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Factors Influencing Agricultural Technology (Agritech) Adoption among KwaZulu-Natal Commercial Farm Managers

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ABSTRACT

The ongoing rise in global population has an impact on the rise in food demand. The pressure on agricultural production is a result of the rising food demand. Although there are difficulties in implementing and using agricultural technology (agritech), it has solutions that might be able to handle the problem of increased food demand. Therefore, this study explored the factors that influence KwaZulu-Natal commercial farm managers in the adoption of agritech. An open-ended e-interview schedule was sent to 26 farm managers in the KwaZulu-Natal North Coast and Midlands as part of the study's qualitative research technique. The NVivo software was used to organise and manage the data gathered from these e-interviews. The researcher used codes and themes to analyse the data. The findings of this study established that the factors that were common in influencing agritech adoption amongst farm managers were; namely, human behaviour factors, economic factors, science factors and legal factors. This study then recommended that policymakers need to consider these factors for realistic policy frameworks. Farm owners should also consider other means of obtaining agritech which are cost-effective such as forming stokvels. Furthermore, a practical approach could be used to fund the upskilling of the farm workers. A collaborative approach between the different stakeholders is required for the implementation of agritech adoption to be a success in South Africa. State the contribution of this study to scholarship.

Keywords: *Agritech, Farm Labour, Technology, Management, Agriculture*

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INTRODUCTION

The agricultural industry has been experiencing continuous technological development. Mtshali and Jili described agricultural technology (agritech) as a tool for a more effective and efficient method of farming.[1] Additionally, Nkonki-Mandleni, Manenzhe and Omotayo stated that agritech has the potential to increase food productivity which could address the challenge identified by the United Nations World Summit (2015) that 70% more food production will be required to accommodate three meals per day per person by 2030.[2] However, according to Vagnani, and Volpe, the reluctance of farm managers to adopt and utilize

[1] Thabisile L Mtshali and Nokukhanya N Jili, "The Effectiveness of the 4ir Technologies in Elevating Small-Scale Farming at Kwadlangezwa, Kwazulu Natal in South Africa," *International Journal of EBusiness and EGovernment Studies* 14, no. 1 (2022): 388–408.
[2] Busisiwe Nkonki-Mandleni, Nnditsheni Godfrey Manenzhe, and Abiodun Olusola Omotayo, "Factors Influencing the Adoption of Conservation Agriculture by Smallholder Farmers in KwaZulu-Natal, South Africa," *Open Agriculture* 7, no. 1 (2022): 596–604.

agritech plays a role in the agricultural industry being less productive than it could be.[3] Several published literature have reported that South Africa is one of the countries with a low agritech adoption rate. Ugochukwu and Phillips stated that the adoption of agritech is influenced by human behaviour, economics, and science.[4] Strydom stated that legal factors also influence the adoption of agritech.[5] This study focused on influences within the South African context such as the legislations, policies, characteristics of agritech, sizes of the farms, labour availability and the relationships between farm managers and extension officers in the country. According to Nkonki-Mandleni, Manenzhe and Omotayo, developing countries lag when it comes to the adoption and utilization of new and developing agritech.[6] This was even though the application of modern agritech in the agricultural sectors of developed countries proved that the use of agritech improved the sector, in terms of productivity, sustainability, economics and efficiency, more than it deteriorated it.[7]

This study focuses on large commercial farms since they are huge agricultural production industry players, possessing more resources than other farms and to some extent hold the most influence on the adoption of agritech by other practices in the agricultural sector. The South African agriculture sector has been identified by the National Development Plan (NDP) 2030 as one of the key sectors that will drive opportunities for employment creation and inclusive economic growth. Agricultural activity plays an important role in the economic development of the country. However, some farm managers continue to rely on the traditional methods of managing and operating a farm which often restricts the performance of the farm.[8] For the benefits presented by the modern agritech to be useful, the factors that influence the adoption or rejection of agritech need to be considered. This is to better understand the reasons that underline the rate of adoption in the country. Furthermore, these factors could also seek to explain the adoption behaviour of the farm managers which could be potentially used for future agricultural production projections.

The South African agriculture sector was identified by the National Development Plan 2030 as one of the key sectors that will drive opportunities for employment creation and inclusive economic growth. However, the sector still has low productivity. Agricultural activity plays an important role in the economic development of the country. The KwaZulu-Natal economy is diverse, and agriculture has contributed 4% of the GDP of the province.[9] The challenges experienced by KwaZulu-Natl, such as the Covid-19 pandemic,[10] the looting,[11] and the flooding, negatively affected the agricultural industry which resulted in an impact of productivity.[12] Not to say that the adoption of agritech would have limited these challenges but offered better solutions to the consequences of the challenges. Amid the mentioned issues, some farm managers continue to rely on the traditional methods of managing and operating a farm which often restricts the performance of the farm.[13] Additionally, there is a continuous human population growth.

For the benefits presented by the modern agritech to be useful, the factors that influence the adoption or rejection of agritech need to be considered. This is to better understand the reasons that underline the rate of adoption in the country. Furthermore, these factors could also seek to explain the adoption behaviour of the farm managers which could be potentially used for future agricultural

[3] Gianluca Vagnani and Loredana Volpe, "Innovation Attributes and Managers' Decisions about the Adoption of Innovations in Organizations: A Meta-Analytical Review," *International Journal of Innovation Studies* 1, no.2(2017):107–33.
[4] Albert I Ugochukwu and Peter W B Phillips, "Technology Adoption by Agricultural Producers: A Review of the Literature," *From Agriscience to Agribusiness: Theories, Policies and Practices in Technology Transfer and Commercialization*, 2018, 361–77.
[5] Jeanthè Strydom, *Farm Attacks in South Africa: An International Comparison of Farm Crimes* (University of Central Oklahoma, 2022).
[6] Nkonki-Mandleni, Manenzhe, and Omotayo, "Factors Influencing the Adoption of Conservation Agriculture by Smallholder Farmers in KwaZulu-Natal, South Africa."
[7] W. Sihlobo, "The Effects of the Covid-19 Pandemic on Agricultural Employment in South Africa," 2020, https://www.bizcommunity.com/Article/196/358/205388.html/.
[8] Raesetse Baloyi, Edilegnaw Wale, and Unity Chipfupa, "Rural Youth Interest in Economic Activities along the Agricultural Value Chain: Empirical Evidence from KwaZulu-Natal (South Africa) and Implications," *International Food and Agribusiness Management Review* 26, no. 1 (2023): 49–65.
[9] Njabulo Lloyd Ntshangase, Brian Muroyiwa, and Melusi Sibanda, "Farmers' Perceptions and Factors Influencing the Adoption of No-till Conservation Agriculture by Small-Scale Farmers in Zashuke, KwaZulu-Natal Province," *Sustainability* 10, no. 2 (2018): 555.
[10] Ferdinand Meyer et al., "A Sector-Wide Review of the COVID-19 Impact on the South African Agricultural Sector during 2020–21," *Agrekon* 61, no. 1 (2022): 3–20.
[11] Moeketsi Kali, "A Comparative Analysis of the Causes of the Protests in Southern Africa," *SN Social Sciences* 3, no. 2 (2023): 28.
[12] Hamlet Hlomendlini, "Developing Strategies to Combat the Impact of Extreme Weather," *Farmer's Weekly* 2022, no. 22019 (2022): 14.
[13] Baloyi, Wale, and Chipfupa, "Rural Youth Interest in Economic Activities along the Agricultural Value Chain: Empirical Evidence from KwaZulu-Natal (South Africa) and Implications."

production projections. That is essential for meeting the continuously increasing food demand the continuous need for job creation, the continuous need for economic growth, and the continuous need to withstand climate change.[14] Sulewski, Kłoczko-Gajewska, and Sroka stated that the mechanization, automation and modernization in the agriculture sector of some developed countries such as Japan suggested that agritech adoption by commercial farm managers have the potential to influence developments of production and business.[15] Agritech goes beyond technology in the agriculture sector covering the underpinning innovative and sustainable business model that has high-impact solutions.[16]

The adoption of technology generally refers to the selection of a certain technology and incorporating it into the regular use of an organisation or an individual. The use of agritech by farm managers is a powerful tool for the increase of productivity and maximisation of profits in agribusinesses.[17] However, a key challenge, which is the resistance of some farm managers, particularly older generations, to transition from traditional methods, emerges.[18] This reluctance influences the hindrance of agribusinesses from reaching their full potential and contributing significantly to achieving Sustainable Development Goals 1 (No Poverty) and 2 (Zero Hunger).[19] The issue of food security, exacerbated by population growth, is particularly pressing in developing countries, where agritech adoption rates lag behind developed nations. South Africa, similar to many developing economies, faces difficulties in embracing new agritech solutions.[20] Modern business leaders recognize the importance of technology integration for future success.[21] In the agricultural context, the absence of agritech often translates to lower productivity. Therefore, exploring the factors influencing agritech adoption among commercial farm managers is crucial to address this challenge and unlock the potential benefits of this technology.

The inspiration for this study is drawn from the connection between technology, business and agriculture. The slow agritech adoption rate in South Africa is the reason for conducting this study. According to Kawula, South African farmers have been adopting agritech at a low level.[22] Musvoto, Nortje, De Wet, Mahumani, and Nahman stated the South African government has encouraged the utilization of agritech by agricultural operations.[23] The Department of Trade and Investment in partnership with Microsoft South Africa has been offering support to initiatives related to the utilization of agritech in agricultural operations.[24] However, this support is often offered without understanding the factors that influence the farmers to adopt agritech at the farms they work at. This lack of understanding has shaped the need to understand the influences of agritech adoption by farm managers. The utilization of agritech in agricultural operations has an impact on the rate that agricultural outputs increase and this increase has an impact on food affordability levels, environmental degradation, profitability, demand for food and other factors.[25]

This paper explores the factors that influence the adoption of agritech by KwaZulu-Natal commercial farm managers. The paper aims to gather and present the influences of agritech adoption for

[14] Nkonki-Mandleni, Manenzhe, and Omotayo, "Factors Influencing the Adoption of Conservation Agriculture by Smallholder Farmers in KwaZulu-Natal, South Africa"; Sihlobo, "The Effects of the Covid-19 Pandemic on Agricultural Employment in South Africa."
[15] Piotr Sulewski, Anna Kłoczko-Gajewska, and Wojciech Sroka, "Relations between Agri-Environmental, Economic and Social Dimensions of Farms' Sustainability," *Sustainability* 10, no. 12 (2018): 4629.
[16] Sulewski, Kłoczko-Gajewska, and Sroka, "Relations between Agri-Environmental, Economic and Social Dimensions of Farms' Sustainability."
[17] Konstantina Spanaki et al., "Disruptive Technologies in Agricultural Operations: A Systematic Review of AI-Driven AgriTech Research," *Annals of Operations Research* 308, no. 1 (2022): 491–524.
[18] Ali Muhammad Garba, "Agri-Tech Opportunities at the Bottom of the Pyramid: How Big Is the Opportunity and How Little Has Been Exploited? Some Selected Cases in Nigeria," *Digital Entrepreneurship in Sub-Saharan Africa: Challenges, Opportunities and Prospects*, 2019, 199–220.
[19] Otto Spijkers, "Intergenerational Equity and the Sustainable Development Goals," *Sustainability* 10, no. 11 (2018): 3836.
[20] Ntshangase, Muroyiwa, and Sibanda, "Farmers' Perceptions and Factors Influencing the Adoption of No-till Conservation Agriculture by Small-Scale Farmers in Zashuke, KwaZulu-Natal Province."
[21] Vagnani and Volpe, "Innovation Attributes and Managers' Decisions about the Adoption of Innovations in Organizations: A Meta-Analytical Review."
[22] Nomvikelelo Kawula, "Farmers' Perceptions and Attitudes to Technology Adoption in the Ugu District of KwaZulu-Natal, South Africa." (2019).
[23] Constansia Musvoto et al., "Imperatives for an Agricultural Green Economy in South Africa," *South African Journal of Science* 111, no. 1–2 (2015): 1–8.
[24] African Union Commission, "Policies to Create Jobs and Achieve Agenda 2063 in the Digital Age," 2021.
[25] Vagnani and Volpe, "Innovation Attributes and Managers' Decisions about the Adoption of Innovations in Organizations: A Meta-Analytical Review."

the guidance and consideration of other farm managers when considering the adoption of agritech. Further to that, it aims to guide future research in the adoption of agritech in commercial farms.

LITERATURE REVIEW

At the farm level, agritech adoption is influenced by human behaviour, economics, science, and legal factors. Although less obvious, human behaviour can have an impact on whether or not agritech is adopted. Whilst the Science component serves as the cornerstone for agritech development, the Economics component acts as a powerful inducer for the adoption of agritech.[26] The literature of this study classifies human capital and interactions with extension officers as human behaviour factors where the availability of agritech skilled labour, technical expertise, farm workforce characteristics, agritech training, and the accessibility of agritech information were the main elements influencing the adoption of agritech in related studies. The economic factors in this literature include the costs related to agritech, its profitability and accessibility. It also includes farm practices where farm ownership, farm location, and farm size for scale-dependent agritech were the main influences of agritech adoption in other agritech adoption research. The characteristics of agritech are classified as a science factor, in this study, where the necessity, effectiveness, and efficiency of the agritech were major influences of the agritech adoption. Another factor that emerges in this literature review, although not entirely at the farm level, is the legal factor where legislation and policies are elements that influence the adoption of agritech at a scale larger than the farm level.

Legislation and Policies

The agricultural sector in South Africa has experienced growth despite policy inconsistencies and a lack of support for commercial agriculture.[27] To foster further growth and enhance the digitalization of farming, it is necessary to update the current policy framework.[28] Whilst there have been efforts to implement smart-farming projects, according to the president of South Africa (2020), these policies have not effectively supported the digitalization of the industry. The lack of clarity and regulations surrounding the collection and management of agricultural data has hindered the adoption of agritech.[29] Strengthening data protection and establishing industry-specific standards and codes of conduct are necessary steps. The use of artificial intelligence (AI) in the agricultural sector is growing, but there is a need for AI-specific legislation and proactive policies in South Africa to encourage its use.[30] According to Smidt and Jokonya, the agriculture industry is important for job creation, but the introduction of new technology has also led to job losses, creating uncertainty in the labor market.[31] Policymakers must consider the economic growth potential of the agriculture sector and develop policies that promote the adoption of agritech whilst mitigating its negative impacts.

Characteristics of Agritech

The choice to adopt agricultural technology is influenced by factors such as its distinctive qualities, understanding of its applications, and training received.[32] However, simply understanding technology does not guarantee its acceptance, as farmers may lack the necessary abilities or not grow the crops it supports.[33] Farmers are more likely to adopt agritech that is easily accessible, adaptable to their farms,

[26] Ugochukwu and Phillips, "Technology Adoption by Agricultural Producers: A Review of the Literature."
[27] Wandile Sihlobo and Johann Kirsten, "Agriculture in South Africa," *The Oxford Handbook of the South African Economy*, 2021, 195.
[28] LINK Public Policy Series et al., "Crafting the South African Digital Economy and Society: Multi-Dimensional Roles of the Future-Oriented State," 2022.
[29] Pablo Aguera et al., "Paving the Way towards Digitalising Agriculture in South Africa," *No. June*, 2020, 1–42.
[30] Timothy Nigel Blaker, "Farm-Level Barriers to the Adoption of Precision Agriculture Technologies in the South African Maize Industry: Variable Rate Application, Section Control, and Guidance" (Stellenbosch University, 2021).
[31] Hermanus Jacobus Smidt and Osden Jokonya, "Factors Affecting Digital Technology Adoption by Small-Scale Farmers in Agriculture Value Chains (AVCs) in South Africa," *Information Technology for Development* 28, no. 3 (2022): 558–84; Strydom, *Farm Attacks in South Africa: An International Comparison of Farm Crimes*..
[32] Alice Mauchline et al., "Evidence-Based Online Courses: An Educational Model to Increase Agri-Tech Adoption?," *Agri-Tech Economics for Sustainable Futures* 20 (2021): 71.
[33] Abdul Rehman et al., "Modern Agricultural Technology Adoption Its Importance, Role and Usage for the Improvement of Agriculture," *Life Science Journal* 14, no. 2 (2016): 70–74.

consistent with their demands, and seen as valuable.[34] According to Senyolo et. al., the price of the technology also plays a role, as high prices and net costs can hinder adoption.[35] However, if the return on investment is greater than the net cost and the technology requires minimal maintenance and is easy to use, farmers are more likely to adopt it.[36] Ultimately, farm managers make adoption decisions based on the availability, affordability, and usability of the technology.

Farming Practices

The size of a farm is a significant factor influencing the adoption of agritech, according to multiple researchers. However, Sarker et. al. argued that farm size has no connection to agritech adoption, as farmers adopt technologies based on their operational needs and the potential benefits.[37] Senyolo et al., supported by Michels, von Hobe, and Musshoff, stated that farm size does affect the adoption of agritech, particularly for scale-dependent technologies.[38] They suggest that farmers with larger commercial farms are more likely to adopt agritech because they have the resources for experimentation. Additionally, Adenle, Wedig and Azadi stated that large farms can benefit from economies of size for heavy machinery.[39] According to Michels, von Hobe, and Musshoff, there is a need to assist, such as access to loans, to small farms to disprove the myth that large farms are necessary for agritech adoption.[40] The land ownership structure also plays a role, as the rules set by landowners can restrict the use of agritech on large-scale farms.[41] The location of the farm also influences agritech adoption, as farms located farther from markets and urban areas may have limited access to information and agricultural extension services.[42] Overall, farm size, land ownership structure, and farm location are variables that can influence the decision to adopt agritech.

Human Capital

Age, gender, and race are just a few of the individual characteristics of the people who work on farms, and their level of education, management, knowledge, skills, and farming experience all have an impact on the decision to adopt agritech at a farm.[43] Mistakes, unplanned leaves of absence, and lack of knowledge or skills also affect human capital. Large commercial farms may train their workers, but hiring new personnel can be costly.[44] According to Michels, von Hobe, and Musshoff, formal education and farm work experience are correlated with agritech knowledge and use.[45] Developing nations should invest in farmers' human resource development to effectively utilize agritech for increased productivity .[46] Molieleng, Fourie, and Nwafor stated that managerial abilities play a crucial role in the adoption of agritech, with farm managers with better skills more likely to adopt new technologies.[47] According to Kudama et al., the success of technological change in some African nations is attributed to improved

[34] Ademola A Adenle, Karin Wedig, and Hossein Azadi, "Sustainable Agriculture and Food Security in Africa: The Role of Innovative Technologies and International Organizations," *Technology in Society* 58 (2019): 101143.
[35] Mmapatla Precious Senyolo et al., "How the Characteristics of Innovations Impact Their Adoption: An Exploration of Climate-Smart Agricultural Innovations in South Africa," *Journal of Cleaner Production* 172 (2018): 3825–40.
[36] Lerato Molieleng, Pieter Fourie, and Ifeoma Nwafor, "Adoption of Climate Smart Agriculture by Communal Livestock Farmers in South Africa," *Sustainability* 13, no. 18 (2021): 10468.
[37] Md Nazirul Islam Sarker et al., "Promoting Digital Agriculture through Big Data for Sustainable Farm Management," *International Journal of Innovation and Applied Studies* 25, no. 4 (2019): 1235–40.
[38] Senyolo et al., "How the Characteristics of Innovations Impact Their Adoption: An Exploration of Climate-Smart Agricultural Innovations in South Africa"; Marius Michels, Cord-Friedrich von Hobe, and Oliver Musshoff, "A Trans-Theoretical Model for the Adoption of Drones by Large-Scale German Farmers," *Journal of Rural Studies* 75 (2020): 80–88.
[39] Adenle, Wedig, and Azadi, "Sustainable Agriculture and Food Security in Africa: The Role of Innovative Technologies and International Organizations."
[40] Michels, von Hobe, and Musshoff, "A Trans-Theoretical Model for the Adoption of Drones by Large-Scale German Farmers."
[41] Senyolo et al., "How the Characteristics of Innovations Impact Their Adoption: An Exploration of Climate-Smart Agricultural Innovations in South Africa"; Sarker et al., "Promoting Digital Agriculture through Big Data for Sustainable Farm Management."
[42] Adenle, Wedig, and Azadi, "Sustainable Agriculture and Food Security in Africa: The Role of Innovative Technologies and International Organizations"; Sarker et al., "Promoting Digital Agriculture through Big Data for Sustainable Farm Management."
[43] Gezahagn Kudama et al., "Will Digital Solution Transform Sub-Sahara African Agriculture?," *Artificial Intelligence in Agriculture* 5 (2021): 292–300.
[44] Mauchline et al., "Evidence-Based Online Courses: An Educational Model to Increase Agri-Tech Adoption?"
[45] Michels, von Hobe, and Musshoff, "A Trans-Theoretical Model for the Adoption of Drones by Large-Scale German Farmers."
[46] Ehsan Elahi, Zainab Khalid, and Zhixin Zhang, "Understanding Farmers' Intention and Willingness to Install Renewable Energy Technology: A Solution to Reduce the Environmental Emissions of Agriculture," *Applied Energy* 309 (2022): 118459.
[47] Molieleng, Fourie, and Nwafor, "Adoption of Climate Smart Agriculture by Communal Livestock Farmers in South Africa."

management skills.[48] Entrepreneurial farm managers are more inclined to adopt new agritech,[49] and access to capital and entrepreneurial acumen directly impact innovation and output.[50]

Interactions with Extension Officers

The accessibility of information about new agritech plays a significant role in its adoption. Extension services act as a bridge between technology creators and users, helping farmers learn about and access new agritech.[51] According to Norton and Alwang, these services can lower transaction costs and reach a diverse group of farmers.[52] However, Thinda et al. stated that there are concerns about fair distribution of knowledge and the potential for misinformation.[53] Extension services can also help close the education gap for farmers and improve adoption rates.[54] In some developing countries, poorly managed extension approaches, and a lack of financial support hinder the adoption of agritech. The training and visiting extension approach has been effective in certain regions, but there is a shortage of extension services in many developing countries, leading to limited programs and outdated information for farmers.[55] Increasing the number of extension officers can positively impact agritech adoption, but inadequate training and resources may be a challenge. The level of industry experience among extension officers can positively influence adoption, but there may be a disconnect between officers' and farmers' perspectives.[56] Effective extension strategies and procedures are essential for providing technical advice to farm managers and improving agritech adoption.

METHODOLOGY

A qualitative research design with a phenomenological research approach was used in this study since it collected and analysed non-numerical data to understand opinions, concepts, and experiences. Furthermore, the study was based on the investigation of a phenomenon through the description and interpretation of the experiences of the farm managers with agritech adoption.[57] The study was situated in a constructivist paradigm which was birthed by the interpretivist paradigm and is an ever-growing paradigm of philosophy. According to Ekpenyong, the constructivist philosophical paradigm was explained as an approach which asserts that people create their understanding and knowledge of the world by experiencing certain phenomena.[58] Additionally, accommodation and assimilation are the two constructivism cardinal processes of knowledge construction. The accommodation process is concerned with shaping the mental representation of the newly experienced external environment of a person. On the other hand, the assimilation process is concerned with the person incorporating new experiences into an existing framework from old experiences whilst not changing that particular framework. This paradigm was suitable for this study since agritech is a new experience trying to fit into the existing methods of farming for farm managers in South Africa and could shape the mental faculties of the farm managers in the agritech adoption process. The study used an inductive inference since it collected data to explore a phenomenon and it identified themes that emerged from each farm to generalise the findings to the areas of the farms.

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[48] Kudama et al., "Will Digital Solution Transform Sub-Sahara African Agriculture?"
[49] Michael Tsan et al., *The Digitalisation of African Agriculture Report 2018–2019* (CTA, 2019).
[50] Monica Fisher et al., "Awareness and Adoption of Conservation Agriculture in Malawi: What Difference Can Farmer-to-Farmer Extension Make?," *International Journal of Agricultural Sustainability* 16, no. 3 (2018): 310–25; Tsan et al., *The Digitalisation of African Agriculture Report 2018–2019*.
[51] HAJI Karine, "E-Commerce Development in Rural and Remote Areas of BRICS Countries," *Journal of Integrative Agriculture* 20, no. 4 (2021): 979–97.
[52] George W Norton and Jeffrey Alwang, "Changes in Agricultural Extension and Implications for Farmer Adoption of New Practices," *Applied Economic Perspectives and Policy* 42, no. 1 (2020): 8–20.
[53] K T Thinda et al., "Understanding the Adoption of Climate Change Adaptation Strategies among Smallholder Farmers: Evidence from Land Reform Beneficiaries in South Africa," *Land Use Policy* 99 (2020): 104858.
[54] Chin-Ling Lee, Robert Strong, and Kim E Dooley, "Analyzing Precision Agriculture Adoption across the Globe: A Systematic Review of Scholarship from 1999–2020," *Sustainability* 13, no. 18 (2021): 10295.
[55] Tsan et al., *The Digitalisation of African Agriculture Report 2018–2019*.
[56] Kristin Davis et al., "Extension Officers' Perceptions of Extension and Innovation in South Africa," *South African Journal of Agricultural Extension* 47, no. 4 (2019): 152–61.
[57] Marianne Daher et al., "Experience and Meaning in Qualitative Research: A Conceptual Review and a Methodological Device Proposal," in *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, vol. 18 (DEU, 2017), 24.
[58] L. E. Ekpenyong, "Constructivist Approaches: An Emerging Paradigm for the Teaching and Learning of Business Education," *NIGJBED* 3, no. 1 (2018): 149–58.

The geographic study site was based in the North Coast and Midlands regions of KwaZulu-Natal. According to the Profile and Analysis District Development Model, these areas had land that fell into good and high potential for agriculture.[59] Agriculture is one of the main drivers of the economy in these regions where the strong agricultural products were sugarcane, citrus, fruits, vegetables, maize, forestry, dairy, sheep, and cattle. This study only focused on crop and livestock-producing farms. 26 farm managers were purposely sampled in the North Coast and Midlands region due to time and financial constraints. Additionally, Hagaman and Wutich stated that a sample size of 20 to 40 participants was required to achieve saturation of the data collected.[60] The sampling method that was suitable for this study was one of the seven purposive sampling types which was the homogeneous purposive sampling method that was suitable for participants with similar traits or shared characteristics. The shared characteristic of the participants of this study was the position of being a farm manager in KwaZulu-Natal.

The study sought subjective information which was the personal views based on opinions, interpretations, and emotions of farm managers since the study explored a phenomenon using a paradigm which asserted that reality is subjective. Therefore, the study used semi-structured interviews which had open-ended, predetermined questions. This data collection method was suitable for exploring the opinions and thoughts of the participants on a phenomenon and for collecting open-ended and qualitative data.[61] The predetermined interview questions made sure to fulfil the objective of the study and were validated by a qualified statistician. A pilot test was also conducted on the interview schedule for any possible weaknesses. The interview questions were compiled by the researcher, in a manner that suited the South African context, using questions from different studies that had objectives similar to the one of this study. The interview questions were sent to the farm managers in a Microsoft Word document via email after contacting them through phone calls and social media messaging. This idea of e-interviews was influenced by the Covid-19 regulations, costs, and time. There were no restrictions on race, age, gender, and work experience on the participation of the farm managers. This study was ethically reviewed and approved by the University of KwaZulu-Natal (UKZN) Humanities and Social Sciences Research Ethics Committee (approval number: HSSREC/00003754/2022) which ensured that the study complied with the UKZN Ethical Consideration of handling human subjects. The study also complied with the Protection Of Personal Information (POPI) Act 4 of 2013 which promotes the protection of personal information by public and private bodies by using pseudonyms when referring to any participants.

The data was analysed using a thematic analysis which emphasized the identification, analysis and interpretation of the patterns in the qualitative data collected. The NVivo software was used to sort and manage the data collected. The software assisted the researcher with coding and forming themes from the memos formed on NVivo using the literature of this study. The researcher still developed codes for the data even though the software assisted in organizing, managing and identifying themes. This implied that the analysis of the data was principally subjective and that was the underlying philosophy of the constructive paradigm used in this study. Triangulation of the findings was done by another researcher to avoid any biases from the researcher and increase the trustworthiness, reliability and validity of the results.

PRESENTATION OF RESULTS

Table 1: Biographic data

Attribute	Attribute value	Number of participants
Location	Midlands	12
	North of KZN	14
Gender	Female	9
	Male	17
Race	Black	14
	White	9
	Coloured	2

[59] *Profile and Analysis. District Development Model.*, 2021, https://www.cogta.gov.za/cgta_2016/wp-content/uploads/2023/11/King-Cetshwayo-DDM-4-July-2020.pdf.
[60] Ashley K Hagaman and Amber Wutich, "How Many Interviews Are Enough to Identify Metathemes in Multisited and Cross-Cultural Research? Another Perspective on Guest, Bunce, and Johnson's (2006) Landmark Study," *Field Methods* 29, no. 1 (2017): 23–41.
[61] Kathryn Roulston and Myungweon Choi, "Qualitative Interviews," *The SAGE Handbook of Qualitative Data Collection*, 2018, 233–49.

	Indian			1
Age	18 – 35			8
	36 – 65			12
	66+			6
Level of education	Primary			0
	Secondary			2
	Tertiary			24
Years of experience	1 – 10 years			12
	11 – 20 years			10
	21 – 30 years			4
Agricultural commodity	Crops	Citrus		4
		Sugarcane		5
		Beans		1
		Maize		3
	Livestock	Cattle	Dairy	1
			Meat	4
		Sheep		3
		Goats		3
		Pigs		2

Table 1 presents the biographic data where male farm managers outnumbered female farm managers in this study. In the sample of this study, black farm managers were heavily represented whereas Indian farm managers were underrepresented. Farm managers under the age of 35 outnumber farm managers over the age of 65. The majority of farm managers have a tertiary education. There are fewer farm managers with the most farm management experience. In this study, crop and livestock farm managers were represented in equal numbers. The majority of crop farm managers come from the sugarcane agricultural commodity. Most farm managers in livestock farming are from cow farming for meat, which is closely followed by sheep and goat agricultural commodities.

Table 2: Recurring themes and codes of the variables influencing the adoption of agritech

Interview question	**Data extract**	**Code**	**Theme**
What would make you use agritech at the farm that you manage?	"The need for traceability/ profitability/ mapping/ precision/ sustainability/ convenience/ monitoring/ effortless data collection and management/ increase quality"	The attributes of agritech make it useful.	The needs that agritech satisfies influence its adoption.
What do you think influences the uptake of technology in agribusinesses?	"The need to improve farming systems/ practices/ quality; accessibility of agritech"	Technology and its accessibility are needed for improvements in agribusinesses.	The accessibility to and improvements provided by technology influence its uptake.
	"cost/ price range/ affordability"	The price range of agritech determines its uptake.	The price of technology influences its uptake.

	"Availability of skilled labour; people to operate agritech; technical expertise"	The ability of the workforce at the agribusiness to operate the agritech determines its uptake.	Skilled labour to operate the agritech at the agribusiness influences its uptake.
Which sources do you get information about agritech?	"scientific/ academic journals/ papers"	Academic research offers information about agritech.	Academic research, mass media, and physical interactions between farmers are communication channels for dispersing agritech information which influences its uptake.
	"farmers/ agriculture books/ magazines/ podcasts/ internet"	Mass media related to farmers or farming spreads information about agritech.	
	"Study groups/ meetings/ other farmers/ seminars"	Physical interactions between farmers circulate information about agritech.	

The common responses (or responses that provided a similar notion) of the research respondents to the interview questions, which are also given in the table, were used as the source of the themes and codes presented in Table 2. The research objective of this study tried to be addressed by these codes and themes. The codes for this study's aim generally indicated that the characteristics of the agritech, its price range, the workers' ability to use it, and the source of agritech information all have an impact on how widely it is adopted. The code for interview question number one, "What would make you use agritech at the farm you manage?" revealed that agritech is valuable because of its characteristics. "What do you think influences the adoption of technology in agribusinesses?" was the second interview question. It had three codes produced, which were: advances in agribusinesses require technology and its accessibility; agritech adoption is influenced by pricing; and agritech adoption is influenced by the labour at the agribusiness. Three codes were created in response to question 3 of the interview, "From what sources do you learn about agritech?" The first code revealed that academic research provides knowledge about agritech. The second code demonstrated how agritech news is disseminated by mass media outlets that are related to agriculture or farmers. The third code demonstrated that information about agritech is spread through direct contact among farmers.

DISCUSSION OF FINDINGS

This study aimed to investigate the factors that influence commercial farm managers to adopt or not adopt agritech. This objective was created to aid in the understanding of the reasons that drive farm managers to implement agritech on the farms they oversee. Additionally, any comparisons between the effects mentioned by the study's respondents and influences from the studied literature were to be made. Whilst the agritech market has been active since 2010, Ayim, Kassahun, Addison and Tekinerdogan mentioned that it was still unexplored in 2020. This was caused by the slow adoption and association with agritech in Africa.[62] The scope of this study, however, did not take place on a continental scale, but rather at the level of two regions in one province in Africa. According to the research findings reported in this study, the majority of the farm managers who took part in it were persuaded to use agritech by factors that were prevalent in South African studies on the topic.

The study's respondents listed several variables they believed affected the adoption of agritech. The availability of technical expertise and skilled labour to operate the technology was highlighted as one of the elements that affected the adoption of agritech. The study by Molieleng, Fourie, and Nwafor, stated that South Africa lacked programs for developing agritech skills and agricultural technical expertise.[63]

[62] Claudia Ayim et al., "Adoption of ICT Innovations in the Agriculture Sector in Africa: A Review of the Literature," *Agriculture & Food Security* 11, no. 1 (2022): 22.

[63] Juliet Amarachukwu Nwafor et al., "Correlates of Intimate Partner Violence among Pregnant and Parenting Adolescents: A Cross-Sectional Household Survey in Blantyre District, Malawi," *Reproductive Health* 20, no. 1 (April 13, 2023): 60, https://doi.org/10.1186/s12978-023-01606-y.

Farm manager "Participant 1" of this study suggested that the sector would benefit from government assistance in the form of skill development. Takahashi, Muraoka, and Otsuka noted that governments in certain industrialized nations, like the United Kingdom, invested in agritech-related skills and training programs to suit market demand.[64] According to Say, Keskin, Sehri and Sekerli, the improved adoption of agritech in developed nations created a need for a workforce with the specialized skills needed by the agritech sector.[65] Further research is needed to look into government intervention in agritech training and skills development programs, according to the literature and the responses of the farm managers who took part in this study. Additionally, this might increase employment opportunities in a nation with a high unemployment rate like South Africa.

According to some farm managers who took part in this study, the cost, accessibility, and availability of the technology have an impact on how widely it is used in agriculture. Some further stated that the adoption of agritech in their areas would be more positively impacted by shared or cooperative purchase, usage, and maintenance. Senyolo et al. stated that the high expenses of agritech, particularly heavy, advanced, and high-maintenance agritech, frequently impede the adoption of agritech.[66] The researcher of this study suggested that stokvels should be taken into consideration for the extremely expensive agritech, even though it could be a drawn-out cycle, based on additional responses from the farm managers who took part in this study, such as collaborations in the adoption of agritech. Another farm manager who took part in this survey stated how the affordability element connects to the profitability of using agritech. This backed the research by Molieleng, Fourie, and Nwafor, who claimed that farmers are more inclined to adopt new technology when the return on investment is more than the net cost.[67]

The importance and effectiveness of agritech were other criteria cited by the farm managers who took part in this study. Based on this, farm managers would choose an agritech if it was necessary for the farm that they oversee. If an agritech was not necessary, adopting it out of trend-following would not be a wise business decision. Contrary to Garba, who claimed that most farm managers, particularly older ones, are hesitant to convert from conventional agricultural methods, the study's respondents demonstrated enthusiasm for using technology.[68] The efficiency factor demonstrates that most farmers look for simpler methods to complete tasks in their operations. When farm managers were asked what would motivate them to employ agritech on the farms they oversee, the other criteria included food traceability, precision farming, agritech's financial viability, and the shift toward sustainable farming.

Literature has also noted that information accessibility affects the adoption of an agritech. This study asked commercial farm managers where they acquired their information because it was presumed that they were aware of what agritech was. According to the majority of farm managers who took part in the study, they learned about agritech from farmer publications like Farmer's Weekly, academic journals, books on technology and farming, social media, and study groups. None of the respondents brought up extension personnel, who, according to Karine help to educate farmers on the applications of new agritech and how to acquire those technologies by serving as a channel between the technology's users and its creators.[69] This may be connected to the recent extension officer-to-farmer ratio in South Africa, which was 1:850.[70] The method of information sharing in study groups appears to be a useful source of information in this study's regions, but it was abandoned in Zimbabwe after a whilst because it was based on the assumption that all farmers faced comparable issues and operated in a uniform environment.[71]

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[64] Kazushi Takahashi, Rie Muraoka, and Keijiro Otsuka, "Technology Adoption, Impact, and Extension in Developing Countries' Agriculture: A Review of the Recent Literature," *Agricultural Economics* 51, no. 1 (2020): 31–45.

[65] Sait M Say et al., "Adoption of Precision Agriculture Technologies in Developed and Developing Countries," *The Online Journal of Science and Technology-January* 8, no. 1 (2018): 7–15.

[66] Senyolo et al., "How the Characteristics of Innovations Impact Their Adoption: An Exploration of Climate-Smart Agricultural Innovations in South Africa."

[67] Molieleng, Fourie, and Nwafor, "Adoption of Climate Smart Agriculture by Communal Livestock Farmers in South Africa."

[68] Garba, "Agri-Tech Opportunities at the Bottom of the Pyramid: How Big Is the Opportunity and How Little Has Been Exploited? Some Selected Cases in Nigeria."

[69] Karine, "E-Commerce Development in Rural and Remote Areas of BRICS Countries."

[70] South African National Treasury, *Annual Report*, 2021, https://www.treasury.gov.za/publications/annual reports/national treasury/2021 NT Annual Report.pdf.

[71] Karine, "E-Commerce Development in Rural and Remote Areas of BRICS Countries"; FAO, *Human-Wildlife Conflict in Africa: Causes, Consequences and Management Strategies*, 2009Avhurengwi Murovhi et al., "Traditional Child Rearing Practices in Vhavenda Families South Africa," *Journal of Gender, Information and Development in Africa (JGIDA)* 7, no. 1 (2018): 21–37.

RECOMMENDATIONS

Stokvels function as rotating savings clubs that can be specifically geared towards agricultural ventures. Members could contribute fixed amounts regularly, and the pooled funds could be allocated to individuals on a rotational basis to finance agritech. This system has the potential to foster financial inclusion and collective resource mobilization. By integrating digital platforms for secure online contributions, transparent record-keeping, and access to expert advice, stokvels can be transformed into powerful tools for facilitating the adoption of agritech. Members could collectively purchase various agritech that are desirable to them and necessary for their agricultural commodities, leveraging the collective power of the stokvel to access innovations that might be cost-prohibitive for individual members.

Policymakers need to keep in mind that the general framework for a policy must be consistent and coherent. It makes sense that achieving policy consistency across several ministries, the government, and other different organizations might be a significant task. However, a more comprehensive strategy is needed when it comes to identifying research and development priorities, prioritizing and executing legislative measures, and setting realistic goals for sustainable agriculture technologies. It is preferable to use local solutions to achieve the goals when a sustainability issue is a local one. Additionally, parties with an interest in the technology must track the technology that has been adopted to ensure that corrections are made before more capital is invested in an unsuitable technology. Policymakers and extension officers can assist in the process of developing policies for future agricultural practices by identifying potential future trends. The agritech sector requires training programs and investments from the South African government. Although the government cannot be held responsible for the slow adoption of agritech, it certainly plays a significant role in it.

FUTURE RESEARCH

26 farm managers took part in this study, but they did not represent the entire population of farm managers. Therefore, future studies could use a larger sample to gather more about the factors that influence commercial farm managers in the adoption of agritech. The adoption of agritech in each commodity should also be studied to better understand and reveal how each commodity responds to the uptake of agritech so that investors can identify the commodities with the greatest potential and those that need the most support. Since this study only examined the influencing factors of large commercial farm managers and numerous works of literature examined the factors of new and small-scale farmers, a comparative study could be conducted to cover the influences of other agritech stakeholders, including the government and policymakers, on the adoption of agritech from their perspective. Future studies are required to compare various farm managers' influences on the adoption of agritech and to focus on particular demographics of farm managers. Future studies should look into whether large commercial farms produce for export markets and the contribution that South Africa's adoption of agritech has to make to the global market.

CONCLUSION

In conclusion, different factors influence the different types of farm managers in the adoption of agritech. Policies should be tailor-made for the benefit of the different farm managers based on their demographics, the area they operate in, and other factors. Agritech literature has shown the potential that it has in advancing the agricultural sector and the opportunities that it presents. However, a collaborative approach between the different stakeholders is required for the implementation of agritech adoption to be a success in South Africa. The factors that influence the adoption of agritech direct the stakeholders toward what should be considered when attempting to make the adoption of agritech efficient.

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