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POLICY BRIEF

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Adoption and diffusion of **advanced ICTs in South Africa's agricultural sector**: Policy issues and implications

Executive summary

Over the past few years, information and communication technologies (ICTs) have been fundamental innovations that have contributed to the growth of different sectors of the economy such as the manufacturing and services sectors. With respect to the agricultural sector, there are various challenges faced by the sector such as climate change, water scarcity, droughts and increased global competition. The adoption and diffusion of ICTs present opportunities to address these challenges. For policymakers to develop, implement and improve policies that facilitate adoption and diffusion while mitigating the potential associated risks, they need to understand the implications involved. The main policy issue at hand is the absence of evidence-based policy instruments intended for facilitating the diffusion and use of these advanced ICTs in the agricultural sector. This policy brief explores the adoption and diffusion of ICTs in the agricultural sector and then assesses the relationship between such adoption and innovation outcomes.

Using data from the South African Agricultural Business Innovation Survey (BIS) covering the period 2016–2018, this policy brief presents insights into the adoption and usage efforts of South African agribusinesses to allow government stakeholders and policymakers to fill the existing policy gaps by providing key policy recommendations on the adoption and diffusion of advanced ICTs in the agricultural sector in South Africa.

Introduction

In the last few decades, ICTs have played important transformative roles in the modernisation of different sectors of the economy. The proliferation and rapid diffusion of ICTs in sectors of the economy, such as the manufacturing and services sectors, have produced significant improvements in how products (goods and services) are developed, produced and delivered to the market.

Unfortunately, the agricultural sector has generally lagged behind in terms of the adoption and diffusion of ICTs. Despite this, there have been encouraging signs in the past few years in terms of uptake of ICTs in the sector (Chavula 2014; Brookings Institution 2020).

According to the OECD, agriculture will inevitably undergo a complete transformation as a result of the wide availability of new and advanced ICTs as well as the digitalisation of services. As such, this transformation presents governments with new opportunities to improve their agricultural and innovation policies (OECD 2021).

According to the World Bank, there are multiple reasons why traditionally the agricultural sector has been slow in adopting ICTs (World Bank 2017). These include: (1) the high cost of IT equipment, including hardware and software; (2) limited and expensive access to internet connectivity; (3) lack of access to information exchange with partners and stakeholders; (4) outdated business models; and (5) lack of skilled labour to maintain and sustain ICTs. However, in the past few years, cheaper and pervasive internet connectivity as well as falling costs of hardware and software have made it possible for farmers to acquire cheaper ICT equipment as well as have access to information and faster and cheaper internet connections.

Although there is no universal formal definition of 'advanced ICTs', this policy brief uses the term to refer to a number, or combination, of IT systems and/or technologies such as artificial intelligence (AI), machine learning or deep learning, big data, and drones or robotics.

Usually, these systems are capable of human abilities and intelligence such as autonomous problem-solving as well as task performance at the speed and precision that is far beyond human natural abilities, thereby increasing productivity. This means that the adoption and diffusion of ICTs can therefore be linked to productivity growth in firms. Furthermore, a number of studies in other sectors of the economy have linked ICT adoption and investments to a significant, positive impact on productivity.

Considering the potential benefits and the challenges presented by these advanced ICTs, it is essential for policymakers to understand their adoption implications. This is to facilitate the development, implementation and improvement of policies that facilitate the adoption and diffusion of these technologies in the agricultural sector while mitigating the potential associated risks. Therefore, the main policy issue at hand is the absence of evidence-based policy instruments intended to facilitate the diffusion and use of advanced ICTs in the agricultural sector, with this policy brief assessing their effects on the sector and the economy at large.

Effective policies that promote adoption and diffusion of ICTs in the agricultural sector may help unlock the innovative capabilities of firms and increase productivity gains of agricultural businesses.

Using data from the Agricultural BIS covering the period 2016–2018 (Agri-BIS 2016–2018), this policy brief presents insights into the adoption and usage efforts of advanced ICTs in South African agribusinesses, to allow government stakeholders and policymakers to fill the existing policy gaps by providing key policy recommendations on the adoption and diffusion of advanced ICTs in the agricultural sector in South Africa.

Summary of methodology

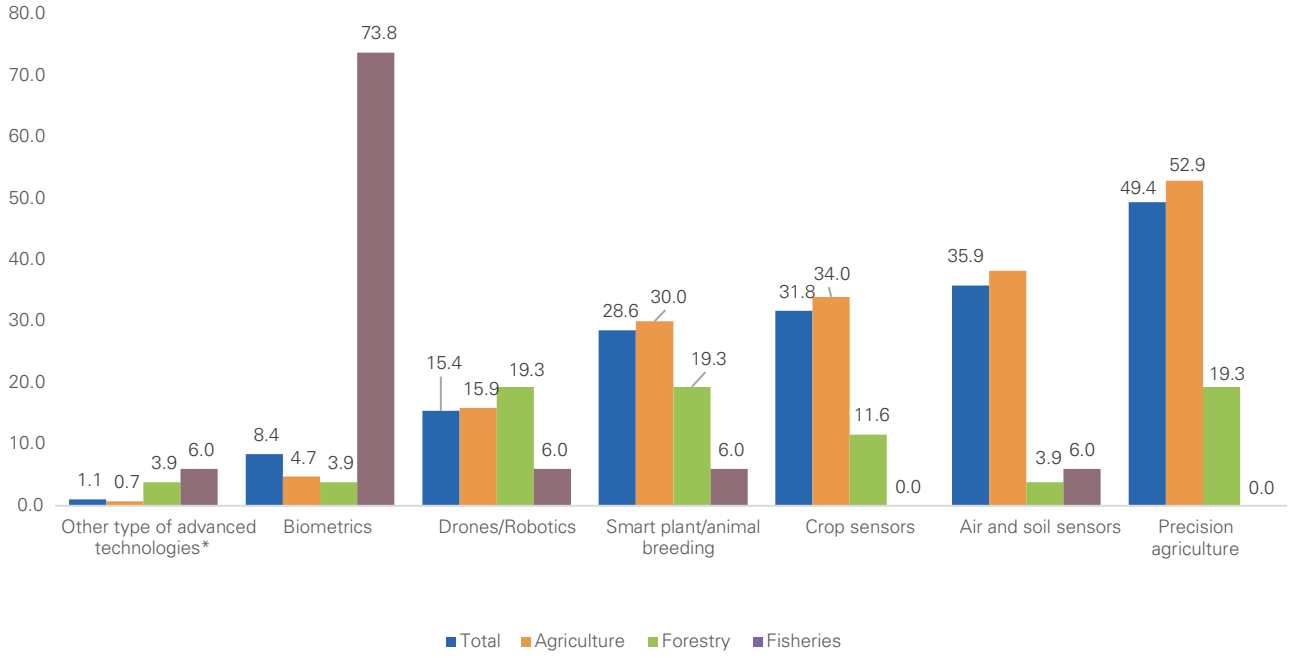
'This policy brief used data from the Agri-BIS 2016–2018. In terms of coverage, the South African Agri-BIS 2016–2018 included three main subsectors of commercial agricultural businesses at the higher level of aggregation: the agriculture subsector (e.g. crop producers, wineries, livestock and poultry), forestry subsector, and fisheries subsector. The Agri-BIS 2016–2018 indicators were adapted from an existing set of standardised business innovation indicators. The standard Community Innovation Survey (CIS)-like survey questions were adapted to be more agriculture-specific and relevant, drawing on inputs from the literature and stakeholders.

A sample was drawn by Stats SA, using Standard Industrial Classification codes 11, 12 and 13, for the agriculture, forestry and fisheries subsectors respectively. Representative sample sizes of 1 514 for the agriculture subsector, 95 for the forestry subsector and 81 for the fisheries subsector gave a total sample of 1 690 businesses. The survey focused on ascertaining how agricultural businesses innovate. The core questions asked about the businesses' product, process, organisational and marketing innovations. The survey also asked questions about the different innovation activities and outcomes. To determine the adoption and diffusion of advanced ICTs, the survey incorporated additional questions on the use of advanced technologies. These questions asked businesses about the different advanced technologies that they had used during the period 2016–2018, as well as those they were planning to use during the next period, 2019–2021.

What type of advanced ICTs are South African agricultural businesses adopting and how are these ICTs being used for innovation?

Empirical analysis from the Agri-BIS 2016–2018 shows that South African agricultural businesses have used a number of advanced ICTs for their innovations. As illustrated in Figure 1, a total of 49% of all innovation-active firms, including firms with ongoing and/or abandoned innovation activity (2 885), after extrapolation to the target population, used precision agriculture technologies, which are a method of farming by observing, measuring and responding to intra- and inter-field variability in crops using satellite-like imagery and mapping technologies. In total, the second and third most popular types of advanced ICTs that were used by agricultural businesses were air and soil sensors (35.9%) and crop sensors (31.8%) respectively.

Figure 1 Usage of Advanced ICTs for agricultural innovation for innovation-active businesses (2016-2018)



Analysing the different subsectors individually reveals that some technologies were used more than others. Precision agriculture was the most frequently reported digital technology in the agriculture subsector (52.9%). Almost three-quarters of businesses in the fisheries subsector used livestock biometrics technologies (73.8%). Forestry businesses were the least likely to adopt advanced ICTs, but almost 20% of them adopted robotics, smart breeding and precision agriculture technologies respectively.

In terms of the future outlook for the period 2019–2021, more businesses reported that they intended to continue developing and using advanced ICTs, compared to the current usage levels. High existing adoption and usage levels of advanced ICTs (Figure 1) are associated with a higher likelihood of future usage of these technologies (Figure 2). For example, precision agriculture (56.7%), air and soil sensors (45%) and biometrics (25.3%) were reported by slightly higher proportions of businesses as planned for future use, compared to the current usage levels. Potential digital technologies with moderate uptake levels included plant and animal breeding (35%) and drones or robotics (28.6%). Of note, higher proportions of fisheries businesses, as compared with businesses in the other subsectors, planned to introduce smart plant or animal breeding, precision agriculture and other advanced technologies.

Figure 2 Innovation-active businesses that planned to develop or use advanced ICTs for agricultural innovation during 2019-2021

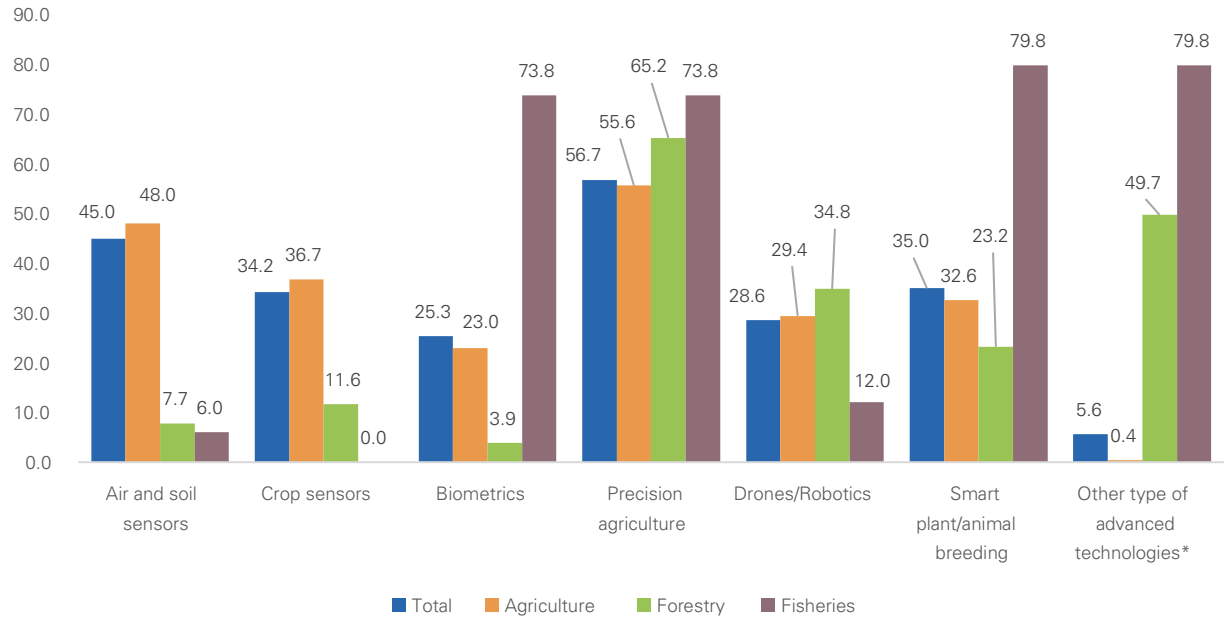


Table 1 Existing use versus planned future use of advanced ICTs

Technologies	In use	Planned use	Difference	Growth rank
	%	%	%	No
Drones/Robotics	27	46	19	1
Precision agriculture	41	51	10	2
Smart plant/animal breeding	21	30	9	3
Crop sensors	29	38	9	4
Air and soil sensors	41	48	7	5
Livestock bibliometrics	17	21	4	6

As the empirical data show, the South African agricultural system is slowly adapting and adopting advanced ICTs to enable and enhance innovation. However, the question remains: to what extent does the acquisition of these advanced ICTs impact on the innovation outcomes of innovation-active agricultural businesses?

Further analysis of the data to determine the relationship between the use of advanced ICTs and innovation outcomes shows that the agricultural innovation outcomes generally have a significant and positive relationship with the use of advanced technologies. This implies that agricultural businesses that used advanced technologies tended to report the different innovation outcomes, compared with those that did not use these technologies.

However, as illustrated in Table 2, there were a few cases where there was no significant relationship between the use of advanced technologies and innovation outcomes. For example, there was no evidence of a relationship between the use of livestock biometrics and increased revenue; reduced costs; increased crop yield, livestock or farmed birds; access to new markets or new intellectual property rights (IPR). Similarly, there was no evidence of a relationship between the use of smart breeding and increased varieties, where a positive relationship would be expected. Such apparent lack of a relationship between the use of some advanced technologies and some innovation outcomes may only be temporal, as it could take some time before businesses start realising the benefits of using some of these advanced technologies.

Table 2 Relationship between the use of advanced ICTs and outcomes of agricultural innovation

	Innovation outcomes									
Advanced technologies	Increased revenue	Reduced costs	Increased crop yield/ livestock/ farmed birds	Biodiversity preservation	Water preservation	Soil fertility improvement	New markets	Reduced gas emissions	New IPR	Increased varieties
Soil and air sensors	+	+	+	+	+	+	+	+	+	+
Crop sensors	+	+	+	+	+	+	+	+	+	+
Livestock biometrics	×	×	×	+	+	+	×	+	×	+
Precision agriculture	+	+	+	+	+	+	+	+	+	+
Drone/ Robot	+	+	+	+	+	+	+	+	+	+
Smart breeding	+	+	+	+	+	+	+	+	+	×

+ Significant and positive relationship: Firms that adopted this type of advanced ICT were more likely to regard this innovation outcome as highly successful.

× No significant relationship: This indicate that there was no relationship observed between the use of advanced technologies and innovation outcomes.

Policy recommendations

As the analysis of the data has shown in Table 2, these results are positive, as they indicate that agricultural businesses generally benefit from innovations that use advanced ICTs. Therefore, to promote the wide adoption and diffusion of advanced ICTs in the agricultural sector, policymakers should do the following:

1. Promote the development of effective knowledge transfer strategies through farmer participatory methods and dissemination programmes that are aimed at the training of farmers, knowledge brokers and other stakeholders (e.g. higher-education institutions, Agricultural Research Council, industry associations). These programmes will, in turn, help educate farmers on the benefits and risks associated with adoption and diffusion of advanced ICTs. These farmer participatory methods and dissemination programmes may lead to sector-wide acceptance or adoption of ICTs, the strengthening of existing relationships between farmers and their stakeholders, as well as compliance with government policies and regulations.
2. Develop a systematic review and identification of agricultural and food policy instruments as well as perform a compatibility analysis with the wider government digital policy instruments, such as the 2019 White Paper on Science, Technology and Innovation and 4IR agenda, and then integrate findings, where necessary, to avoid any potential policy misalignment.
3. Promote the opening up of trade agreements and enablement of collaborative partnerships with developed economies involved in developing these advanced technologies, to enable local agricultural businesses to acquire these advanced technologies or the knowledge to develop them.

Endnotes

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