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Research Article

The Fourth Industrial Revolution and its Implication for Agricultural Advisory Services in South Africa: A review

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ABSTRACT

The fourth industrial revolution has a distinct role in transforming the agricultural sector in South Africa. This paper examined the trajectory, social, economic, and political implications of the fourth industrial revolution and agricultural advisory services in South Africa. Moreover, highlights of opportunities and challenges presented by the fourth industrial revolution were discussed. The paper scrutinized and searched numerous literatures, using many search engines, data bases and notable institutional repositories. One hundred and seventy (170) scientific papers and grey literatures published between 2009 and 2020 were carefully chosen and comprehensively reviewed. Results revealed that upskilling of extension agents on digital technologies to respond to the needs of farmers is an immediate necessity. Furthermore, government policies indicate gaps for reappraisal to address aspects of digitalisation in agriculture which must be accentuated. The paper concludes that the early adoption and use of the fourth industrial revolution and accompanying technologies has the potential to contribute towards poverty alleviation and improving the economy of South Africa. It is recommended that reskilling and retraining of extension practitioners to develop digital skills and capability is crucial. A conducive and stable policy setting will not only support access to technology but also allows for infrastructural development that will minimize the constraints in accessing digital technologies which is critical.

***Keywords**:* Fourth Industrial Revolution, Advisory services, economic, social, political, implication, opportunities, challenges, technologies, communication

INTRODUCTION

The fourth industrial revolution refers to an era that is characterised by rapid and radical emergence of new and advanced technologies that brings together the physical, digital words (Schwab 2016). According to FAO (2017), artificial intelligence, robotics, nanotechnology, three-dimensional printing, internet of things (IoT) and unmanned vehicles constitute the six major technological advancements of the fourth industrial revolution. Suvedi& Kaplowitz (2016) postulates thatextension advisory service should transform from conventional ways of facilitation and adopt technology driven facilitation approachesto remain relevant, adequately empower farmers and be at par with social dynamics.

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Love *et al.* (2006) states that the United Nation has reviewed and critiqued the poor, limited and inadequate extension advisory services aimed at smallholder farmers in developing countries. Agholor *et al.*(2013) also shares the concerns and sentiments of the United Nations as echoed by Love *et al.* (2006) and posited that agricultural extension service in developing countries has not lived up to expectations in yielding results due to concerns in relevancy, accuracy and applicability of extension programmes and approaches. Agricultural extension has a fundamental role in changing and bettering the livelihoods of rural farmers in developing countries (Ndoro 2011).

The South African agricultural sector is considered as a fundamental pillar for economic expansion, development and sustenance and contributes about 2.6 percent towards the Gross Domestic product (GDP) (Department of Agriculture, Forestry and Fisheries 2011). The agricultural sector has realised a plummet in contribution towards the GDP (van Wyk*et al.* 2009). The contraction of the agricultural sector may be attributed to the poor rate of advance technology adoption and poor facilitation of modern technologies by agricultural extension particularly towards smallholder farmer to enhance food production. South Africa has a dual agricultural sector which comprises of the formal sector and informal sector (Vink& Kirsten 2003). The formal sector is constituted by commercial agriculture and is predominantly own by white people and the informal sector is constituted by emerging and smallholder farmers who are predominantly black. According to Raidimi&Kabiti (2017), public agricultural extension and advisory service offered by the government is the backbone of farmers in South Africa, particularly emerging and smallholder farmers. This is an indication that South Africa has a dualistic agricultural advisory service, namely public and private. According to DAFF (2014), agricultural extension and advisory service is strained and overwhelmed due to the over influx of farmers requiring aid.

With the overly strained agricultural advisory service, the adoption of advanced technologies of the fourth industrial revolution are necessary to breach the gap of high demand for extension services. Worldwide, the inevitable technology disruptions will affect agricultural production causing a shift towards smart and precision methods (Chisoro-Dube *et al.* 2019). Advanced agricultural technologies of the fourth industrial revolution such as new breeding technologies including gene editing, crop pest technologies including integrated pest management, smart water technologies, agricultural robots, precision agriculture, cold storage technologies and materials, ICT for ease of communication, delayed ripening technology and sensors technologies and others will require training of agricultural extension and advisory service providers for ease of facilitation to farmers.

In South Africa, agricultural advisory service has extension models which are in line with facilitating and cascading advanced technological developments. The linear model is one extension model in which extension practitioners transfer technology to farmers (Ndoro 2011).Sulaiman& Hall (2001) argues that, for agricultural extension and advisory service to deliver technology effectively and efficiently, certain approaches must be adopted. These approaches include the training and visits model, which involves the transfer of technology by agricultural extension and advisory service based on existing and conventional technologies used by farmers. For agricultural advisory service to be relevant, accurate and applicable in the fourth industrial revolution, it requires policy reappraisal to prepare extension workers for the technological era.

In accessing and adopting new technologies by farmers, agricultural extension and advisory service plays an immense and critical role (Walisinghe *et al.* 2017). Masere (2015) asserts that the transfer of technology to small-scale farmers fosters innovation and development. The immediate adoption of technologies associated with the fourth industrial revolution (4IR) has the potential of reducing poverty and ensuring food security. According to Payne *et al.* (2018), a digitally enabled extension and advisory service can cater for the broader needs and aspirations of more farmers in an effective and cost-efficient manner while increasing impact and accountability.

Against this backdrop, this study seeks to unpack the implication of fourth industrial revolution for agricultural advisory services in South Africa. This paper adopted the following objectives: (i) determine opportunities in fourth industrial revolution for agricultural extension and advisory service in South Africa; ii) highlight the challenges of adopting the fourth industrial revolution in agricultural development in South Africa; and iii) examined the implication of the fourth industrial revolution on agricultural advisory services in South Africa.

REVIEW OF LITERATURE

The first industrial revolution

The first industrial revolution began in England between 1750 and 1760 and existed up until 1820 and 1840 (Heradhan 2019). The first industrial revolution is a prestigious historical human turning point that introduced coal, water and the use of steam-powered engines that enabled advanced manufacturing and production of goods and services such as iron, chemical and textiles (Haradhan 2019). Civilisation was at the centre of the first industrial revolution as people began to migrate to cities for employment at factories and were no longer dependant much on local production and farming as their primary livelihoods. The first industrial revolution introduced mechanical tools that reduced physical human and animal labour (Haradhan 2019). The major drivers of the first industrial revolution are the improved technologies of making iron and steam engines (Agarwal & Agarwal 2017). The first industrial revolution introduced waged labour whereby industrial companies employed people to render services in exchange for low wages while these companies maximised on production and profit. According to Haradhan (2019), the first industrial revolution created a wide gap between the wealthy and the indigent in as much as it changed the global production systems.

Before the first industrial revolution people used handmade tools that were powered by animals, production was quite low, and land was the biggest commodity were people invested most of their wealth for returns (Clark 2010). The agricultural sector realised a shift from organic food production to synthesised farming in the first industrial revolution (Griggs 1987); and the agricultural sector improved through the use of advanced farming and agricultural methods (Mokyr & Nye 2007). Conventional methods such as using stored seeds from previous harvests, animal manure and plant residues were replaced by reputable inorganic seeds and chemicals which improved farming for the better (Hobsbawm 1996). The agricultural sector had a decline in the population of workers involved in the field, as many migrated to the cities to work in manufacturing industries in Britain around 1850 (Easton *et al.* 2014).

The second industrial revolution

The United States of America introduced the second industrial revolution in 1860, associated with electricity driven innovations which lasted until 1914 (Gordon 2000). The revolution

allowed the use of electricity to intensify and increase mass production and manufacturing of goods and services. Electricity prompted the production of electrical communication invention such as radios, telephones, chemicals, and combustion engines. According to Haradhan (2020), the second industrial revolution reconstructed the global economy for the better as industrialisation improved prompting a radical production and manufacturing of cars, communication technologies and textiles. The second industrial revolution required employer to upskill and capacitate their employees with the required skills to enable them to use the electricallypowered machines to maximise production (Chin *et al.* 2004). The United States of America gained its status of being a global superpower during the second industrial revolution superseding Europe in terms of GDP and innovations (Cook & Ehrlich 2018). According to Richard (2010), the second industrial revolution created a lot of jobs which elevated the standard of living of many people.

Agriculture in the second industrial revolution also improved as factories began manufacturing herbicides, pesticides, and fertilisers to strengthened agricultural productivity. Less labour-intensive farming inventions such as farming implements, mechanical reapers and irrigation systems were introduced (Persson, 2010). Food processing factories created a variety of food choices for people which ultimately reduced malnutrition and promoted healthy diet (Persson 2010). Associated farming problems such as weeding, milking, land preparation, harvesting was reduced through mechanisation which resulted in mass agricultural production and intensification.

The third industrial revolution

The third industrial revolution began between 1950 and 1960 with the advent of computers, electronics, telecommunication, information technology, internet and automatic machines for producing goods (McKenzie 2007). the shift to renewable energy, transformation of the building stock into green micro-power plants to collect renewable energies on-site, deployment of hydrogen and other storage technologies, use of internet technology to transform the power grid of every continent into an energy-internet, and transition of the transport fleet to electric plug-in and fuel cell vehicles are the main drivers of the third industrial revolution (Rifkin,2011). The third industrial revolution had a greater impact on advanced manufacturing, education, health, defence, Information Communication Technology (ICT) and continuously impacted these sectors as new discoveries (Roberts, 2015),

The third industrial revolution heralded the promulgation of Green Revolution in Agriculture (McKenzie 2007). The Green revolution was an international programme aimed at alleviating hunger as the world population vastly increases geometrically resulting in food shortages. These food shortages were attributed to the decline in arable land, pest and disease infestation and climate change (Piper 2017). The third industrial revolution presented combined harvesters that separated the kernel, cob, husk and chopped the stalks of maize for ease of harvesting (USB 2017). It further revolutionised agriculture through the scientific production of drought, pest, and disease resistant modified seeds (FAO 2014). Third industrial revolution brought forward satellites for farmers to get an aerial view of their farm and software technologies that were used to collect and analyse farm data. ICT enabled farmers to access information on the internet via their mobile phones to understand emerging farm problems such as unknown pests and parasites better while on the field (FAO 2015; Alsubaie& Lyndon (2020).

The fourth industrial revolution

The fourth industrial revolution is a phenomenon that is noted for digital, biological, and physical world, characterised by advance and emerging technologies such as cloud computing, unmanned vehicles, robotics, nanotechnology, three-dimensional printing, artificial intelligence, and internet of things (IoT) (Schwab 2016). With global inequalities between the developed and developing countries, the fourth industrial revolution presents a threat of further deepening societal inequalities, primarily because of inadequate resources for adaptation to new ways of doing things (Business, Society Conference 2018). The gap between the wealthy and the needy is likely to widen. Lekhanya (2019) posited that the lives of people are likely to improve for the better when they begin to understand and appreciate the opportunities that comes with the fourth industrial revolution. Competition among countries in the world is expected to rise in the fourth industrial revolution. The fourth industrial revolution will stimulate a shift from intensive-labour programmes to smart production which will requirenew skills training which are in line with new technologies (WEF 2018).

According to Marucci*et al.* (2017), the fourth industrial revolution in agriculture will bring innovations such as cloud systems that are linked to farm activities and can analyse and interpret farming data to give comprehensive information. The fourth industrial revolution will promote smart farming which will allow a shift from conventional farming to new robust method. It will also influence and bring about changes on how farming takes place, where it takes place and the type of person that farms (Shaharudin 2019). The digitalisation of agriculture should be complemented by relevant human technical skills and that contradictions between the two will not transform the sector (Braun *et al.* 2018).

RESEARCH METHODOLOGY

The study adopted exploratory literature search. The authors searched numerous literaturesindependentlyby using many search engines which includeWeb of Science (WoS), Science Direct, Scopus, SciELO, Microsoft Academic, Research gate and Google Scholar (GS). Notable institutional repositories were employed to review journals and many scientific materials obtained from the online library of various universities, using its Online Public Access CatLog (OPAC), Cat Plus and Digital Collections. The authors itemized some literature search criteria as follows: (1) All scientific paper to be reviewed were written in English (2) All papers, journals, book chapters only focus on 4IR (3) literature search was not limited to journal articles but also from recognised peer-reviewed and original research work(3) Information sought from grey literature such as book chapters, conference proceedings, technical reports, working papers, white papers and other government documents were considered for the review paper.

Selected keywords were used to search for related articles in the databases and search engines,and some of which includes: 4IR, agriculture, advisory, services, implication, and phases of industrial revolution amongst other range of terminology. One hundred seventy (170) scientific papers and grey literatures published between 2009 and 2020 were carefully chosen for use. These include scientific papers published in peer-reviewed journals and published literatures which includes documents from Food and Agriculture Organization/United Nation Environment Programme (FAO/UNEP), The World Bank report, ACTIONAID, Council for Scientific and Industrial Research (CSIR)report were used for the review.

Precisely, the study addresses the following questions: (a) What are the opportunities embedded in the fourth industrial revolution for agricultural extension and advisory service in South Africa? (b) What are the challenges of adopting the fourth industrial revolution in agricultural development in South Africa? (d) What is the implication of the fourth industrial revolution on

agricultural advisory services in South Africa? In answering these questions, it became necessary to explore the agricultural policy shift toward 4IR in South Africa.

RESULTS AND DISCUSSION

Agricultural extension service in South Africa

Agricultural extension service is an integral part of the South African agricultural sector. Agricultural extension and advisory service refers to the dissemination of skills, information, and advice to farmers to develop and enabled them to solve their own problems and to realise improved farm production (Collett & Gale 2009). According to Msunya*et al.* (2017), the fundamental objectives of agricultural extension and advisory service includes information dissemination to farmers, promoting agricultural development, educating farmers about decision making and improving productivity and income of farmers. According to Davis (2009), agricultural extension service is not only limited to skills transfer to farmers but is an integral part of sustainable economic growth and rural development.

The agricultural extension was introduced in around 1924 in South Africa (Worth 2012). The agricultural extension system of South African was dualistic and distinguishable along race relations as influenced by colonial and repressive laws. According to Koch (2007), there was an extension system for the white minority commercial farmers and another system for most smallholder black farmers. The few white farmers received the best agricultural extension service from the government of that time while the resource poor black smallholder farmers receive extension service with low skilled extension advisors, low funding models and policies (Worth 2012). The repressive colonial policies left most black farmers vulnerable and underdeveloped. The dawn of democracy in 1994 had policies to create a singular extension system with the aim of redressing the past injustices in the agricultural sector.The public agricultural extension has not given adequate support to smallholder farmers in South Africa. Agholor *et al.* (2013) asserts that the inadequate provision of extension service to farmers is subject to the inaccurate systems used to provide the required services. Therefore, there is a need to review and adjust extension models and systems used by the South African department of agriculture,to respond to the concerns ofprecision, applicability, and relevancy.

The capacity of agricultural extension service in the fourth industrial revolution

Technology transfer is an integral component of agricultural extension services. Agricultural extension service requires technology related skills to advance the interest and aspirations of farmers in the fourth industrial revolution. According to Masere(2015), the primary requirement of an extension agent is technical training to receive skills that enable them to respond to the needs of farmers. Farmers need to be trained in technology for them to be able to disseminate technology to farmers for adoption (Aphunu&Otoikhian 2008).The South African extension and advisory service has not adequately addressed the needs of farmers as required. According to DAFF (2014), agricultural extension and advisory service is strained and overwhelmed due to the over influx of farmers requiring aid. There is a shortage of extension officers per province, despite the Department of Agriculture, Forestry and Fisheries employed 3369 extension practitioners in 2012 (DAFF 2012). This alludes that the adoption and facilitation of technologies of the fourth industrial revolution would be elusive and slow among extension and advisory service. A study conducted by William *et al.* (2008) revealed that about 2800 extension officers'

serviced farmers at a ratio of 1:1878 for smallholder farmers and 1:21 for commercial farmers. This shows that extension and advisory service has been favourable towards commercial farmers who are predominantly white in terms of South African demographics.

The role of extension service in promoting technology adoption to farmers

According to Akudugu*et al.* (2012), the farm size, cost of technology, expected benefits from the technology, age, level of education, gender, access to information and extension services are the primary factors that influences the technology adoption. Certain qualities are important in promoting technology adoption to farmers (Masere 2015). Extension advisors should be well equipped with the relevant technological skills to inspire confidence when facilitating and promoting technology adoption to farmers. Extension advisors should earn the trust of farmers to ensure ease of dissemination of technology for adoption. According to Asiedu-Darko (2013), the undermining of indigenous practices of farmers by extension officers leads to the poor adoption of technology. Extension officers need to respect indigenous practices and have a smart approach of communicating and introducing new technological development. For smallholder farmers to adopt technology better, extension officers should be at the forefront of ensuring that new farming technological developments are designed to suit their farming space and environment. Smallholder farmers must be encouraged to adopt technological designand innovations when modern farming technology introduced. Technology should be made affordable and user-friendly such that adoption by smallholder farmers is enhanced.

Agricultural extension and innovation

In South Africa, the Department of Agriculture, Land Reform and Rural Development (DALRRD) is responsible for overseeing the agricultural sector. It is dualistic in approach, comprising of the formal commercial sector and informal small emerging sector (Vink& Kirsten 2003). According to the African Development Bank (AfDB) (2019), the formal commercial sector adopts new technology earlier than the informal small emerging sector due to more resources being channelled towards it. This provides an overarching analysis that in the fourth industrial revolution smallholder and emerging farmers will face the plight of being late adopters of new technologies. The inadequate access to financial resources is the main contribution towards poor adoption technology adoption by small emerging farmers (Koo 2014).

Sufficient internet access and use, data and technological instruments affordability are the benchmarks of digitalisation of the agricultural sector in South Africa in the fourth industrial revolution (Aguera*et al.*2020). A study on access to internet by the Research ICT Africa discovered that in Sub-Saharan Africa, South Africa is the highest rank country with 53% of people who have access to the internet (Aguera*et al.* 2020). The study also indicated inequalities of access to internet between the urban and rural areas. This is an indication that, with advert of the fourth industrial revolution, more investments are required towards ICT infrastructure in rural areas for the interest of smallholder farmers.

Changes in agriculture during the fourth industrial revolution will not be limited to the orthodox ways of farming but will also be impactful on what is being produced, the producers and the environment in which production activities take place (Shaharudin 2019). According to (EIP-Agri 2017), agriculture in the fourth industrial will comprise of advanced technologies ranging from wireless communication, robotics, climate smart technologies, remote in-field sensors, phone application, irrigation technologies, satellites, drones, and others. These advanced

technologies will be pivotal in monitoring the growth phases of plants and livestock, conserve and control water use and manage the nutrition status of soil (EIP-Agri 2017).

Opportunitiesof the fourth industrial revolutionfor extension service in South Africa

Advanced technologies such as information and communication technology (ICT) has the potential of addressing the constraints that confront extension and advisory service (Aker *et al.* 2016).With ICT systems, extension and advisory service can reach out to as many farmers as possible with limited resources and staff (Bell 2015). These ICTs include websites, video conference, mobileapps, e-learning and social media. Feure*et al.* (2012) asserts that setbacks in information flow between researchers, extension officers and traders are limiting factors to effective and efficient agricultural advisory services. The fourth industrial revolution requires improved skills and human resources (Braun *et al.* 2018). The Directorate, Education and Training (2007), discovered that 80% of South African extension agents had a diploma or lower qualifications, citing concerns as the norms and standards requires a degree or higher qualifications.The potential prospect of 4IR will be experienced using digital equipment that will reduce drudgery and bureaucracy and inefficiency in service delivery (World Bank 2019).

Challenges in adopting the 4IR in South Africa

In South Africa, record shows a dearth of skills in relevant areas and now, government is desiring that people should embrace technology and 4IR without recognising the impact of inadequate skill (Shava&Hofisi, 2017). This is a challenge for government of South Africa that is already grappling with several developmental challenges. Poverty remains a foremost challenge in South Africa. It is arguable that money earmarked for 4IR infrastructure would otherwise be used to provide weather and climate related equipment which will be used to improve yields and limit wastages of food crops(George Fomunyam, 2019).The emerging speed of 4IR will allow fast-paced technology which will render human labour and skill obsolete in developing economy such as ours in South Africa. Trade-off between 4IR and loss of skill and jobs must be properly managed to allow for social solidity. To partake in the 4IR, nations, not just South Africa only will require skills and sufficient knowledge to be relevant (Singh, et al., 2018).

According to the Agricultural Research Council (ARC) (2011), a report on the South African public sector extension officials indicated that public extension does not have adequate education and training to respond to needs of farmers in their database. This primarily highlights that agricultural extension and advisory service in South Africa requires thorough workshops and training to be able to comprehend the new and advanced technologies towards the fourth industrial revolution. When agricultural extension and advisory service is well equipped and technologically inclined, then facilitation of programmes aimed at aiding farmers become more responsive. According to Njuki*et al.* (2013), the poor technological adoption rate by smallholder farmers is attributed to the lack of education and technical skills among smallholder farmers.To be able to understand the functioning of processes in 4IR, such as nanomaterials, 3D printing and robotics would require deep data information and analysis in science and engineering.

Agricultural innovations and technologies in the fourth industrial revolution

The first industrial revolution in agriculture brought about man made and animal powered farming tools (Morkyr& Nye 2007). The second industrial revolution saw the introduction of mechanical reapers, chemicals such as herbicides, pesticides and fertilisers and steam-powered

thrashers that resulted into massive production (Persson 2010). The Green Revolution was introduced third industrial revolution, which brought about improved synthesised seeds, machinery, and new crop cultivars, basic technologies to improved food production (McKenzie 2007). The fourth industrial revolution in agriculture will realise the advent and use of robotics technologies, artificial intelligence (AI) and big data systems converging with of precision agriculture, IoT and cloud computing to enhance agricultural production (FAO 2017).

Agriculture in the fourth industrial revolution will introduce farm-management software that predicts and analysis data, Sensors for monitoring soil quality, weather and crop health, animal data for genomics and breeding pattern understanding, drones and smart irrigation (AFGRI 2017). In this technological era, the marketing of agricultural products is broadening as producers, suppliers and consumers are directly connected through technological platforms (USB 2018). According to Weltzien (2016), the reduction of environmental impact in agriculture and working conditions of farmers will improve through digitalisation.

Agricultural policy shift towards the fourth industrial revolution

The restrictive policies of the South African government pose difficulty to the timeous adaptation to movements of the fourth industrial revolution (Pretorius 2016). Policies governing the South African agricultural sector have often overlooked digitalisation (Gillwald*et al.* 2019). The nine-point sectorial intervention plan of the National e-Strategy of 2017, which includes the transformation of the agricultural value chain through the deployment of smart farming techniques, which are biased towards emerging and smallholder farmers (Gillwald*et al.* 2019). This National e-Strategy has not materialised towards digitalising the sector. The Agricultural Policy Action Plan (APAP) of the Department of Agriculture, Land Reform and Rural Development (DALRRD) aligns itself to the National Development Plan (NDP), which seeks to alleviate poverty, create jobs, and reduce inequality by 2030 (University of Stellenbosch Business School (USB) 2018). The APAP policy is not clear on the strategic objectives of the government on the technological advancements for the fourth industrial revolution in agriculture. In 2018, the President of South Africa, Mr Ramaphosa established a commission on the fourth industrial revolution to develop a comprehensive national strategy plan in all sectors (Government Gazette 2018).

Implications of the fourth industrial revolution for agricultural extension services

Environmental implications

Climate change and water scarcity are crucial environmental concerns that are anticipated to pose a challenge to food production in future and this could potentially increase food prices. According to Fraser *et al.* (2016), food experts, farmers and economists have claimed that the twenty first century presents challenges of sustainable food production. Digital agriculture is viewed as a panacea in addressing the challenges within the agricultural sector. Digitalisation is a component of the fourth industrial revolution innovations. Through digital agriculture which involves precision agriculture, automation farmers can produce food within a controlled environment, on less land and with limited input (Franks 2014).

In dealing with the new converging technologies of the fourth industrial revolution, agricultural advisors need to be capacitated accordingly. Technologies such as yield monitors, remote sensing, robotic milking machines and global positioning systems (GPS) play an important role

in enabling farmers to customise their practices (Wolfert *et al*. 2017). Such technologies ensure the limited use of harmful chemical which have a negative impact on the environment.

According to (Conway & Wilson 2012), technological innovations and enabling policies are a necessity to deal with the plethora of challenges confronting the environmental stability in agriculture. The growing demand for food results in the need for expanded and intensified agricultural production which has the potential to destroy important environmental features such as wetlands, forests, and their associated biodiversity (Balmford *et al*. 2012). Agricultural extension has a role of ensuring that natural resources are conserved and preserved to ensure environmental sustainability. Technological innovations such as precision farming through agricultural extension service can help farmers to maximise production on existing farmlands without disturbing other important environmental factors. Over a period, there will be a competition of land between food production and nature conservation (DeFries& Rosenzweig 2010). Agricultural extension has a crucial role to rethink positioning of agriculture to ensure that there is a balance in natural resources for environmental sustainability. Environmental sustainability is achievable through the less use of toxic chemicals, nature conservation, reducing greenhouse emissions and technology application that can interpret data to help farmers in decision making.

Political implications

The global shift to the fourth industrial revolution requires an ideal political environment that is fertile and conducive for the predictable changes. Agricultural extension programmes are subject to changes over a period (Norton &Alwang 2020) and such changes expected in agricultural extension programmes in the fourth industrial revolution are technology driven innovations for advanced and effective farming (Rotz*et al*. 2019). Within the political context, there is a need for reappraisal of policies that are going to respond to the technological demandof farmers. According to Dawson & Anand (2018), agricultural extension should be at the centre of government agricultural policies and legislations of the fourth industrial revolution. Ngongo (2016), posited that agricultural extension needs to be supported and developed, to adequately respond to the aspirations, production, and developmental desires of farmers.

Agricultural extension advisors must be capacitated with technological skills for the fourth industrial revolution to remain relevant in the era of 4IR. A well-organised agricultural extension service has a crucial role play in agricultural development and rural transformation (Gerba 2018). Thus, an enabling political environment in which agricultural extension is given adequate financial support to execute its tasks and responsibilities is paramount.The 4IR, is a digital era that requires the relevant technology for farmers to thrive and fully benefit from it. Government policy position must be flexible to accommodate all stakeholders and potential participants in advancing the interest and workability of the 4IR in South Africa.

Social implications

Farmers belong to communities with different tribes, beliefs, groupings, expectations, and attitudes. Agricultural extension in the fourth industrial revolution will need to be sensitive and take precautions to the different societal dynamics in relation to technology. Age, gender, cultural believes, religion and shared economic interests are some of the important social factors in society. Communities have prominent leaders that are influential and respected by others and

such leaders will be fundamental in the success of extension services during the period of 4IR (Qange&Mdoda 2020),

For agricultural extension to promote technology adoption, amongst rural farmers, the societal norms andcultural beliefs, pride and dignity, and relative values of the community must be considered. Agricultural extension should also take into consideration the current farming systems of farmers and not undermine them in the process of introducing new farming technologies (Mahlangu *et al.* 2020). The views and perception of farmers is very crucial in the adoption process and relative to this, the decision to adopt any given technology by farmers is influenced by social function (Rehman *et al.* 2007; Walisinghe 2017; and Masere 2015). Agricultural extension has a special role of making sure that no farmers are excluded from the advanced technologies that are presented through the 4IR. The agricultural extension personnel in South Africa should advocate for the inclusion and prioritisation of smallholder farmers in disseminating technology innovations while acknowledging the influence of other farmers (Ghane*et al.*2011).

Economic implications

According to Stats'SA (2019), about 20% of the South African population is food insecure and the situation may worsen if nothing is done to improve food production. Innovative ideas and advance technologies that will emanate from the 4IR can ultimately contribute to eradicating food insecurity (Aguera 2020). The fourth industrial revolution will however, present improved technology, efficient innovation that can boost the agricultural sector in South Africa.The living standards, income and production of farming communities can improve if the agricultural extension information on new technologies is adopted (Bonye*et al.*2012). Swanson (2008) stated that agricultural extension is not only about technology transfer but also about developing communities by improving skills and expertise to enable rural people to get access to markets, trade and protect natural resources.

Smallholder farmers are grappling with poor infrastructure, outdated farming systems, low farming skills and lack of resources, thus they remain at the periphery of benefiting from the opportunities in the agricultural sector.This makes them unable to compete and contribute meaningfully towards economic growth, exacerbated by limited access to credit, markets and farming inputs (Aguera*et al.* (2020). The adoption and implementation of 4IR may be a herculean task judging from the present well-being of the smallholder farmers.

Agricultural extension services should thrive to be at the centre of new technological development agenda in the new era of 4IR. Technologies such as the IoT, remote sensing technologies and drones improves the accuracy of the farm data. On the economic power relations, there are concerns that the digital era of the fourth industrial revolution will broaden inequalities in the food value chain (Bronson and Knezevic 2016). This concern comes because of the dualistic agricultural sector in South Africa that is divided into commercial and smallholder farmers. The commercial sector will be early adopter of technologies inthe 4IR such that the further broaden the gap and inequality in the agricultural sector in South Africa.

CONCLUSION

The paper clearly outlined the current and pre-empted technological gaps, challenges and opportunities for advisory services in the fourth industrial revolution. Agricultural extension has

a long-standing commitment to adequately respond to needs and aspirations of farmers in general, and particularly in ensuring the transfer of advanced technologies to aid in improving farming approaches while increasing production. Preceding studies revealed that the transfer of technology approach used by the South African advisory services has not been effective and efficient due to its top-down approach nature that prohibits the consultation and participation farmers. Public advisory services is understaffed and therefore unable to execute its duties particularly among emerging and smallholder farmers, let alone adopting the 4IR. Agricultural policies aligned to the national policy are not definite on digitalisation in the context of the fourth industrial revolution. The early adoption and use of the fourth industrial revolution related technologies by farmers through extension and advisory services will increase yield. Although 4IR may have the potential to contribute towards poverty alleviation and improve the economy of South Africa, the required infrastructures and enabling environment for the 4IR to thrivemay be elusive.

The envisaged implication of 4IR are numerous, cascading through economic, political, environmental and social aspects. Even though South Africa lags in accessing 4IR infrastructure, the capability to leapfrog could bring succour and assist in benefitting from the 4IR. Fundamentally, access to digital infrastructure and the ability to mitigate associated risk inherent in 4IR are indeterminate. A conducive and stable policy setting that allows for infrastructural development that will minimize the constraints in accessing digital technologies is critical. The assumed nature of 4IR demands a multi-sectoral cooperation to absorb it benefit and mitigate the challenges. From the foregoing, knowledge and education must be given prominence to lay the foundation to equip extension officers, youth, farmers, and the society with necessary know-how.

The reskilling and retraining of extension practitioners to develop digital skills and capability to ensure improve transfer of advanced technology is recommended. The syllabus of agricultural related studies needs to be reappraised to include theory and skills that are aligned with technologies of the fourth industrial revolution. In addition, the enactment of policies that will support the access to technology information, technology funding and infrastructure is crucial to enable investments and the inclusion of smallholder and emerging farmers. Lastly, pluralism should be endorsed in extension and advisory services thereby involving public-private stakeholder collaborations to improve the adoption rate and facilitation of agricultural technologies towards farmers and ultimately improve production.

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