently as possible. (P7)

I employ an irrigation system powered by electric pumps to water the crops. This system allows for efficient and controlled watering, ensuring that the plants receive the right amount of moisture to thrive. (P8)

I have a tractor at my disposal, which aids in various farming activities such as ploughing, tilling and transporting equipment. These tools play a crucial role in enhancing the productivity and effectiveness of our farming operation. (P9)

The two participants who were not using technology in their farming business indicated that they expected to gain benefits from using technology. They indicated that

Farming involves a lot of work and, therefore, technology can assist in a big way, such as packaging technologies. (P10)

As such, I'm not much on those big technology in terms of machinery, which is my vision for the coming 1–2 years. (P11)

Challenges of Using Digital Technologies in Farming Operations

The participants stated that knowledge and skills scarcity were the major challenges. This is related to a lack of skills in managing technology and the lack of ICT literacy. They also mentioned financial constraints relating to the costs of servicing and maintaining the technologies, costs of outsourcing installations and costs of outsourcing maintenance.

Technical backup to service or programming of some of the technologies being used.
Lack of higher skilled labour to understand and manage the type of technology.
Financials to service and maintain the type of technologies used. (P1)

Installation and maintenance are mainly outsourced from outside my area. (P2)

I don't want to lie to you, the ones using the engines, they really complain of the high cost. The cost factor plays a major role. (P3)

But they're so expensive that one cannot afford them. We are a very small farm, and to an extent, we can't afford it. (P4)

What comes to mind immediately is access to bank finance, which is not an easy route when it comes to government finance; government finance has also become highly politicised and increasingly difficult to access. (P5)

I have financial constraints at the moment. I do not want to be heavily indebted while I'm still trying to find my niche and my special space in the farming sector. (P6)

We do not have access to modern technologies such as advanced tractors, automated ploughing and fertilising systems, or modern irrigation schemes. While I know these technologies, they are costly for our small farm, making them unaffordable. (P7)

I must admit that I am not well versed in technology. Learning and implementing technology can be challenging, but if someone offers to help or provides the necessary tools, I am more than willing to learn and adapt. (P8)

No challenges, apart from the fact that I am not digitally literate and social media remains tricky. If I had been more savvy, we would have advanced faster and more. (P9)

To address the challenges they face regarding the use of technology in their businesses, the participants indicated that they were employing knowledge and skills development, and financial solutions. The related knowledge and skills development solutions included hiring external consultants and building the capacity of staff to manage the type of technologies used. The financial solutions included fundraising, financial prudence in running the business and searching for affordable technologies.

At the moment, we are raising money from sales to develop and invest. As an emerging farmer, I am not ready for heavy indebtedness. (P1)

Trying to overcome them by being more economical and sustainable in our business, building the capacity of staff to manage the type of technologies. (P2)

Still searching for other affordable technologies that can also yield good results within the farm. (P3)

Forge collaboration with expertise in the same field. So far, we have a mutual agreement with a few companies for mentorship and coaching. (P4)

Have an organised body that we could be members and be classified as agri and have conferences, you see, be invited to conferences as farmers as agri processors as financiers, investors, and be organised. (P5)

Practice and pay other companies to create an online shop and website. (P6)

Mitigating the Challenges of Using Digital Technologies in Farming Operations

All the participants were positive about the use of technology in their farming businesses. They encouraged other farmers to explore and implement technology in their farming businesses. They suggested that farmers need to evaluate their need for technology before adopting it and think outside the box regarding marketing.

Learn social media, learn web design, etc. Think outside the box in terms of apps and marketing. (P1)

There is need to adopt and invest in technologies now more than ever before. This should be considered seriously. (P3)

Make use of different technologies as you see fit. Do adapt to modern technologies. New technologies lead to higher productivity and better and more sustainable income streams. (P5)

If, as a farmer, you have the means and are able to afford the technologies that are in the markets, you must go for it and be open-minded about adopting the technology. (P7)

Before adopting a technology, evaluate if it is indeed necessary for your case as they come in expensive, and explore more with other farmers and ask questions. (P9)

I believe that introducing technology, especially in this era of the Fourth Industrial Revolution, is crucial for survival and competitiveness. Without embracing technology, businesses risk stagnation or decline. To grow and succeed, adapting to digital technology is imperative (P11)

The suggestions that the participants had for the farming sector included the need for government organisations and institutions to create awareness and promote farming technologies among farmers, and to provide skills development and financial support to farmers. Regarding the promotion and awareness of digital farming technologies among farmers, the participants indicated that there was a need to make information available about digital technologies, to create platforms to expose and encourage emerging farmers to use technologies in their businesses. Concerning skills development, the participants indicated the need for the stakeholders to sponsor short courses, support emerging farmers with training and development, and provide guidance and information in the country's Indigenous languages. Finally, the participants suggested that emerging black farmers be provided with financial support to procure digital technologies to be used in their businesses and to correct the procurement policies as well as the biased access to markets.

I would recommend investment in the farming sector and provision of support in finances and training and development. A drive for farming at a national level is important. It is sad that, with all the land and other key resources, Africa should be importing food. Farming conscious culture at every level and with whatever small to largest piece of land, from the apartment to the commercial farmer. (P2)

To set the platform to introduce, maintain and sustain adequate new technologies over time in their farming operations. Make women farmers more aware that change can be positive in a business. Financial backup. (P4)

Stakeholders should make information available about technologies that can be adopted in farms and have alternative technologies in place for those who cannot afford them. It is also important for them to encourage and expose emerging farmers, be it youth or women, to try and adapt to the use of technology. (P6)

The procurement policies, as well as skewed access to the market, should be reviewed. The form of training should not exclude what people already know (IKS) in agriculture because there is no one model fits all, many factors play a major role. Allow us to engage with these technologies using indigenous languages. (P7)

Introducing a collaborative model where technology can play a role is vital. The aggregation process can be streamlined with the help of digital technologies, such as online platforms or mobile apps. (P8)

Using apps and digital platforms can significantly benefit rural agricultural environments. While there may be challenges related to education and adoption, these technologies can help streamline processes and connect farmers to markets. (P12)

Discussion

The purpose of this study was to investigate the experiences of emerging black women farmers in using digital technologies in their farming operations. Black women farmers understand the significance of accessing and utilising data related to crucial variables such as soil conditions, crop health, livestock management and weather patterns to optimise their agricultural activities. However, the lack of advanced digital tools poses a challenge to their ability to efficiently analyse and derive valuable insights from these data. The limited availability of advanced connectivity and equipment restricts these farmers' access to digital tools that have the potential to enhance decision-making and improve productivity in agriculture. The findings indicate that, regardless of the size of the farm, the women are generally aware of the need to use technology in their farming businesses and, from the sample interviewed, most are using a range of old methods and machinery. These include moisture readers, spray carts, heat pumps, soil mixing machines and potting machines. With regard to farming methods, these farmers use fogging systems, tunnel cooling and heating systems, hydroponic systems, drip irrigation systems, raised beds and growing towers. What is also clear, is the fact that the black women farmers are also using technologies such as social media, colour

coders, computers and mobile phones in their day-to-day farming and management activities. This indicates that there is an awareness of the importance of technology in making farming more efficacious.

These findings are important at two levels. First, the findings indicate a lack of digital technologies in farming. None of the respondents indicated that they used technologies such as smart farming systems, UAV's big data analytics, drones, the IoT, automated fertigation systems, automatic irrigation, sensors and blockchain. Second, the findings indicate limited access and knowledge about these technologies. This tallies with the findings of Huyer (2016), which indicate that there is gender bias regarding technology access in agriculture, with men having better access to technology than women. This shows the social and economic structural issues faced by emerging black women farmers that require addressing (Manfre et al. 2017).

The findings that indicate that women in agriculture have limited access to digital technologies, also indicate that there is a general awareness of their importance. The participants highlighted that with the use of digital technologies, it is possible to increase productivity and maximise labour usage while at the same time reducing the number of manual tasks that need to be carried out on the farm. The participants also highlighted that, with the use of technology, it is possible for them to reduce the number of inputs and consumables that are used across the farm. They pointed out that, with the adoption of digital technologies, they will manage to reduce the amount of water as well as the amount of electricity that is consumed on the farm. All in all, the use of digital technologies will result in increased profitability.

The key challenges that the participants faced with the use of digital technologies related to their skills deficiency in managing the use of technology, the lack of ICT literacy and financial constraints. The finding is consistent with that by the HURISA (2013) conducted in Malawi and Zimbabwe, which also found that women farmers face challenges such as limited knowledge and use of farming technologies. It also confirms that women farmers often do not have access to finance and credit (Lynch and Njuki 2017; Sandhu et al. 2012); therefore, they cannot afford the cutting-edge digital technologies that will enable them to compete and become commercial farmers. In addition, it also supports the assertion by Mtombeni et al. (2019) that access to finance is key to the success of a farming business in South Africa.

It was not surprising that the participants pointed out their lack of general understanding of ICTs and the skills to manage them, because they are often developed outside the farming sector. For these technologies to be used efficaciously, farmers must have the necessary knowledge (Mwangi and Kariuki 2015). This means that farmers must be trained and educated about the technologies, yet this is not often the case in developing countries. The integration of advanced digital technologies and connectivity in agriculture has the capacity to bring about a significant transformation by equipping farmers with valuable information and enhancing productivity. Nonetheless, it is crucial

to address the digital divide and ensure widespread access to these technologies in less-developed regions to fully unlock their potential benefits for farmers on a global scale. By embracing and implementing advanced digital technologies, black women farmers can gain access to real-time data and insights that enable informed decision-making and optimised agricultural practices. These technologies offer valuable tools for monitoring soil conditions, crop health, weather patterns and other essential variables, and contributing to improved productivity and resource management in farming. Furthermore, connectivity facilitates the exchange of knowledge and best practices among farmers, which promotes collaboration and innovation in the agricultural sector.

The challenges voiced by the participants in this study have been acknowledged in the recent draft National Policy on Comprehensive Producer Development Support (DAFF 2018) and effective strategies to address these challenges have been mentioned. For example, the policy indicates that several vocational training courses in different aspects of agricultural, forestry and fisheries activities, including value addition and processing of agro-products, would be introduced. The mainstreaming of women into the sector and providing them with access to finance have been highlighted. Other important aspects mentioned in the policy are on- and off-farming infrastructure including mechanisation, investment in agriculture, forestry and fisheries mechanisation and policy intervention on mechanisation. However, these strategies have not been implemented. It is also not clear how the government will implement and monitor the abovementioned ideas. These strategies could go a long way in addressing the needs that the participants in this study have articulated, such as the need for short courses and access to finance to afford digital technologies. There is a need for government to support black women farmers and play a role in promoting business growth, to the level where these black emerging women farmers can farm commercially. It is important that the support that women receive from industry stakeholders, such as government departments, need to use indigenous languages when sharing information.

Recommendations

The South African government and other stakeholders in the agricultural sector such as institutions, big-scale farmers and incubators should look at introducing initiatives and programmes that will facilitate, capacitate and support the black women farmers in adopting and embracing the digital technologies. This requires efforts to enhance infrastructure, expand internet connectivity and provide training and support for farmers to effectively utilise digital technologies. By enabling equal access to digital tools and knowledge, the agricultural sector can experience a more inclusive and sustainable transformation that enhances productivity and livelihoods for farmers around the world. Furthermore, women farmers would increase productivity, reduce farming costs, increase profitability and add value in the value chain in a sustainable manner. The initiatives and programmes will accelerate rural development, ensure economic growth and promote sustainable development. Government should also propel the engagements

of all other stakeholders in the agricultural sector and create an agricultural value chain policy that aims to foster the growth of rural emerging black women farming businesses.

Conclusions and Future Research

This study investigated the challenges experienced by emerging black women farmers in using technologies in their farming operations with a specific focus on the South African agricultural environment. Emerging black women farmers play an important role in the South African agricultural sector and face a number of challenges such as financial constraints, access to digital technologies, and the lack of digital skills and technology management skills. The study highlighted the benefits of using digital technologies in farming operations, the challenges of using digital technologies in farming operations as well as the strategies for mitigating the challenges of using digital technologies in farming operations. This shows that emerging black women farmers are aware of digital technologies and their benefits in farming, however, they are facing challenges in accessing and adopting these technologies.

We found that the emerging black women farmers are significantly hampered in their efforts to achieve scalability and profitability because of the pronounced lack of technology know-how and skills. This challenge is worsened by the pervasive digital divide, which restricts their access to vital infrastructure, farming technologies, digital literacy and crucial farming information, thereby severely limiting their capacity to build sustainable and commercial businesses in the rapidly evolving 4IR era. The findings suggest that some of the strategies mentioned in the draft National Policy on Comprehensive Producer Development Support are what is needed by emerging black women farmers. Therefore, the effective implementation of the draft policy will be able to assist emerging black women farmers in growing and transitioning into commercialised farming operations.

The study recommends that there is an urgent need for programmes designed to enhance black women farmers' digital skills that will enable them to leverage modern agricultural practices and access new markets. Significant investment is required to enhance digital infrastructure, connectivity and access to relevant technologies, and to bridge the existing digital divide. The development of a tailor-made framework for the agricultural value chain is crucial to ensure fair participation and promote rural economic development and sustainable black women farming.

The limitation of the study is that, although the study was conducted in three South African provinces, it only used a sample of 12 women farmers. This, and the fact that the study is qualitative, makes it difficult to generalise the findings. The sample cannot be considered representative of all women farmers in South Africa regarding background, education levels and other factors, and that makes the study's applicability problematic.

Further research using quantitative methodology is needed on the same topic. There is still room for more research on women, technology and agriculture, which includes looking at aspects such as urban farming, vertical farming, precision farming, smart farming and their impact on small-scale women farmers and farming from a gender or feminist perspective.

References

- Ahmed, M. A., J. L. Gallardo, M. Zúñiga, M. Pedraza, G. Carvajal, N. Jara and R. Carvajal. 2022. "Lora-Based IoT Platform for Remote Monitoring of Large-Scale Agriculture Farms in Chile." *Sensors* 22 (8): 2824. <https://doi.org/10.3390/s22082824>.
- Aldag, M. C., and B. Eker. 2018. "What is Quality 4.0 in the Era of Industry 4.0?" In *Proceedings of the 3rd International Conference on Quality of Life*, Kopaonik, Serbia, 28–30.
- Anderson, C. L., T. W. Reynolds, P. Biscaye, V. Patwardhan and C. Schmidt. 2021. "Economic Benefits of Empowering Women in Agriculture: Assumptions and Evidence." *Journal of Development Studies* 57 (2): 193–208. <https://doi.org/10.1080/00220388.2020.1769071>.
- Cohen, L., L. Manion and K. Morrison. 2011. *Research Methods in Education* (7th ed.). Routledge.
- Corallo, A., M. E. Latino and M. Menegoli. 2018. "From Industry 4.0 to Agriculture 4.0: A Framework to Manage Product Data in Agri-Food Supply Chain for Voluntary Traceability." *International Journal of Nutrition and Food Engineering* 12 (5): 146–50.
- Creswell, J. W. 2013. *Qualitative Inquiry & Research Design: Choosing Among Five Approaches* (3rd ed). Sage.
- Crowe, S., K. Cresswell, A. Robertson, G. Huby, A. Avery and A. Sheikh. 2011. "The Case Study Approach." *BMC Medical Research Methodology* 11 (1): 1–9. <https://doi.org/10.1186/1471-2288-11-100>.
- DAFF (Department of Agriculture, Forestry and Fisheries). 2018. *Estimate of the Contribution of the Agriculture Sector to Employment in the South African Economy*. DAFF. https://www.nda.gov.za/images/Branches/Economica%20Development%20Trade%20and%20Marketing/Statistic%20and%20%20Economic%20Analysis/economic-analysis/2010-analytic-reports-of-key-macroeconomic-issues-estimate-of-the-contribution-of-agriculture-sector_p42551.pdf.
- Diao, X., P. B. Hazell, D. Resnick and J. Thurlow. 2007. "The Role of Agriculture in Development: Implications for Sub-Saharan Africa." Research report 153. IFPRI.

- Dlamini, S. N., A. Craig, A. Mtintsilana, W. Mapanga, J. du Toit, L. J. Ware and S. A. Norris. 2023. "Food Insecurity and Coping Strategies and Their Association with Anxiety and Depression: A Nationally Representative South African Survey." *Public Health Nutrition* 26 (4): 705–15.
- Drewry, J. J., and P. Stahlmann-Brown. 2025. "Influences Affecting Adoption of Management to Mitigate Impacts of Intensive Winter Grazing of Forage Crops." *New Zealand Journal of Agricultural Research* 68 (7): 1683–95.
- Fan, S., M. Johnson, A. Saurkar and T. Makombe, T. 2008. *Investing in African Agriculture to Halve Poverty by 2015*. IFPRI.
- FAO (Food and Agriculture Organization of the United Nations). 2022. *The State of Food Security and Nutrition in the World 2022*. FAO.
- Freeman, K., and H. Qin. 2020. "The Role of Information and Interaction Processes in the Adoption of Agriculture Inputs in Uganda." *Agronomy* 10 (2): 202.
- Fresco, R., and G. Ferrari. 2018. "Enhancing Precision Agriculture by Internet of Things and Cyber Physical Systems." *Atti Della Società Toscana Di Scienze Naturali Memorie* 125: 53–60. <https://doi.org/10.2424/ASTSN.M.2018.8>.
- Ghoreishi, M., and A. Happonen. 2020. "New Promises AI Brings Into Circular Economy Accelerated Product Design: A Review on Supporting Literature." *E3S Web of Conferences* 158 (2020): 06002. <https://doi.org/10.1051/e3sconf/202015806002>.
- Goedde, L., J. Katz, A. Ménard and J. Revellat. 2020. *Agriculture's Connected Future: How Technology Can Yield New Growth*. McKinsey & Company.
- Greyling, J. C., N. Vink and E. Mabaya. 2015. "South Africa's Agricultural Sector Twenty Years After Democracy (1994 to 2013)." *Professional Agricultural Workers Journal* 3 (1): 10. <http://tuspubs.tuskegee.edu/pawj/vol3/iss1/10>.
- HURISA (Human Rights Institute of South Africa). 2013. "Study to Audit and Monitor Compliance and Implementation of Protocols, Conventions and Decisions of the AU Member States." Southern Africa Trust.
- Huyer, S. 2016. "Closing the Gender Gap in Agriculture." *Gender, Technology and Development* 20 (2): 105–16.
- Ingutia, R., and J. Sumelius. 2022. "Determinants of Food Security Status with Reference to Women Farmers in Rural Kenya." *Scientific African* 15: e01114.
- Jakku, E., B. Taylor, A. Fleming, C. Mason and P. Thorburn. 2016. "Big Data, Trust and Collaboration: Exploring the Socio-Technical Enabling Conditions for Big Data in the Grains Industry." *CSIRO*. <https://publications.csiro.au/publications/publication/PIcsiro:EP164134>.

- Johnson, D. W., R. T. Johnson and K. A. Smith. 2014. "Cooperative Learning: Improving University Instruction by Basing Practice on Validated Theory." *Journal on Excellence in College Teaching* 25 (3–4): 85–181.
- Kamble, S., A. Gunasekaran and H. Arha. 2019. "Understanding the Blockchain Technology Adoption in Supply Chains-Indian Context." *International Journal of Production Research* 57 (7): 2009–33. <https://doi.org/10.1080/00207543.2018.1518610>.
- Khapayi, M., and P. R. Celliers. 2016. "Factors Limiting and Preventing Emerging Farmers to Progress to Commercial Agricultural Farming in the King William's Town Area of the Eastern Cape Province, South Africa." *South African Journal of Agricultural Extension* 44 (1): 25–41. <https://doi.org/10.17159/2413-3221/2016/v44n1a374>.
- Khatri-Chhetri, A., A. Pant, P. K. Aggarwal, V. V. Vasireddy and A. Yadav. 2019. "Stakeholders Prioritization of Climate-Smart Agriculture Interventions: Evaluation of a Framework." *Agricultural Systems* 174: 23–31. <https://doi.org/10.1016/j.agsy.2019.03.002>.
- Klasen, S. 2018. "The Impact of Gender Inequality on Economic Performance in Developing Countries." *Annual Review of Resource Economics* 10 (1): 279–98. <https://www.jstor.org/stable/26773490>.
- Kimenyi, M. S. 2002. "Agriculture, Economic Growth and Poverty Reduction (No. 3)." Kenya Institute for Public Policy Research and Analysis. Accessed 27 May 2020, <http://repository.kippra.or.ke/handle/123456789/2573>.
- Kiptot, E., and S. Franzel. 2012. "Gender and Agroforestry in Africa: A Review of Women's Participation." *Agroforestry Systems* 84 (1): 35–58.
- Li, Z., M. Wu, Y. Qin, T. Li and X. Zheng. 2025. "Social Capital and Rural Household Energy Poverty: Evidence from the China Family Panel Studies." *Energy* 138286.
- Lingireddy, H., K. Bhargava, E. Abhishek, B. Madhusudhan, C. Banu Teja and B. Guru Sri. 2023. "An Overview of Digital Technologies in Agriculture and Their Applications." *Biological Forum* 15 (2): 750–7.
- Lohmer, J., and R. Lasch. 2020. "Blockchain in Operations Management and Manufacturing: Potential and Barriers." *Computers and Industrial Engineering*, 149: 106789.
- Lynch, S., and J. Njuki. 2017. "Key Factors to Success in Agribusiness." *SPORE* 187: 22–26. <https://cgspace.cgiar.org/bitstream/handle/10568/90012/Spore-187-EN-WEB.pdf>.
- Mabaso, S. M. 2014. "Impact of Agricultural Development Projects on Poverty Alleviation in Amajuba District Municipality (KZN)." Master's diss., University of Fort Hare. <http://libdspace.ufh.ac.za/bitstream/handle/20.500.11837/373/M%20Agric%20%28Agric%20Eco%29%20MABASO.pdf?sequence=1&isAllowed=y>.

- Manfre, C., D. Rubin and C. Nordehn. 2017. "Assessing How Agricultural Technologies Can Change Gender Dynamics and Food Security Outcomes Toolkit." USAID. Accessed 6 June 2020, https://culturalpractice.com/wp-content/uploads/Introduction-to-the-Toolkit-Final-10_17.pdf.
- Mbiba, B. 1995. *Urban Agriculture in Zimbabwe: Implications for Urban Management and Poverty*. Avebury.
- Mkentane, L. 2019. "Ramaphosa Eyes Silicon Valley in South Africa." <https://newsexpressngr.com/news/78454-Ramaphosa-eyes-Silicon-Valley-in-South-Africa>.
- Mohlatlole, R. P., E. F. Dzomba and F. C. Muchadeyi. 2015. "Addressing Production Challenges in Goat Production Systems of South Africa: The Genomics Approach." *Small Ruminant Research* 131: 43–49. <https://doi.org/10.1016/j.smallrumres.2015.08.003>.
- Mtombeni, S., D. Bove and T. Thibane. 2019. "The Competition Commission." Working Paper Series. Accessed 30 July 2020, <http://www.compcom.co.za/working-paper-series/>.
- Mwangi, M., and S. Kariuki. 2015. "Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Countries." *Journal of Economics and Sustainable Development* 6 (5): 208–16. <https://www.iiste.org/Journals/index.php/JEDS/article/view/20710>.
- National Planning Commission. 2011. *National Development Plan: 2030*. National Planning Commission. <https://nationalplanningcommission.wordpress.com/downloads/>.
- Ngwexana, T. 2018. "Access to Land and Productive Resources Among Female Farmers in Stellenbosch: Implications for Women's Empowerment and Household Food." PhD diss., University of the Western Cape.
- Ojha, T., S. Misraa and N. S. Raghuwanshi. 2015. "Wireless Sensor Networks for Agriculture: The State-of-the-Art in Practice and Future Challenges." *Computers and Electronics in Agriculture* 118: 66–84. <https://doi.org/10.1016/j.compag.2015.08.011>.
- Orr, A. 2000. "'Green Gold'?: Burley Tobacco, Smallholder Agriculture, and Poverty Alleviation in Malawi." *World Development* 28 (2): 347–63. [https://doi.org/10.1016/S0305-750X\(99\)00127-8](https://doi.org/10.1016/S0305-750X(99)00127-8).
- Owen, A., K. Arnold, C. Friedman and L. Sandman. 2016. "Nominal Group Technique: An Accessible and Interactive Method for Conceptualising the Sexual Self-Advocacy of Adults with Intellectual and Developmental Disabilities." *Qualitative Social Work* 15 (2): 175–89. <https://doi.org/10.1177/1473325015589803>.
- Pandya, V. M. "Comparative Analysis of Development of SMEs in Developed and Developing Countries." In *The 2012 International Conference on Business and Management*, 6–7 September 2012, 426–33.

- Paraforos, D. S., V. Vassiliadis, D. Kortenbruck, K. Stamkopoulos, V. Ziogas, A. A. Sapounas and H. W. Griepentrog. 2016. "A Farm Management Information System Using Future Internet Technologies." *IFAC-PapersOnLine* 49 (16): 324–29. <https://doi.org/10.1016/j.ifacol.2016.10.060>.
- Patton, M. Q. 2002. "Two Decades of Developments in Qualitative Inquiry: A Personal, Experiential Perspective." *Qualitative Social Work* 1 (3): 261–83. <https://doi.org/10.1177/1473325002001003636>.
- Piek, M., D. von Fintel and J. Kirsten. 2023. "The Impact of Agricultural Minimum Wages on Worker Flows in South Africa." *South African Journal of Economics* 91 (4): 446–65. <https://doi.org/10.1111/saje.12357>.
- Roller, M. R. 2019. "A Quality Approach to Qualitative Content Analysis: Similarities and Differences Compared to Other Qualitative Methods." *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research* 20 (3): 1–21.
- Sandhu, N., J. Hussain and H. Matlay. 2012. "Barriers to Finance Experienced by Female Owner/Managers of Marginal Farms in India." *Journal of Small Business and Enterprise Development* 19 (4): 640–55. <https://doi.org/10.1108/146260012112774>.
- Sebola, M. P. 2018. "Financing Emerging Black Farmers for Agricultural Development in South Africa: A Wasteful and Unworkable Model for Creating Black Farmers." *Journal for Transdisciplinary Research in Southern Africa* 14 (1): 1–7. <https://doi.org/10.4102/td.v14i1.555>.
- Senyolo, M. P., T. B. Long, V. Blok and O. Omta. 2018. "How the Characteristics of Innovations Impact Their Adoption: An Exploration of Climate-Smart Agricultural Innovations in South Africa." *Journal of Cleaner Production* 172: 3825–3840.
- Sharma, J., A. Sangwan and R. P. Singh. 2023. "A Review on Evolving Domains of Internet of Things: Architecture, Applications, and Technical Challenges." *International Journal of Communication Systems* 36 (18): 5631. <https://doi.org/10.1016/j.jclepro.2017.06.019>.
- Sibanda, S., and T. E. Simalenga. 2010. "Field Performance of Draft Animal Power Weeding Implements Under Small Holder Cotton Farming in the Zambezi Valley in Zimbabwe," paper presented at the International Conference on Agricultural Engineering, 6–8 September 2010, Clermont-Ferrand, France.
- Siegel, P. B., and J. Alwang. 2005. "Poverty Reducing Potential of Smallholder Agriculture in Zambia (No. 85)." World Bank. Accessed 28 May 2020, <https://documents1.worldbank.org/curated/en/836971468170651506/pdf/342460PAPER0ZM0smallholder0AFRwp85.pdf>.
- Sihlobo, W., and J. Kirsten. 2021. "Agriculture in South Africa." In *The Oxford Handbook of the South African Economy*, edited by A. Oqubay, F. Tregenna and I. Valodia, 194–216. <https://doi.org/10.1093/oxfordhb/9780192894199.013.10>.

- Smidt, H. J., and O. Jokonya. 2022. "Factors Affecting Digital Technology Adoption by Small-Scale Farmers in Agriculture Value Chains (AVCs) in South Africa." *Information Technology for Development* 28 (3): 558–84.
- Statistics South Africa. 2020. "Stats SA Releases Census of Commercial Agriculture 2017 Report." Statistics South Africa. Accessed 22 April 2020, <http://www.statssa.gov.za/publications/Report-11-02-01/Report-11-02-012017.pdf>.
- Subramanian, H., and S. Subramanian. 2022. "Improving Diagnosis Through Digital Pathology: Proof-of-Concept Implementation Using Smart Contracts and Decentralised File Storage." *Journal of Medical Internet Research* 24 (3): e34207. <https://doi.org/10.2196/34207>.
- Tsan, M., S. Totapally, M. Hailu and B. K. Addom. 2019. "The Digitalisation of African Agriculture Report 2018–2019." CTA. <https://cgspace.cgiar.org/handle/10568/101498>.
- United Nations Centre Against Apartheid. 1978. "The Effects of Apartheid on the Status of Women in South Africa." *Black Scholar* 10 (1): 11–20. <https://doi.org/10.1080/00064246.1978.11412667>.
- Victor, B. F., and S. S. Akadiri. 2019. "Poverty and Agriculture in Southern Africa Revisited: A Panel Causality Perspective." *Sage Open*. <https://doi.org/10.1177/2158244019828853>.
- Von Grebmer, K., J. Bernstein, M. Wiemers, L. Reiner, M. Bachmeier, A. Hanano, R. N. Chéilleachair, C. Foley, T. Sheehan, S. Gitter, G. Larocque and H. Fritschel. 2023. *Global Hunger Index 2023: The State of Food Security and Nutrition Worldwide*. IFPRI.
- Xaba, T., and C. S. Dlamini. 2015. "The Comprehensive Agricultural Support Programme's (CASP) Training and Capacity Building: An Impact Analysis on Income Levels of Emerging Farmers in Limpopo Province (South Africa)." *American Journal of Economics, Finance and Management* 1 (3): 153–63.
- WCDOA and USB. 2018. "The Future of the Western Cape Agricultural Sector in the Context of the Fourth Industrial Revolution – Synthesis Report." Accessed 15 July 2019. <https://www.usb.ac.za/wpcontent/uploads/2018/07/THE-FUTURE-OF-THE-WC-AGRICULTURAL-SECTOR-IN-THE-CONTEXT-OF-4IRFINAL-REP.pdf>.
- Zantsi, S., J. Greyling and N. Vink. 2018. "Towards a Common Understanding of 'Emerging Farmer' in a South African Context Using Data from a Survey of Three District Municipalities in the Eastern Cape Province." *South African Journal of Agricultural Extension*. <https://doi.org/10.17159/2413-3221/2019/v47n2a505>.