AGRICULTURAL BUSINESS INNOVATION SURVEY 2016 - 2018

FOR A MORE INNOVATIVE SOUTH AFRICA

*INCLUDING FARMING, FORESTRY AND FISHERIES

INNOVATION PERFORMANCE IN SOUTH AFRICAN COMMERCIAL AGRICULTURE, FORESTRY AND FISHERIES BUSINESSES, 2016-2018

Results of a baseline survey with key national and sectoral trends

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

HSRC
Human Sciences
Research Council

stats sa
Department:
Statistics South Africa
REPUBLIC OF SOUTH AFRICA

"Innovation is doing something new and different and getting it out there. Innovation is both new things and how one does new things. Innovation is what South Africa needs badly. Now."[1]

[1] M. Kahn, '2020 State of Innovation Address', *Daily Maverick*, 13 February 2020. Available online at https://www.dailymaverick.co.za/opinionista/2020-02-11-2020-state-of-innovation-address/

WHAT THE RESULTS COVER

SURVEY REFERENCE PERIOD:

2016 2017 2018

AGRIBUSINESS SUB-SECTORS COVERED:

SOUTH AFRICAN COMMERCIAL AGRICULTURE, FORESTRY AND FISHERIES BUSINESSES ("AGRIBUSINESSES")*

"AGRICULTURE SUB-SECTOR"
(includes farming of crops, animals or mixed)

"FORESTRY SUB-SECTOR"

"FISHERIES SUB-SECTOR"

TOTAL NUMBER OF BUSINESSES:

SOUTH AFRICAN COMMERCIAL AGRICULTURE, FORESTRY AND FISHERIES BUSINESSES:

AGRICULTURE SUB-SECTOR: **4 159**

FORESTRY SUB-SECTOR: **316**

FISHERIES SUB-SECTOR: **181**

4 657

TOTAL NUMBER OF PEOPLE EMPLOYED:

466 212

BUSINESS SIZES:

LARGE (2 472) MEDIUM (419) SMALL (1 049) VERY SMALL (717)

TYPES OF INNOVATION:

PRODUCT
PROCESS
MARKETING
ORGANISATIONAL

NOVELTY LEVELS:

NEW TO THE FIRM
NEW TO THE MARKET
NEW TO THE WORLD

* For the purposes of this report, the term agribusiness/es refers to the agglomeration of companies surveyed within the agriculture, forestry and fisheries sub-sectors. Note that the number of businesses cited in this infographic refers to the population size and not the sample size.

EXECUTIVE SUMMARY

What are the factors that drive business innovation activities in commercial agriculture, forestry, and fisheries businesses ("agribusinesses") in South Africa? How, and when, do these agribusinesses benefit from innovation? Conversely, what are the barriers that constrain their innovation performance? What sources of information do agribusinesses draw on when they innovate? A sectoral innovation survey helps to answer these—and other—critical questions that agriculturalists, business leaders, industry groups, and government policy makers face.

Key results from the South African Agricultural Business Innovation Survey, 2016-2018

The big picture

1 Innovation was pervasive across agribusinesses as a whole, though less so in the forestry sub-sector.

- Nearly two-thirds (62%) of South African agribusinesses were innovation-active. They took some scientific, technological, organisational, financial, or commercial steps, during 2016-2018, towards the implementation of an innovation.
- Nearly all (99.5%) of these innovation-active companies introduced an innovation in their businesses or markets in 2016-2018.
- Process innovation was implemented by more agribusinesses (47.9%) than other types of innovation—product innovation (42.2%), organisational innovation (32.3%) and marketing innovation (31.4%).

2 Training and acquisition of new technology and equipment were the innovation activities undertaken by most agribusinesses.

- The three innovation activities most frequently reported by innovation-active agribusinesses were training (65.4%), acquisition of new machinery and equipment (57.2%), and acquisition of computer software (49.2%). Conversely, design and engineering activities, or acquisition of agricultural land, were not widely reported activities.
- Advanced technologies most used by innovation-active agribusinesses were precision agriculture technologies (49.2%), air and soil sensors (35.9%), and crop sensors (31.8%).

3 While innovation-active agribusinesses were younger and employed more people than their counterparts without innovation activity, their contribution to total turnover was only about one-third.

- More than two-thirds (68.7%) of innovation-active agribusinesses were less than 20 years old, while only 19.9% of businesses older than 20 years were innovation-active.
- Innovation-active companies employed about 63.6% of the total number of employees in South African agribusinesses.
- 6.0% of innovation-active agribusinesses were part of a group of companies during 2016-2018, while 9.8% owned a subsidiary or subsidiaries outside South Africa.
- Total turnover of all South African agribusinesses in 2018 was recorded as R219.5 billion. Innovation-active businesses accounted for 34.8% of this turnover.

4 Although access to global markets remained low overall, agribusinesses with innovation activity reached more international markets than those without.

- Markets for goods and services produced by both innovation-active and non-innovation-active agribusinesses remained concentrated locally in South Africa.
- Half of all innovation-active agribusinesses reported selling their goods and services in only some provinces, while 39.5% sold their goods and services on national markets.
- Conversely, non-innovation-active businesses were more likely to access national (36.8%) than provincial markets (33.8%).

5 Multiple outcomes of innovation—from strategic to sustainability to financial outcomes—were reported by agribusinesses with product and process innovation activity.

- About one-fifth (20.2%) of innovation-active businesses rated 'increased variety' as a highly successful innovation outcome, while 23.0% rated improvement in soil fertility in the same way.
- Reduced greenhouse gas emissions were rated by 10.7% of innovation-active agribusinesses as a highly successful sustainability outcome.
- Development of new intellectual property (18.3%) was the most widely reported strategic outcome, while reduced unit production costs the most prominent financial outcome (11.7%).

6 Weather, access to water, labour, and access to finance were reported as the most important factors promoting, but also impeding, innovation.

- Weather/climate change was rated by the largest number of innovation-active agribusinesses as highly important in promoting innovation (69.6%), followed by access to water (64.8%) and labour (54%). For non-innovation-active businesses, access to finance was most frequently rated as highly important (50.0%), followed by access to water (47.1%) and labour (45.6%).
- The top three barriers to innovation rated as highly important by innovation-active agribusinesses were access to water (76.0%), weather/climate change (73.7%), and access to finance (61.8%). For non-innovation-active businesses, the top three barriers to innovation were access to finance (30.9%), weather/climate change (25.0%) and labour (25.0%).

7 Agribusinesses mostly used the combination of suppliers, internal sources, trade fairs, or private R&D to acquire information to innovate.

- Innovation-active agribusinesses mostly relied on suppliers (32.6%) or their own internal information sources (25.0%), as highly important sources of information for innovation. Conferences and trade fairs were also frequently rated as highly important information sources (21.4%), as were private research institutes (19.4%).

8 Innovation-active agribusinesses were more likely to be aware of government support for innovation than those without innovation activity.

- More than one-third (38.1%) of innovation-active agribusinesses reported awareness of government support mechanisms for innovation. Less than one-third (30.9%) of non-innovation-active businesses were aware of these mechanisms.
- 42.9% of smaller businesses with ongoing or abandoned innovations were aware of government support for innovation.

Sub-sectoral innovation profiles

9 Proportionally more crop farming businesses were innovation-active when compared to animal or mixed farming businesses.

- The share of innovation-active businesses in the agriculture sub-sector (64.3%) was slightly larger than it was for the entire population of South African commercial agriculture, forestry and fisheries businesses (62.0%).
- The largest proportion of businesses in the agriculture sub-sector (55%) focused on crop farming, and they were also most likely to be innovation-active (75.9%). The 16% of businesses focused on animal husbandry were much less likely to be innovation-active (46.2%). The 11% of businesses engaged in a mix of crop and animal farming were also very likely to be innovation-active (70.6%).

10 South African fisheries businesses innovated to 'catch up' by building the technological capabilities required to compete locally.

- Compared to agribusinesses as a whole, fisheries companies reported very high levels of both technological (product and process) and non-technological (organisational and marketing) innovation (85.6% of fisheries businesses were innovation-active). However, innovation in the fisheries sub-sector primarily resulted in process outcomes related to the sustainability of fish stocks.
- Innovation-active businesses in the fisheries sub-sector rated government support (79.8%) and agricultural policies and regulation (73.8%) as highly important to support and promote their innovation.

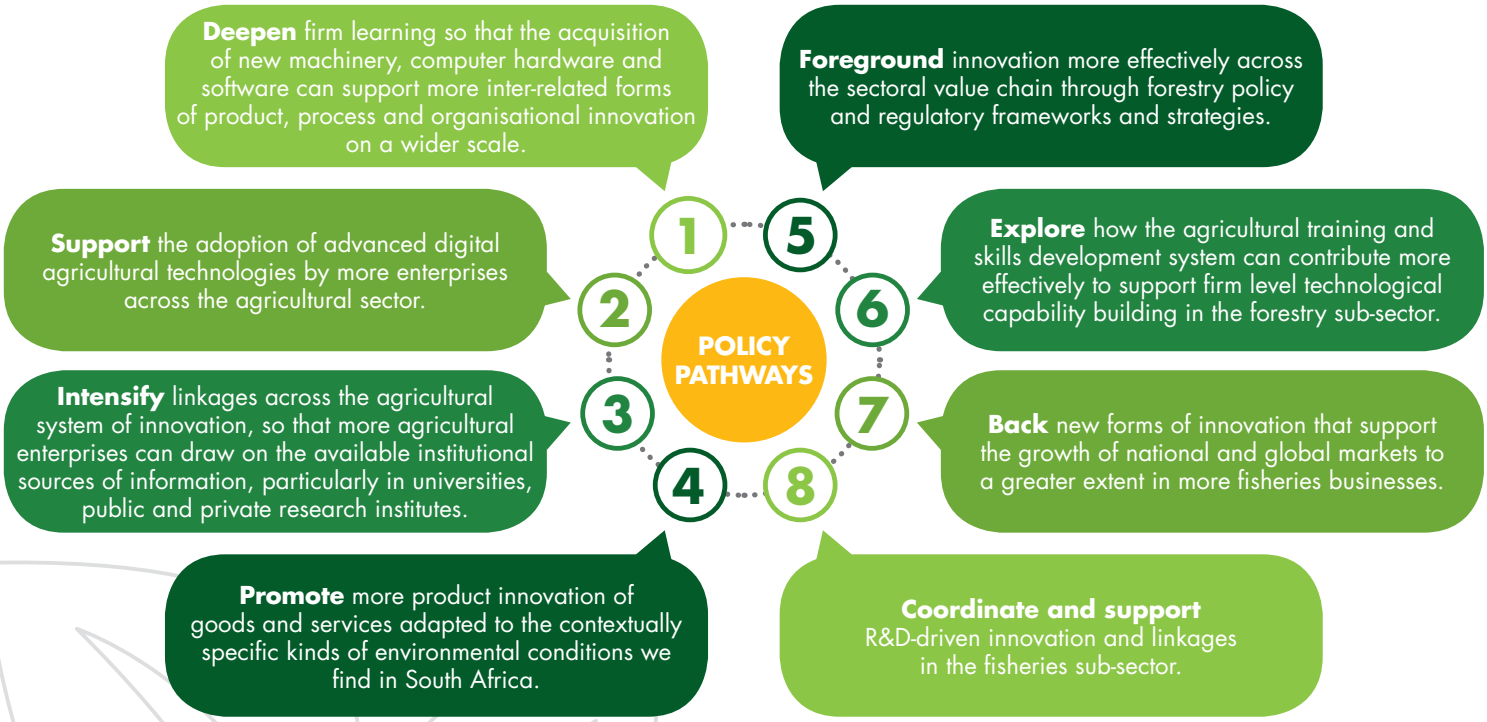
11 Forestry businesses had low levels of innovation activity.

- Survey data reflects a profile of the forestry sub-sector as a mature, 'low-tech' industry: many businesses (42%) were older than 30 years, while 61.3% were older than 20 years, and a very high number of businesses (82.3%) did not report innovation activity.
- Where innovation was reported, businesses mostly implemented process innovation, such as more efficient and effective tree planting, harvesting and processing methods, as well as logistical solutions for advanced manufacturing. Technological and non-technological innovation activity was low in the forestry sub-sector.
- More than 50% of the small proportion of innovation-active forestry businesses used innovation to support their profitability objectives, through increasing revenue and reducing costs.

Policy pathways

12 Survey results can aid policy actors in improving existing instruments and funding mechanisms to enhance current and desired forms of innovation in South African agribusinesses as a whole, and within specific subsectors.

- Distinct patterns of innovation were found across South African agribusinesses—as a whole—and within the agriculture, forestry, and fisheries sub-sectors. Sectoral and sub-sectoral patterns of innovation were shaped by the unique combinations of economic and competitive challenges, but also environmental and social urgencies, experienced during 2016-2018. To ignite new policy thinking, eight policy pathways are highlighted in this report, for businesses, business associations, government departments, and universities.



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INTRODUCTION

Innovation to address multiple objectives

South Africa as a country, and agriculture as a sector, both face multiple and inter-connected challenges. In the context of the global Covid-19 pandemic, South Africa's unemployment level has risen, and economic growth has slowed to record low levels. The need to maintain food security has become an increasingly pressing policy priority, while sustainability of the agricultural sector has hung in balance. Even prior to the pandemic's onset, the agricultural sector experienced unprecedented and mounting challenges, including severely rising input costs, increased global competition, climate change, and the rising demand of production to meet national and global food security.

So, while agriculture plays a significant role in the economic and social development of South Africa, over the last few years, the sector's contribution to the national economy has significantly decreased—from a total share of 7.7% of gross domestic product (GDP) in 1969, to approximately 3% at present (DAS, 2012). As a result, economists define the agricultural sector as a 'traditional' sector with low productivity outputs, even though it contributes to economic growth through the provision of food, labour, and capital (Hazell & Thurlow, 2007). Agriculture also remains an important contributor to employment and livelihoods in South Africa's rural areas (Stats SA, 2020).

To address these challenges, harness opportunities, mitigate risks and improve productivity, innovation is a critical strategic consideration, for both agribusinesses and sector support groups, as well as government departments and other actors in the agricultural system.

The South African government is committed to revive agriculture as a sector, to achieve the objectives of the National Development Plan (NDP) and the Sustainable Development Goals (SDGs) (NPC, 2012; The Presidency, 2020). Government departments have designed and implemented several policy initiatives to respond to these demands and challenges, and contribute to social and economic reform. The White Paper on Science, Technology and Innovation (DSI, 2019) targets agriculture as one of the critical sectors requiring modernisation to support growth and development. At the same time the White Paper acknowledges the complex relationships between innovation, sustaining employment, economic inclusion, and export competitiveness.

Why measure innovation in agribusinesses?

In this policy context, which values evidence as the basis of decision-making, it is critical to measure the scale, nature and outcomes of innovation in South African agribusinesses. What are the characteristics of South African agribusinesses? How do agribusinesses innovate? What facilitates innovation in agribusinesses? How do agribusinesses benefit from innovation? What constrains innovation in agribusinesses? How do patterns of innovation differ in crop farming, animal husbandry, or the fishing or forestry sub-sectors?

Understanding the current patterns of innovation provides a basis to design and target effective policy interventions. However, standard methods to measure innovation, such as national business innovation surveys, typically do not cover the agriculture sector.

To address this, the Department of Science and Innovation (DSI) commissioned the Centre for Science, Technology and Innovation Indicators (CeSTII) to conceptualise and undertake a baseline survey that measures innovation within agribusinesses in South Africa. The survey, reported on here, covered the reference period 2016-2018.

The measurement challenge

Measuring innovation in the agricultural sector is a challenging task, both conceptually and practically. Innovation activity in different agricultural sub-sectors—such as forestry, crops or animal husbandry—is distinctive, and there is much variation in practices across spatial locations (Ariza *et al.*, 2013; Walder *et al.*, 2016; Guaitero *et al.*, 2013). Even more complexity is added by the growing demand for more ecologically, economically, and socially sustainable approaches (Pigford *et al.*, 2018), and the use of advanced digital technologies (Fielke *et al.*, 2019). As a result, many studies focus on profiling innovation in a single sub-sector, or a few selected sub-sectors and regions (Nossal and Lim, 2011; Ariza *et al.*, 2013). However, using evidence from only a few sub-sectors makes it difficult to inform policy making across a national agricultural innovation system.

To inform the design of this baseline survey in South Africa, with the support of DSI, CeSTII sought input at all stages of the process from an array of stakeholder experts in the agricultural sector, based in industry associations, public research institutes and academia, government departments and agencies. These actors in the agricultural system of innovation stressed the need for a nationally representative analysis of innovation trends, as well as analysis disaggregated to reveal patterns of innovation in specific types of farming businesses.

The baseline survey of innovation in commercial agriculture, forestry and fisheries businesses in South Africa has the advantage of creating a data set that covers all sub-sectors, and so, can illuminate trends in agro-industrial innovation nationally. The use of the data to profile innovation activity at a detailed sub-sectoral level, however, remains a challenge and, at this stage, it is only possible to conduct illustrative and experimental analyses.[2]

NOTES TO GUIDE READERS

The SA Agricultural Business Innovation Survey, 2016-2018, report and data set

This report points to both high level results and trends. Accompanying this report is a the full aggregate data set, which is downloadable as a Microsoft Excel spreadsheet:

http://www.hsrc.ac.za/en/departments/cestii/latest-results

Data tables are cross-referenced for each table and chart as "Appendix Table A#". For any data-related enquiries in this report or in the report's appendices, write to innovation@hsrc.ac.za.

[2] Profiling at sub-sectoral level requires a large enough sample to allow for disaggregation. The data challenges for the baseline survey of innovation in agribusinesses are explained in the Methodology section of this report.

About this report

This report presents the trends from the South African Agricultural Business Innovation Survey, 2016-2018, to evaluate how commercial agriculture, forestry, and fisheries businesses measured up to the multiple and complex challenges they faced. It is structured in three parts:

- **Part 1** describes patterns of innovation in agribusinesses in South Africa for the period 2016-2018, analysed at an aggregate level for all agribusinesses, and compares trends across the three main sub-sectors: agriculture (including farming of crops, animals and mixed), forestry, and fisheries.
- **Part 2** presents a more in-depth, contextualised profile of innovation patterns within the fisheries and forestry sub-sectors, as an illustration of the kind of analysis that could be of value to policy actors across government, business, universities and civil society organisation.
- **Part 3** proposes ways in which stakeholders, particularly in government, can use the data to inform agricultural and innovation policy.

To inform further research of this nature, we also include in this report notes on the design and methodology of the survey, the quality of the data, and proposals for future surveys. The survey instrument, and a set of accompanying Microsoft Excel appendix tables that analyse the data by sub-sector and by size class, complement the analysis conducted. Together, the analysis in this report, and accompanying data set, represent a public resource that can help government, but also agribusinesses and industry associations, to make better decisions about innovation investment and support, and agricultural policy making.

Important definitions

In this report we use the term "agribusiness" very specifically, as an agglomerative term to describe agriculture, forestry and fisheries businesses that were included in the survey sample provided by Statistics South Africa (Stats SA). For the purposes of illuminating the analysis, our definitions of the sub-sectors can be aligned with those in use more generally.

Agriculture: 'The art and science of cultivating the soil, growing crops and raising livestock. It includes the preparation of plant and animal products for people to use and their distribution to markets. These products, as well as the agricultural methods used, may vary from one part of the world to another.' (Agrivi, n.d)

Forestry: The science and practice of planting and producing and managing trees, forests, and their associated resources for human benefit. (Adapted from IGI Global, n.d)

Fisheries: 'The science of producing fish and other aquatic resources to provide human food, although other aims are possible, such as sport or recreational fishing, obtaining ornamental fish, or developing fish products, such as fish oil.' (IGI Global, n.d)

"AGRICULTURE SUB-SECTOR" (includes farming of crops, animals or mixed)

"FORESTRY SUB-SECTOR"

"FISHERIES SUB-SECTOR"

SOUTH AFRICAN COMMERCIAL AGRICULTURE, FORESTRY AND FISHERIES BUSINESSES ("AGRIBUSINESSES")*

We also use the term "innovation" very specifically.

The definition of **innovation** used for the South African Agricultural Business Innovation Survey, 2016-2018 comes from the OECD's *Oslo Manual* (2005).

INNOVATION:

An **innovation** is the introduction of a new or significantly improved product (goods and services), process, organisational method, or marketing method by an enterprise/business. The innovation must be new to a business, although it could have been developed originally by other businesses.

It covers a range of activities but only if they occurred during the survey period.

It is important to note that innovation is an outcome of various combinations of activity, but not all innovation activity results in an innovation.

INNOVATION ACTIVITY:

Includes all scientific, technological, organisational, financial, and commercial steps, that lead, or are intended to lead, to the implementation of innovations. Some of these activities may be innovative in their own right, while others are not novel but are necessary to implementation (OECD and Eurostat, 2005, par. 40).

TECHNOLOGICAL INNOVATION:

Technological innovation occurs when businesses introduce new or significantly improved products or processes.

NON-TECHNOLOGICAL INNOVATION:

Non-technological innovation occurs when businesses introduce marketing or organisational innovations.

In this report, we distinguish between four types of business:

INNOVATION-ACTIVE BUSINESS:

A business with **innovation activities** in 2016-2018, including ongoing and abandoned activities. It does not matter if the activity resulted in the implementation of an innovation, or not (OECD and Eurostat, 2005, par. 215).

NON-INNOVATION-ACTIVE BUSINESS:

A business without any innovation activities.

INNOVATIVE BUSINESS:

A business that implemented an innovation in 2016-2018 (OECD and Eurostat, 2005, par. 152).

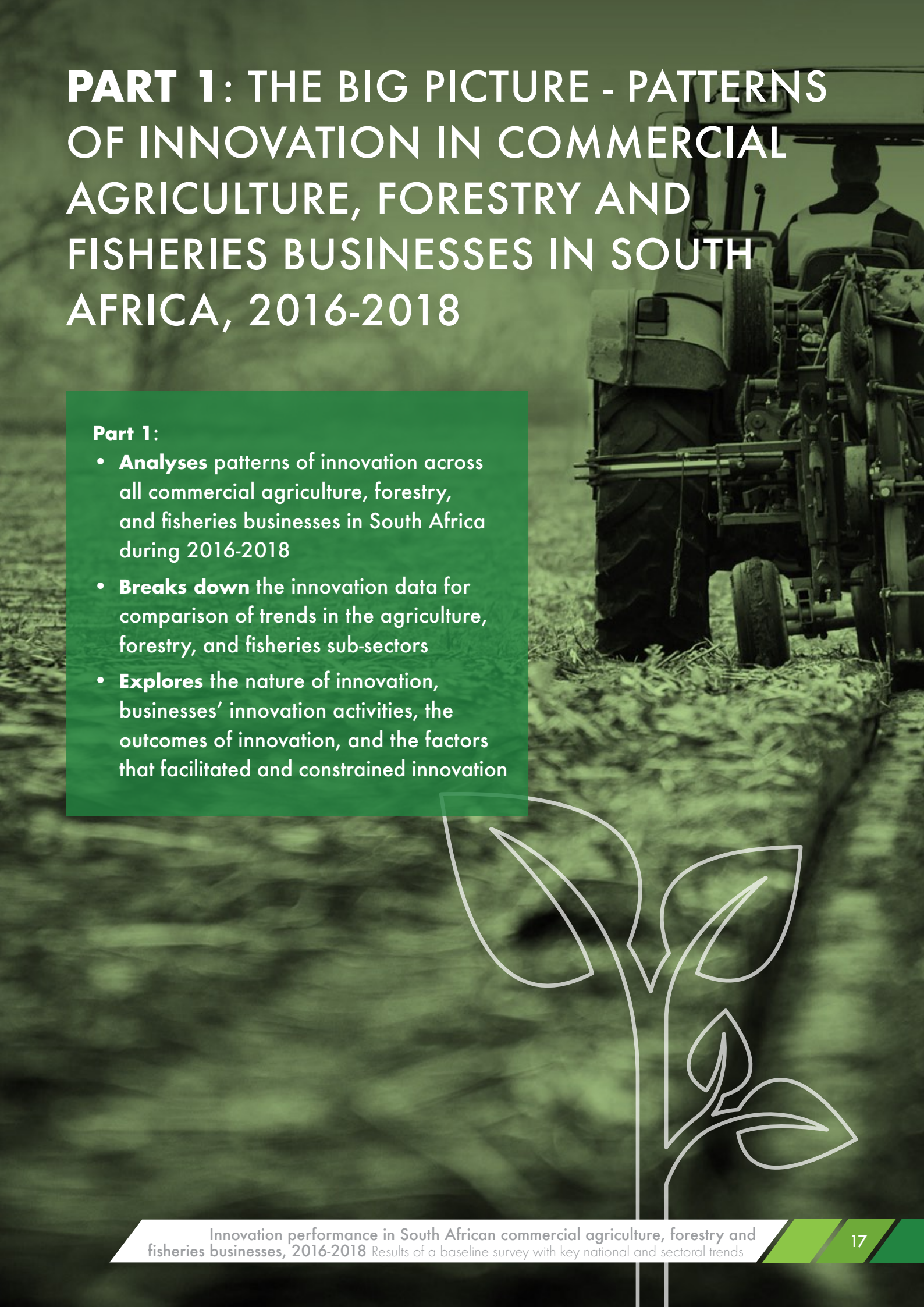
NON-INNOVATIVE BUSINESS:

A business that did not implement an innovation during 2016-2018.

Acronyms

BIS	South African Business Innovation Survey, 2014-2016
Agri-BIS	South African Agricultural Business Innovation Survey, 2016-2018
CeSTII	Centre for Science, Technology and Innovation Indicators
CIS	Community Innovation Survey
COCA	Statistics South Africa Census of Commercial Agriculture
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
DEFF	Department of Environment, Forestry and Fisheries
DSI	Department of Science and Innovation
GDP	Gross domestic product
HSRC	Human Sciences Research Council
OECD	Organisation for Economic Co-operation and Development
NDP	National Development Plan
R&D	Research and experimental development
SASQAF	South African Statistical Quality Assessment Framework
SIC	Standard Industrial Code
STI	Science, technology and innovation

PART 1: THE BIG PICTURE - PATTERNS OF INNOVATION IN COMMERCIAL AGRICULTURE, FORESTRY AND FISHERIES BUSINESSES IN SOUTH AFRICA, 2016-2018



Part 1:

- **Analyses** patterns of innovation across all commercial agriculture, forestry, and fisheries businesses in South Africa during 2016-2018
- **Breaks down** the innovation data for comparison of trends in the agriculture, forestry, and fisheries sub-sectors
- **Explores** the nature of innovation, businesses' innovation activities, the outcomes of innovation, and the factors that facilitated and constrained innovation

CHARACTERISTICS OF BUSINESSES IN THE SA AGRICULTURAL BUSINESS INNOVATION SURVEY, 2016-2018

Most South African agribusinesses were innovation-active with one or more innovation including new products, processes, marketing methods, and organisational strategies. Small and medium businesses were most innovation-active and innovation-active businesses employed the majority of employees. Younger agribusinesses were more innovation-active than their older peers.

Innovation performance

Nearly two-thirds (62%) of South African agribusinesses undertook some form of innovation activity in the 2016-2018 period (Figure 1). These businesses were **innovation-active** (see Notes to Guide Readers). Notably, almost all of these innovation-active businesses (99.5%) actually implemented one or more innovations (whether product, process, organisational and/or marketing innovations). Only a few (0.3%) reported that they had abandoned innovation activities during 2016-2018, or that these activities were still ongoing.

Disaggregating survey data by business size and sub-sector is useful to identify where innovation is more or less likely, and to prompt further investigation of specific innovation patterns. Overall, fewer large agribusinesses were innovation-active (29.4%) when compared to their medium, small, and very small counterparts combined (98.8%).

By sub-sector, higher proportions of businesses in the agriculture and fisheries sub-sectors were innovation-active, compared with the forestry sub-sector (Table 1). Large fisheries businesses were more likely to be innovation-active when compared with large businesses in the agriculture and forestry sub-sectors. However, large businesses in the agriculture sub-sector were more likely to be innovation-active than their forestry counterparts. The comparison within the agriculture sub-sector in the table below shows that very small businesses were more likely to be innovation-active than large businesses.

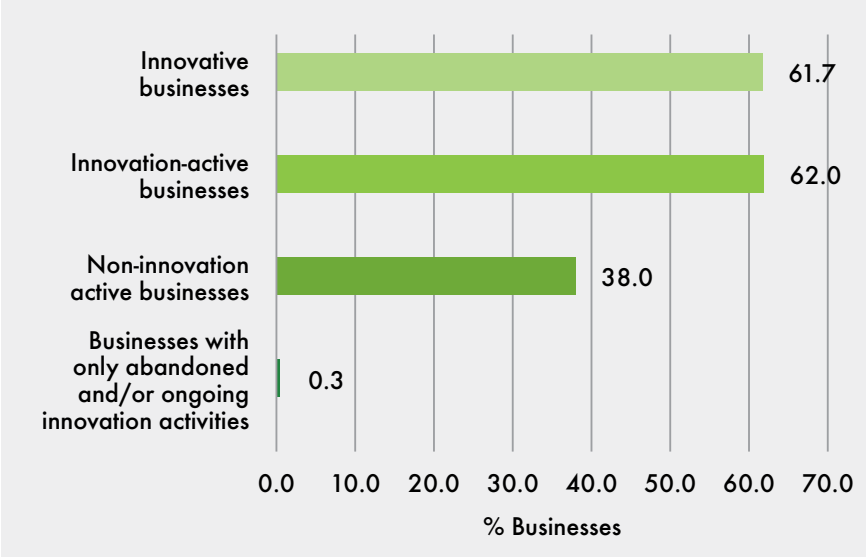
NOTES TO GUIDE READERS

Examples of innovation activity

- Performing R&D
- Sourcing patent rights
- Buying or leasing equipment, software, hardware or buildings
- Training
- Design or engineering activities

To compare the proportion of types of innovation activity by sub-sector, see Appendix Table A15.-2.

Figure 1: Split of innovation-active and non-innovation-active businesses



Source: Appendix Table A1.2

Table 1: Proportion of innovation-active and non-innovation-active businesses by sector and size (%)

		Total	Large	Medium	Small	Very small
Agriculture	Innovation-active	64.3	31.4	-	100.0*	96.4
	Non-innovation-active	35.7	68.6	0.0	0.0	3.6
Forestry	Innovation-active	17.7	11.1	-	100.0*	-
	Non-innovation-active	82.3	88.9	-	0.0	-
Fisheries	Innovation-active	85.6	51.7	100.0*	100.0*	-
	Non-innovation-active	14.4	48.3	0.0	0.0	-

Source: Appendix Tables B1.3-5

* Very few medium and small businesses responded to the survey. Of those that did, all were innovation-active. Generalisation to the population of businesses cannot therefore be taken as representative of the proportion of innovation-active businesses.
\- Refers to a missing data point owing to non-responsive businesses within this sector and size class stratum.

Employment

In total, the South African agribusinesses surveyed employed approximately 466 212 people in 2018. The innovation-active businesses employed about 63.6% of the total number of employees (see Table 2).[3] Innovation-active businesses in the agriculture sub-sector employed 67.9% of all workers, whilst a much lower 27.6% of employees in the forestry sub-sector worked for innovation-active businesses. It was not possible to calculate the proportion for the fisheries sub-sector (see note below Table 2).

Table 2: Total businesses and employees: comparison of businesses with innovation activities

	Total	Agriculture	Forestry	Fisheries
Number of businesses				
All businesses	**4 657**	4 159	316	181
Innovation-active businesses	**2 885**	2 674	56	155
Innovation-active businesses (as % of all businesses)	**62%**	**64.3%**	**69.4%**	**85.6%**
Number of employees				
All businesses	**466 212**	400 034	56 742	9 435
Innovation-active businesses	**296 815**	271 665	15 715	9 435
Employees in innovation-active businesses (as a % of employees in all businesses)	**63.6%**	**67.9%**	**27.6%**	**100%***

Source: Appendix Tables A1.3 and A2

* In the fisheries sub-sector, only the innovation-active businesses reported their number of employees, with none of the non-innovation-active businesses providing this information. Hence, 100% refers only to innovation-active businesses.

[3] Calculated by generalising from the sample to the total population.

Ownership

Six percent of innovation-active businesses indicated that they were part of a corporate group during 2016-2018, while 9.8% reported ownership of a subsidiary or subsidiaries outside South Africa (Table 3). For non-innovation-active businesses, a higher 11.8% of businesses indicated that they were part of a group, but a lower 2.9% reported owning a subsidiary or subsidiaries outside of South Africa. Thus, the majority of agribusinesses were domestically owned or stand-alone businesses or both, making it less likely for their propensity to innovate to be influenced by a business group.

Table 3: Ownership of businesses (as a % of all businesses)

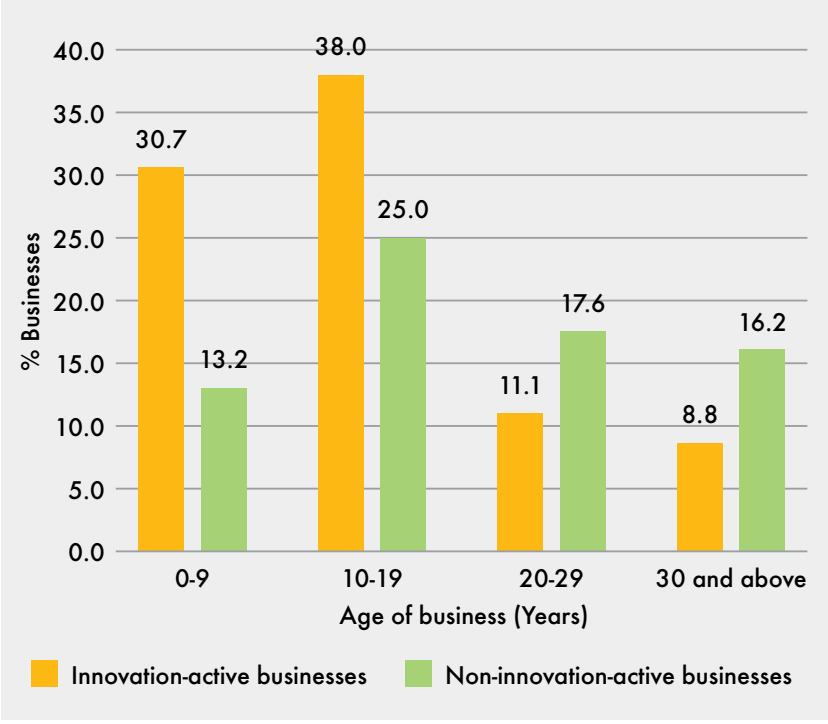
	Total	Agriculture	Forestry	Fisheries
Innovation-active businesses				
Part of a group	**6.0%**	5.7%	15.5%	8.2%
Subsidiary/subsidiaries outside South Africa	**9.8%**	9.8%	0.0%	12.0%
Non-innovation-active businesses				
Part of a group	**11.8%**	14.0%	0.0%	0.0%
Subsidiary/subsidiaries outside South Africa	**2.9%**	3.5%	0.0%	0.0%

Source: Appendix Table A4.2

Age

The age distribution of non-innovation-active agribusinesses followed the 'normal curve', with fewer 'young' businesses (0-9 years) (13.2%) and 'old' businesses (30 years and older) (16.2%) than 'middle-aged' businesses (25.0% for 10-19 years and 17.6% for 20-29 years) (Figure 2). The distribution of innovation-active businesses did not follow the normal curve, with the bulk falling in the 'young' (30.7% of 0-9 years) and 'lower-middle' (38.0% for 10-19 years) age groups. Businesses established more recently were trying to innovate more than older and more established businesses. The Oslo Manual (OECD and Eurostat, 2018: 105) points out that younger businesses may be more 'agile in implementing change' and though older businesses might have more accumulated knowledge and experience from innovation, they may face inertia.

Figure 2: Age of innovation-active and non-innovation-active businesses



Source: Appendix Table A5

Turnover

Total turnover of all agribusinesses surveyed was R219.5 billion in 2018. Innovation-active businesses accounted for 34.8% of total turnover (Table 4), and innovation-active businesses in the agriculture (33.8%) and forestry (39.3%) sub-sectors accounted for a similar share of sub-sectoral turnover, respectively. Innovation-active businesses in the fisheries sub-sector accounted for total sub-sectoral turnover, as non-innovation-active fisheries businesses did not provide turnover information (see Table 2 data note).

Large non-innovation-active businesses contributed 74.0% to total turnover of all large businesses, which by far outweighed their medium, small and very small counterparts combined (0.5%).

This may suggest that small and medium-sized businesses attempted to stay competitive by innovating, compared with their large counterparts.

Table 4: Turnover comparison of businesses with innovation activities by sector

	Total	Agriculture	Forestry	Fisheries*
Total number of businesses	**4 657**	4 159	316	181
Turnover (R billions)	**219.48**	201.15	16.34	1.99
Turnover of innovation-active businesses (R billions)	**76.45**	68.03	6.42	1.99
Turnover percentage contribution of innovation-active businesses	**34.8%**	33.8%	39.3%	-

Source: Appendix Table A6

* All businesses that reported their turnover were innovation-active. As none of the non-innovation-active businesses provided this information it was not possible to calculate the turnover share for innovation-active businesses.

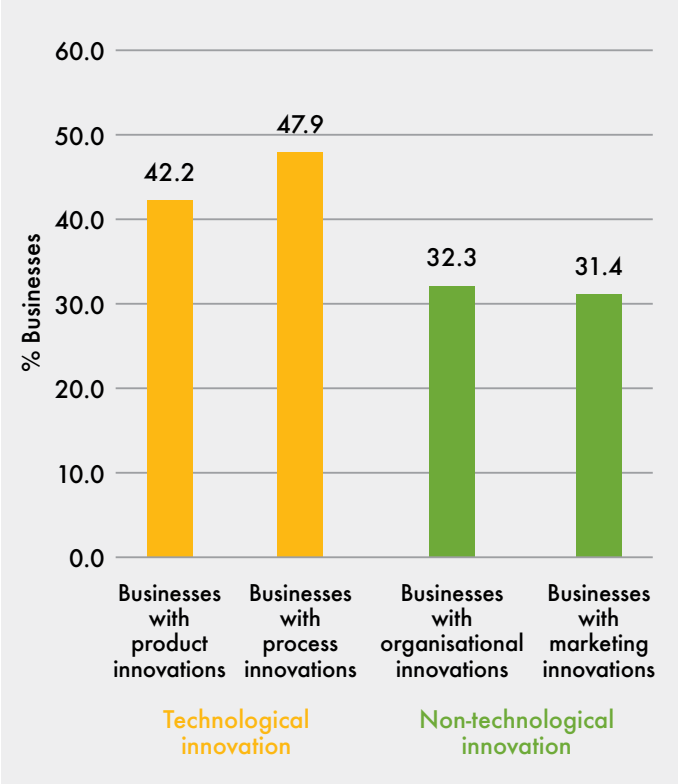
HOW SOUTH AFRICAN AGRIBUSINESSES INNOVATED

Process innovation was most prominent in South African agribusinesses with a strong focus on reducing negative environmental impacts followed by using innovation to increase yields. Product innovations were used to significantly improve existing goods and services, rather than introduce entirely new ones to the market.

What were the different types of innovation that agribusinesses implemented?

Businesses may implement **technological innovations**—product and process innovations—and **non-technological innovations**—organisational and marketing innovations (see Notes to Guide Readers). It may also be the case that a single business reports implementing multiple types of innovation. Figure 3 shows that 42.2% of agribusinesses reported product innovations, 47.9% reported process innovations, 32.3% reported organisational innovations and 31.4% reported marketing innovations.

Figure 3: Businesses that performed product, process, organisational and marketing innovations



Source: Appendix Table A9

NOTES TO GUIDE READERS

Technological vs. Non-technological innovation

Technological innovation: When a business introduces to the market, or brings into use within the firm, a new or significantly improved product or process.

Non-technological innovation: When a business introduces a new or significantly improved marketing or organisational method.

Process innovation

Strikingly, most agribusiness process innovators (70.4%) aimed at reducing negative environmental impacts (Table 5). This pattern was evident across all three sub-sectors, with 69.9% of businesses in the agriculture sub-sector, 63.4% in forestry, and 79.8% in fisheries. A similar proportion of process innovators (70.1%) reported implementing new or significantly improved methods to deal with the effects of climate change, such as droughts or floods.

In addition to deploying process innovations that helped sustain the environment, agribusinesses implemented process innovations to increase yields and, by extension, revenue and productivity. More than half of process innovators (54.4%) introduced new or improved processes to improve yields. Notably, all of the process innovators in the fisheries sub-sector and almost all of the forestry process innovators were motivated to improve yields. Process innovations to improve logistics were less frequent, except in the fisheries sub-sector.

Table 5: Businesses performing specific process innovations as a percentage of all product innovators

Process innovators	Total	Agriculture	Forestry	Fisheries
New or improved processes to improve yields	**54.4**	50.0	95.4	100.0
New or improved processes to reduce any negative environmental impacts generated	**70.4**	69.9	63.4	79.8
New or improved processes to improve logistics (delivery or distribution) for the sale of your products	**23.2**	18.6	58.8	73.8
New or significantly improved methods to deal with the effects of climate change (e.g. droughts, floods, etc.)	**70.1**	68.3	77.1	91.8

Source: Appendix Table A10

Product innovation

Product innovation was the second most reported type of innovation for South African agribusinesses in 2016-2018 (Figure 3). Did these product innovations relate to goods or services (or both)? Did they lead to entirely new products on the market, or to improvements in existing products? Data in Table 6 demonstrate that the largest proportions of product innovators implemented significantly improved goods (89.5%) and significantly improved services (61.8%), compared to entirely new goods (53.6%) and entirely new services (19.3%). This suggests that agribusinesses preferred incremental changes to existing products, as opposed to developing cutting-edge or radical innovations. Even though there may be other barriers to entry, innovation that is of an incremental nature is not likely to help businesses enter new or international markets.

Fisheries businesses were much more likely to introduce entirely new goods than agriculture and forestry businesses (Table 6). These were large and small businesses, with large businesses more likely to introduce entirely new goods. Forestry businesses were the most likely to introduce entirely new services (36.4%), with very few fisheries businesses implementing such product innovations.

Agriculture sub-sector businesses (96%) were most likely to introduce significantly improved goods, and fisheries businesses were least likely (15.1%). About two-thirds of both agriculture and forestry businesses were also likely to introduce significantly improved services, likely relating to the production phase of the value chain, such as government agricultural extension, crop brokers and shippers, meat packers, produce distributors and wholesalers, and veterinarians.

Table 6: Breakdown of total product innovators (%)

Product innovations	Total	Agriculture	Forestry	Fisheries
All product innovators				
Entirely new goods	**53.6**	50.5	54.5	91.3
Significantly improved goods	**89.5**	96.0	54.5	15.1
Entirely new services	**19.3**	20.1	36.4	6.4
Significantly improved services	**61.8**	66.3	63.6	6.4

Source: Appendix Table B8.2

Novelty of product innovations

Table 7 shows that low levels of novelty were a feature of agribusiness product innovation in 2016-2018, but that these innovations were critical to improving goods and services. Almost 50% of all product innovators introduced products that were new-to-the-business only, followed by 49.5% that introduced innovations that were new to the market. Only 13.7% introduced innovations that were new to the world. This pattern holds for the agriculture sub-sector. A high proportion (72.7%) of forestry businesses reported new-to-the-business product innovations, suggesting a strong focus on local upgrading, given that these businesses were more likely to be part of a larger group, and catering to well-established domestic and global markets. Fisheries businesses reported new-to-the-market products most frequently (84.9%), possibly newly bred fish species (Tables 6 and 10).

NOTES TO GUIDE READERS

Degrees of novelty

One novelty scale was used in the SA Agricultural Business Innovation Survey, 2016-2018. An innovation could be classified as:

- New to the world
- New to a business's market
- New to a business

Table 7: Proportion of businesses with specific levels of novelty of product (goods and services) innovations (%)

Novelty of product innovations	Total	Agriculture	Forestry	Fisheries
All businesses with product innovations	**100.0**	100.0	100.0	100.0
Innovations new to the business	**49.9**	52.6	72.7	12.8
Innovations new to the market	**49.5**	47.0	18.2	84.9
Innovations new to the world	**13.7**	14.8	9.1	0.0
Businesses with product innovations only				
Innovations new to the business	**1.3**	1.4	0.0	0.0
Innovations new to the market	**0.7**	0.7	0.0	0.0
Innovations new to the world	**0.2**	0.2	0.0	0.0
Businesses with product innovations and other innovations*				
Innovations new to the business	**48.1**	50.7	72.7	12.8
Innovations new to the market	**48.2**	45.6	18.2	84.9
Innovations new to the world	**13.2**	14.3	9.1	0.0

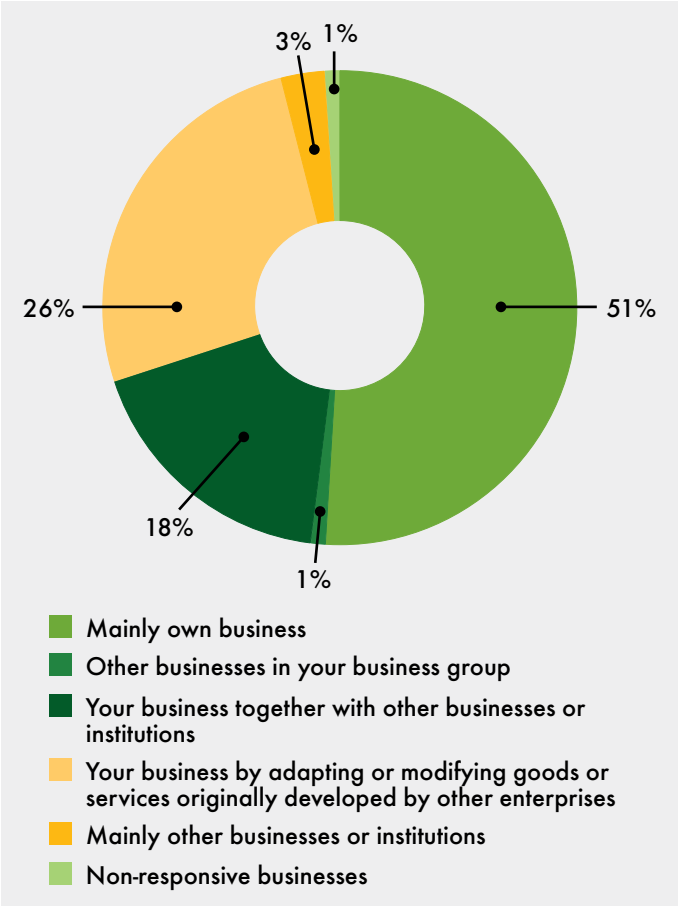
Source: Appendix Table A14.2

* Other innovations include process, organisational, marketing and abandoned/ongoing.

Development of product innovations

Businesses may collaborate or draw on external sources to support the development of product innovations (see Notes to Guide Readers). South African agribusinesses were more likely to introduce product innovation in the form of significantly improved, rather than entirely new, goods and services (Table 6). Figure 4 shows that product innovations were most frequently developed within businesses (51.0%). Hence, for the majority of product innovators, the business relied on its own resources. However, there was some collaborative activity. Almost half of the product-innovative businesses also involved other external actors, whether collaborating indirectly through adapting or modifying innovations developed by other businesses (26%), or directly through co-development of innovation in partnership with other businesses or institutions (18%). This trend is consistent with the finding below that all innovation-active businesses sought information for their innovations from a range of internal and external sources (Table 11).

Figure 4: Collaboration in the development of product innovations



Source: Appendix Table A13

NOTES TO GUIDE READERS

Innovation development

Innovations can be developed in different ways:

- A company working alone
- A company working as part of a group of companies
- A company working with other companies or institutions, such as universities
- A company adapting or modifying goods and/or services originally developed by another company

Innovations can also be developed in-country or abroad.

Organisational innovation

South African agribusinesses were likely to introduce organisational innovations to promote linkages and collaboration. Table 8 shows that a very high proportion (88.8%) of organisational innovations took the form of strategies to strengthen linkages with external actors to promote research or technology transfer. For these organisational innovations that attempt to harness strategic linkages, the pattern for sub-sectors is different, with innovation-active businesses in the agriculture and fisheries sub-sectors more likely to implement such innovations.

An almost equal proportion of innovation-active businesses (86.4%) introduced new or significantly improved business processes, managerial methods, or changes in business structure. Particularly high proportions of businesses in the agriculture (94.1%) and forestry (94.7%) sub-sectors reported this kind of organisational innovation. These internal changes were intended to improve the organisation, and they align with the trend of businesses relying on their own resources for innovationas well as the focus on upgrading within businesses.

NOTES TO GUIDE READERS

Examples of new or significantly improved business practices

- Knowledge management
- Systems to better use or exchange information, knowledge and skills within the business
- First time use of supply chain equipment
- Business re-engineering
- Lean production
- Quality management

Table 8: Percentage of innovation-active businesses that introduced organisational innovations

Specific organisational innovations	Total	Agriculture	Forestry	Fisheries
All businesses with organisational innovations				
New or significantly improved business processes, managerial methods, changes in business structure intended to improve organisation	**86.4**	94.1	94.7	15.1
Strategies to generate and/or strengthen links with outside companies or organisations for research, project development, technology transfer, etc.	**88.8**	89.6	21.2	100.0*

Source: Appendix Table A11.2

* Very few businesses responded and they all fell under this category, making this proportion not generalisable to the wider population.

Marketing innovation

Businesses that introduced marketing innovations mostly focused on new activities or strategies to reach new markets (95.3%) (Table 9). Businesses in the agriculture and fisheries sub-sectors were more likely to implement this kind of marketing innovation than activities or new methods to improve positioning, promotion and/or pricing of products. The fisheries businesses all used marketing innovations to grow new markets, but very few used marketing innovations to improve the position of their products. The opposite was the case for the forestry sector, where businesses were more likely to introduce activities to improve the positioning and pricing of products, but not very likely to implement new activities to reach new markets.

Table 9: Proportion of businesses that introduced specific marketing innovations

Specific marketing innovations	Total	Agriculture	Forestry	Fisheries
All businesses with marketing innovations				
New activities or strategies to reach new markets	**95.3**	96.7	25.2	100.0
Activities or new methods to improve positioning, promotion and/or pricing of products	**87.2**	95.2	93.7	15.1

Source: Appendix Table A12.2

What were the different ways South African agribusinesses implemented and invested in innovation?

Businesses implement different types of product, process, organisational and marketing innovations by investing in a wide range of innovation activities. Notably, more agribusinesses innovated than invested in R&D activities in 2016-2018, a pattern observed also in the South African Business Innovation Survey, 2014-2016 (HSRC/CeSTII, 2020). The pattern of agricultural innovation activity in Figure 5 reflects the prevalence of process innovations, and of product innovations that are mainly significantly improved goods and services (Figure 3), and new to the business (Table 7).

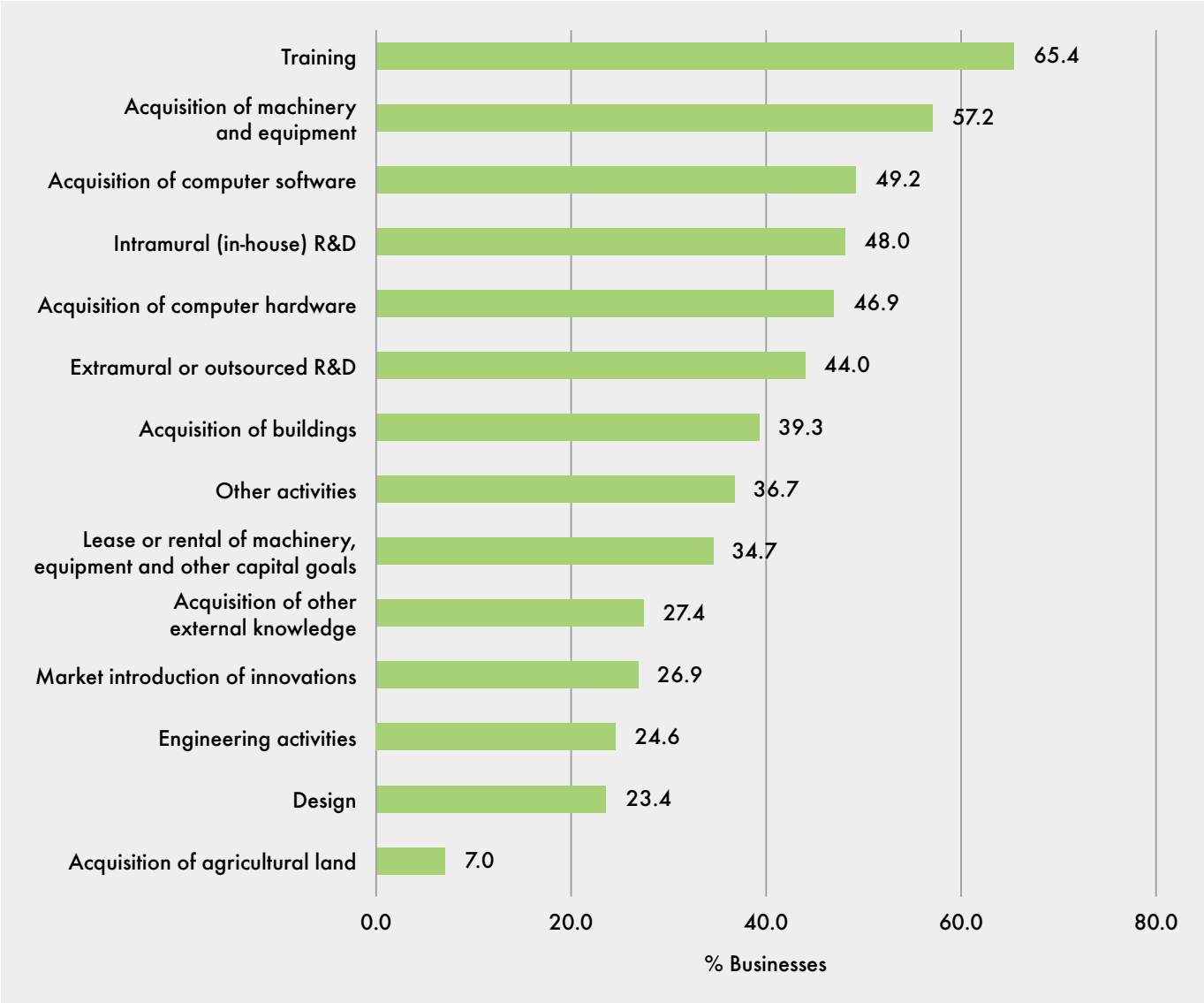
So, innovation-active agribusinesses were most likely to invest in the innovation activity of training (65.4%).

Directly linked to this trend was the acquisition of new forms of technology, whether traditional or digital—machinery and equipment (57.2%), computer software (49.2%) and computer hardware (46.9%), or the lease of machinery and equipment, a relatively high 34.7%.

As a result, businesses also invested highly in training their employees, likely in relation to the new business processes that come with the acquisition of machinery, computer hardware and computer software.

Just under half of the businesses reported that they innovated through knowledge activities, by conducting in-house R&D (48.0%), outsourcing R&D (44.0%), or acquiring other forms of external knowledge (27.4%).

Figure 5: Proportion of innovation-active businesses that engaged in specific innovation activities



Source: Appendix Table A15.2

Despite design and engineering activities being important to agricultural innovation, the results show that the lowest proportion of firms engaged in these activities—engineering activities (24.6%) and design (23.4%). A similar proportion is allocated to market introduction of innovations (26.9%) (Table 9). Innovation activities related to the acquisition of infrastructure such as agricultural land (7.0%) was low, which is surprising as agriculture depends on land use. Recent changes in land policies may be a factor that needs to be explored further to understand this trend.

What advanced technological capabilities did agribusinesses use to enhance their innovations?

Agriculture is one of the sectors that the South African government has identified as critical to support growth and development, and that requires technological modernisation. The OECD argues that through new technologies and digitalisation, agriculture is transforming, and, equally, that governments are presented with new opportunities to improve their agricultural policies and practices (OECD, 2020). The OECD identifies three key ways in which digital technologies are playing a role. First, digital technologies such as the Internet, mobile devices, data analytics, artificial intelligence and digitally delivered agricultural services, satellite data and remote sensing, are used at different phases of the agro-food system value chain. Examples include using farm machinery automation to refine inputs and reduce the demand for manual labour, and using satellite data and associated remote sensing to improve accuracy, whilst also reducing the cost of monitoring crop growth and quality of land and water. Second, using digital technologies, government can monitor and hence improve the efficiency and effectiveness of existing agricultural policies and programmes, and design better ones. Third, digital technologies can be used to increase efficiency and ensure compliance in agriculture and food trade. For example, they can be used to link private sector suppliers to markets more effectively and timeously. They can also enable governments to monitor and ensure adherence to standards and increase efficiency and speed for essential border procedures for perishable agricultural goods.

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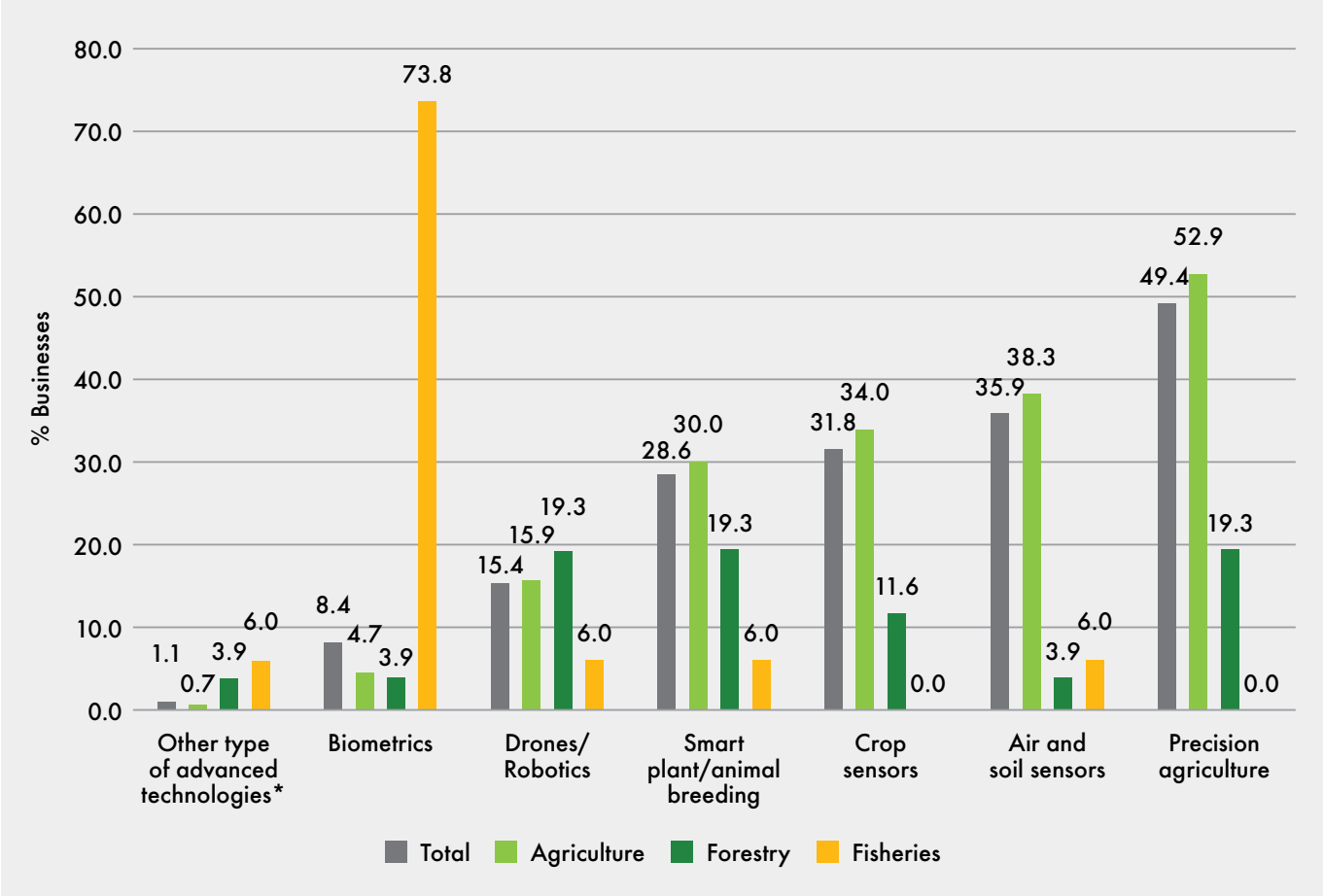
Business capabilities

Business capabilities, as defined in the SA Agricultural Business Innovation Survey, 2016-2018, included a list of advanced technologies, such as crop sensors, drones/robotics, and precision agriculture. Respondents were asked to indicate if any of these technologies were used during the reference period, as well as if they planned to use these in the future.

South African agribusinesses are acquiring new technologies—whether machinery, computer hardware or software (refer to Figure 4)—and the question is, how they are innovating by acquiring these new digital capabilities.

Figure 6: Development and use of capabilities/advanced technologies for agricultural innovation for innovation-active businesses



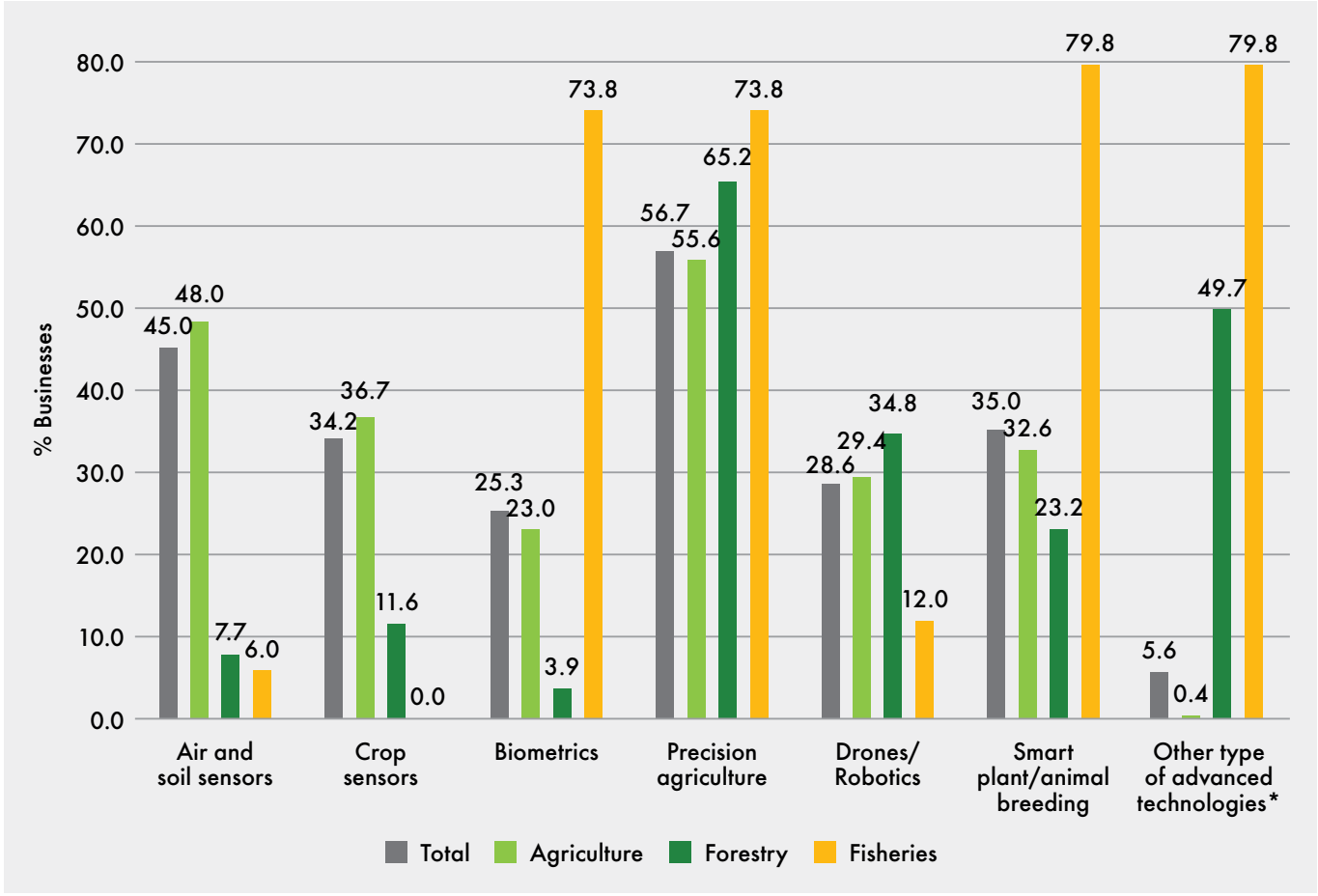
Source: Appendix Table A18.1

Figure 6 reflects that innovation-active agribusinesses used or adopted a wide range of advanced digital technologies. Almost half (49.4%) of all innovation-active businesses used precision agriculture technologies—defined as a method of farming used by observing, measuring and responding to inter- and intra-field variability in crops using satellite-like imagery and mapping technologies. The second and third most frequently reported advanced technologies were air and soil sensors (35.9%) and crop sensors (31.8%). Smart animal and crop breeding technologies were also used by almost one-third of businesses.

Precision agriculture was the most frequently reported digital technology used in the agriculture sub-sector (52.9%). Almost three-quarters of businesses in the fisheries sub-sector used livestock biometrics technologies (73.8%). Forestry businesses were least likely to adopt digital technologies, but almost 20% adopted robotics, smart breeding and precision agriculture technologies respectively. These encouraging trends indicate that South Africa is among the countries with moderate uptake levels of new agricultural digital technologies, with many South African businesses keeping up as the rest of the world moves forward with digital technology.

In terms of the future outlook for the period 2019-2021, more businesses reported that they intended to continue using and developing digital technologies. The trends for intended use mirror those most frequently reported as already in use for the 2016-2018 period (Figure 7), but are slightly higher—for example, for precision agriculture (56.7%), air and soil sensors (45%) and biometrics (25.3%). Potential digital technologies with moderate uptake levels included plant and animal breeding (35.0%) and drones/robotics (28.6%). Notably, many more fisheries businesses planned to introduce smart plant breeding, precision agriculture and other advanced technologies. These projections confirm a positive outlook for South African agribusinesses, in which they are not lagging behind the rest of the world.

Figure 7: Innovation-active businesses that planned to develop or use capabilities/advanced technologies for agricultural innovation during 2019-2021



Source: Appendix A18.3

BENEFITS OF INNOVATION

Innovation successes included accessing new markets, improved soil fertility, higher yields, biodiversity preservation and water conservation. Reduced greenhouse gas emissions were a highly successful innovation outcome for some businesses, while others developed new IP. Forestry businesses saw strong revenue increases.

What were the outcomes of innovations?

Businesses were asked to rate the level of success of a set of innovation outcomes, which allows us to understand how agribusinesses benefitted from their innovation (Figure 10). Aligned with the prevalence of process types of innovation, **process outcomes** tended to be the most highly successful for innovation-active businesses, and these reflect sustainability concerns most strongly. Innovation-active businesses reported improvement in soil fertility as a highly successful innovation outcome (23%), particularly businesses in the agriculture (24.1%) and forestry sub-sectors (36.2%). For the forestry sub-sector, increased biodiversity of trees was also a highly successful outcome for 24.1% of businesses. For the fisheries sub-sector, a much higher proportion of businesses reported increased biodiversity preservation and increased water preservation (73.7% respectively) as a highly successful innovation outcome. In addition, 10.7% of businesses rated reduced greenhouse gas emissions as a highly successful innovation outcome.

Highly successful product outcomes were more likely to take the form of increased variety—20.2% of innovation-active businesses—than increased yields (4.2%), particularly for agriculture businesses. Increased yields were more prevalent for forestry businesses (12%). While innovation was instrumental in allowing businesses to diversify their product offerings, one might expect higher yields to be a highly successful outcome for more businesses in all sub-sectors. In terms of strategic outcomes, innovation enabled businesses to access new markets—13.2% of innovation-active agribusinesses benefitted from innovations by reaching new markets. An encouraging trend, perhaps linked to the use of new digital capabilities and the relatively high levels of internal and outsourced R&D, 18.3% of innovation-active businesses rated the development of intellectual property as a highly successful innovation outcome, particularly in the agriculture sub-sector.

Like the relatively low proportion of businesses reporting increased yields as a successful outcome, the trends in financial outcomes point to potential spaces for intervention. In particular, only 5.3% of innovation-active businesses rated increased revenue—the most widely-cited motivation for driving innovation activity—as a highly successful innovation outcome. Of note, financial outcomes were critical for forestry sub-sector businesses, with 55.7% reporting both increased revenue and reduced unit production costs as highly successful outcomes.

This analysis allows for the identification of strengths and weaknesses in the potential outcomes of innovation, to inform strategies for intervention to expand desirable outcomes in more agribusinesses.

Table 10: Highly successful outcomes for product and process innovation-active businesses (%)

Outcomes of innovation	Proportion of innovation-active businesses (%)			
Product outcomes	**Total**	**Agriculture**	**Forestry**	**Fisheries**
Increased varieties (e.g. cultivars)	**20.2**	21.8	0.0	0.0
Increased yield (crop) / livestock / farmed birds (turkeys, chickens, pigeons, geese), fish, etc.	**4.2**	3.9	12.0	6.0
Strategic /marketing outcomes				
Reached new markets	**13.2**	13.8	4.0	6.0
Developed new intellectual property (IP)	**18.3**	19.5	0.0	6.01
Process outcomes				
Increased biodiversity preservation	**8.1**	3.9	24.1	73.7
Increased water preservation	**9.5**	5.6	12.0	73.7
Improvement in soil fertility	**23.0**	24.1	36.2	0.0
Financial outcomes				
Increased revenue	**5.3**	4.1	55.7	6.0
Reduced unit production costs	**11.7**	11.2	55.7	6.0
Other outcomes				
Reduced greenhouse gas emissions	**10.7**	10.8	12.0	8.1

Source: Appendix Table A16.2

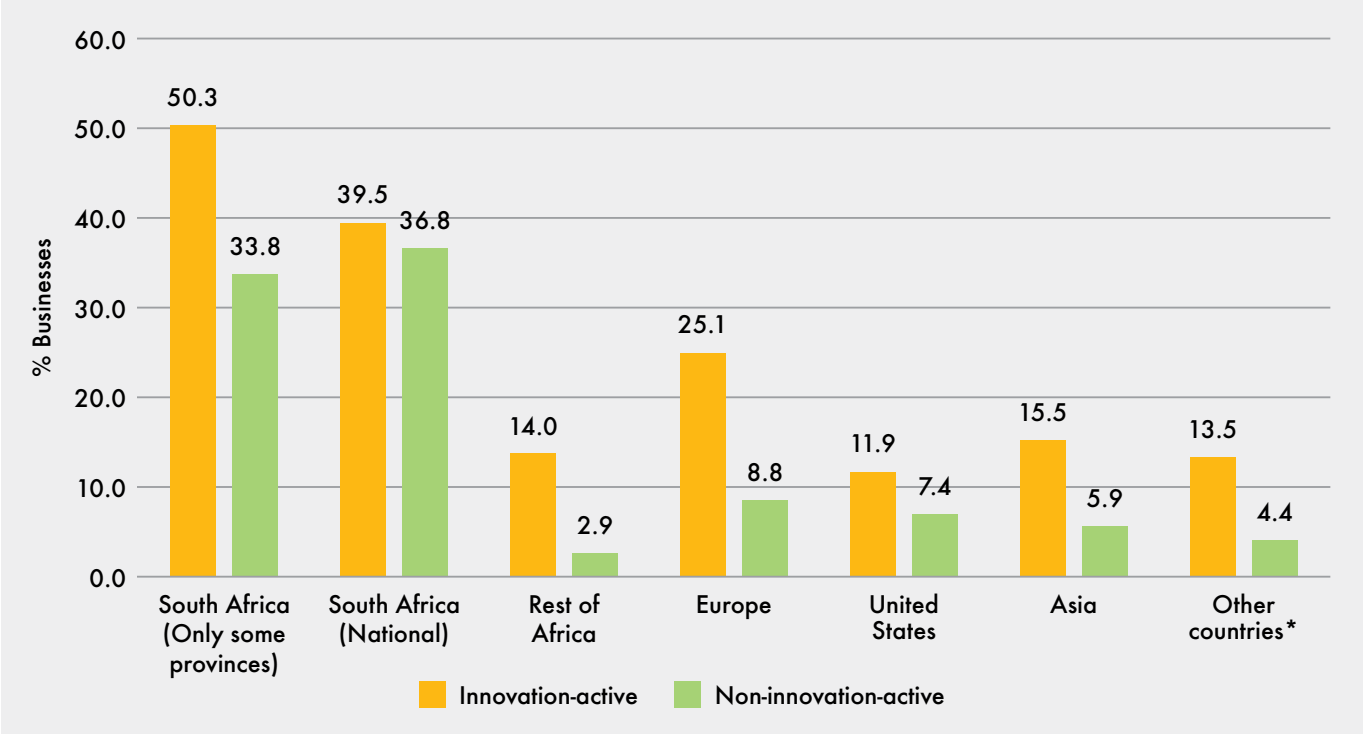
What were the geographical markets for goods and services for innovation-active and non-innovation-active businesses?

An important outcome of innovation is access to new markets (Table 10). Markets for goods and services produced by both innovation-active and non-innovation-active businesses remained concentrated locally in South Africa. Innovation allowed agribusinesses to access new local markets primarily, but also more global markets (Figure 8), a trend that holds for businesses in general, as found in the South African Business Innovation Survey, 2014-2016.[4]

Most innovation-active businesses (50.3%) reported selling to only some provinces in South Africa, with 39.5% of innovation-active businesses selling their goods and services to national markets. Non-innovation-active businesses were slightly more likely to access national (36.8%) than provincial markets (33.8%), however.

Although access to global markets remained low overall, innovation-active businesses reached more international markets—25.1% reported exports to European markets, compared to only 8.8% of non-innovation-active businesses; and 15.5% of innovation-active businesses also exported to Asian markets, compared to a low 5.9% of non-innovation-active businesses. Despite low access to international markets, the data suggest that innovation plays a role in opening up new geographic markets.

Figure 8: Geographical markets for goods and services for innovation-active and non-innovation-active businesses



Source: Appendix Table A7.2

[4] Available online at https://sabizinnovationsurvey.blog/

ENABLERS OF AGRIBUSINESS INNOVATION

Climate, water and labour were the top enablers for innovation-active businesses followed by agro-chemicals, regulations and finance. Businesses not yet innovation-active highlighted access to finance, training and skills as necessary for innovation. Suppliers, customers and research institutes were all important sources of information supporting innovation.

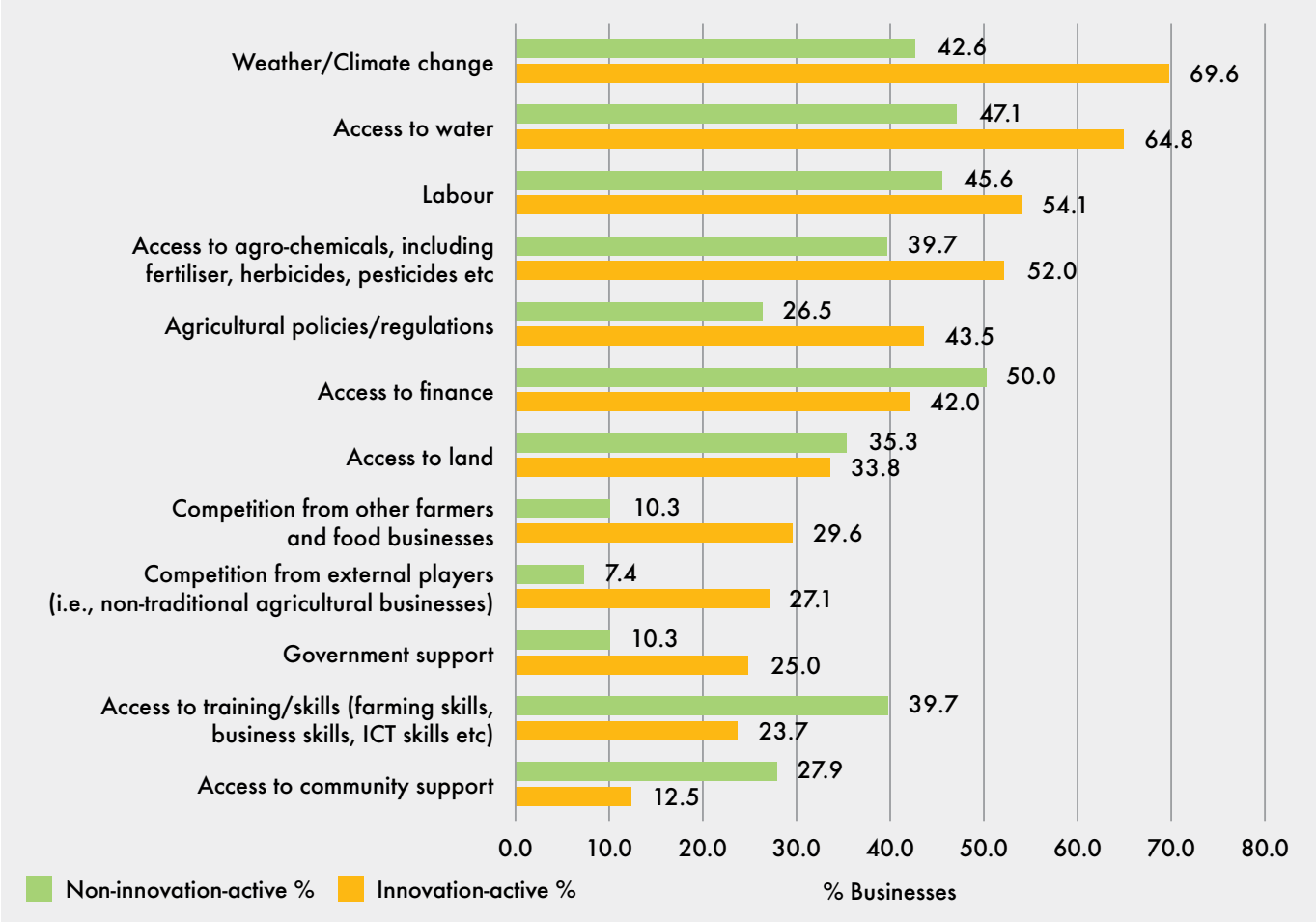
What factors supported and promoted innovation in South African agribusinesses?

An understanding of businesses' perceptions of the factors that support and promote their innovation provides essential insight for policy makers and sectoral support organisations to design intervention strategies. The facilitating factors highlighted as highly important by innovation-active and non-innovation-active businesses differ in some notable ways.

A much higher share of innovation-active businesses rated environmental factors as the most important factor that promoted innovation, such as weather and climate change (69.6%), followed by access to water (64.8%). Resources for agriculture, such as access to agri-chemicals (52%), access to finance (42%) and land (33.8%) were also highly important for many innovation-active businesses. In terms of human resource factors, access to labour (54.1%) seemed to be more significant in promoting innovation than access to skills (23.7%) for innovative businesses. Market factors such as competition from other farmers (29.6%) or external players (27.1%) were seemingly as important as institutional factors such as government support (25%) for innovative businesses.

Some factors were rated as highly important by more non-innovative businesses, significantly, access to finance (50%), access to skills (39.7%), access to land (35.3%) and community support (27.9%). Presumably, they would be more innovative if they had access to these resources.

Figure 9: Factors that supported/promoted innovation



Source: Appendix Table A19.2 and A19.4

What were the sources of information for agribusinesses working on an innovation?

Innovation entails putting new knowledge or technology into use, so understanding the sources of information used to innovate also provides critical information to facilitate and support innovation in more businesses.

South African agribusinesses relied on a wide range of information sources to innovate (Table 11). A quarter of innovation-active businesses relied on their own **internal sources** of information, particularly almost half of the businesses in the forestry sector. **External market sources** were rated as the most important sources of information for more businesses. In total, 32.6% of innovation-active businesses rated information sources from suppliers of equipment, materials, components or software as the most important source, followed by clients or customers (30.9%).

Information from **external institutional sources** was rated as important by fewer innovation-active businesses, and here, private research institutes were the most likely partner (19.4%), particularly for agriculture businesses (20.5%). Government and public research institutes were not highly rated as sources of information for innovation (9.2%), while information sources from traditional knowledge producers like universities and higher education institutions were considered as highly important by 15.5% of innovation-active businesses. A high 85.8% of fisheries businesses relied on universities. Businesses are as likely to source information themselves from **other external trade-related sources**, such as scientific journals and trade publications (15.8%), attending conferences and trade fairs (21.4%) or through support from professional associations (14.3%).

These trends indicate that there is space to grow collaboration in support of innovation in the agricultural sector, particularly with external public institutional sources.

Table 11: Sources of information for innovation rated as 'highly important' by innovation-active businesses

Sources of information	Percentage of innovation-active businesses (%)			
Internal sources	**Total**	**Agriculture**	**Forestry**	**Fisheries**
Sources within your business or business group	**25.4**	26.1	49.7	6.0
External - market sources				
Suppliers of equipment, materials, components or software	**32.6**	33.3	53.6	12.0
Clients or customers	**30.9**	31.8	23.2	18.0
Competitors or other businesses in your sector	**18.4**	19.2	11.6	6.0
Consultants, commercial labs or private R&D institutes	**22.4**	23.7	3.9	6.0
External - institutional sources				
Universities/higher education institutions	**15.5**	11.8	0.0	85.8
Government and public research institutes	**9.2**	9.6	0.0	6.0
Private research institutes	**19.4**	20.5	3.9	6.0

Continues overleaf...

Sources of information	Percentage of innovation-active businesses (%)			
External - other sources	**Total**	**Agriculture**	**Forestry**	**Fisheries**
Conferences, trade fairs, exhibitions	**21.4**	21.7	7.7	20.2
Scientific journals and trade/technical publications	**15.8**	12.4	3.9	79.8
Professional and industry associations	**14.3**	14.3	11.6	14.2

Source: Appendix Table A17.2

INNOVATION CONSTRAINTS

Resource factors including access to water, land, finance and community support were the major barriers to innovation. Access to skills and agro-chemicals, and a lack of labour were other impediments along with market factors including competition from external players.

What were the barriers to innovation?

Resource factors were the most frequently reported highly important barrier for innovation-active businesses: access to water (76.0%), access to finance (61.8%), access to agro-chemicals (45.0%) and access to land (38.1%). A similar pattern was found for non-innovation-active businesses, but here, access to finance was most frequently reported as a highly important barrier to innovation (30.9%). Access to water and land are determined by government policy intervention and institutional regulation, so the importance of these barriers point to spaces for policy intervention. The importance of access to finance reinforces the typical perception that the ability to innovate is highly dependent on accessing finance, again, pointing to a space for public sector intervention.

Environmental factors, of weather or climate change, which are not within the direct control of businesses, were also rated as highly important barriers by 73.7% of innovation-active businesses, and a quarter of non-innovation-active businesses. We noted the high proportion of process innovations oriented to reducing the negative environmental impacts generated by agricultural activities, and innovations to deal with the effects of climate change (Table 5). The involvement of government departments responsible for environmental regulation to create an environment in support of innovation seems to be necessary.

Hence, institutional factors are significant, with 53.6% of innovation-active businesses reporting that agricultural policies or regulations are highly important constraints on innovation, and others highlighting the importance of government support. This amounts to a clear call from businesses for improvements in the institutional and public funding environment. Knowledge factors were also highly important barriers for significant proportions of businesses. Access to labour was important for both innovation-active (55.7%) and non-innovation-active businesses (25%). Although access to training and skills was slightly less important as a barrier, this must be interpreted in light of the high proportion of businesses that invest in training as an innovation activity (Figure 5).

Finally, although market factors were less important than resource, knowledge or institutional factors, they remain important for many businesses. Innovation-active businesses reported competition from other farmers and food businesses (35.5%), as well as competition from external players (26.3%) as highly important barriers. As noted in the Oslo Manual, competition can affect how businesses make decisions about their innovation activities and investments (OECD and Eurostat, 2018, par 7.15). The importance of market factors can be linked to the high proportion of businesses that implemented marketing innovations to improve access to markets (Table 9) as well as the need to enter more national and global markets. In general, for both innovative and non-innovative businesses, there are critical resource, environmental, knowledge, institutional and market barriers to innovation. Government could target addressing barriers in this order of priority.

Table 12: Highly important barriers to innovation by percentage of business

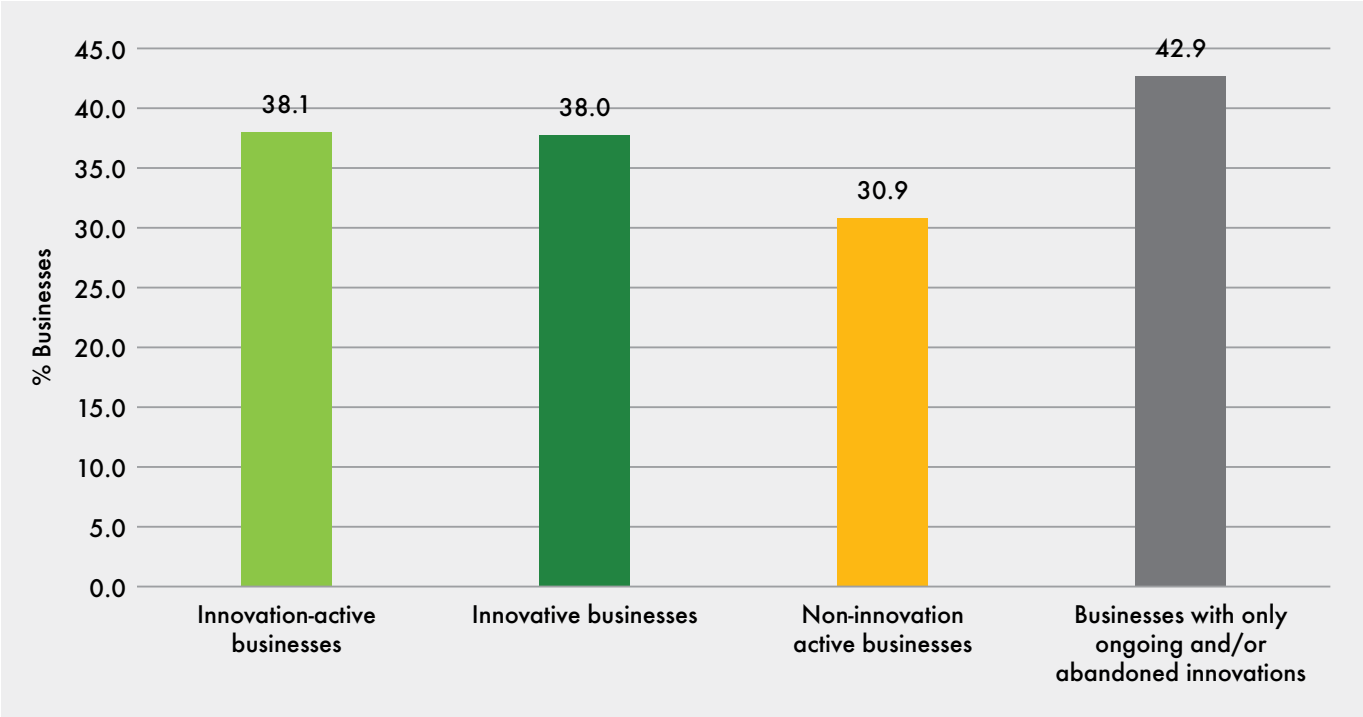
Resource factors	Innovation-active (%)	Non-innovation-active (%)
Access to finance	61.8	30.9
Access to land	38.1	20.6
Access to water	76.0	23.5
Access to community support	26.5	8.8
Knowledge factors		
Access to training/skills (farming skills, business skills, ICT skills, etc)	35.8	19.1
Access to agro-chemicals, including fertiliser, herbicides, pesticides, etc.	45.0	22.1
(Lack of) labour	55.7	25.0
Market factors		
Competition from other farmers and food businesses	35.5	7.4
Competition from external players (i.e., non-traditional agricultural businesses)	26.3	2.9
Institutional factors		
Government support	27.6	14.7
Agricultural policies/regulations	53.6	19.1
Environmental factors		
Weather/climate change	73.7	25.0

Source: Appendix Tables: A20.2 and A20.4

Were agribusinesses aware of government support for innovation?

Institutional factors were a significant barrier constraining innovation-active businesses. South African agribusinesses are more likely to innovate and grow when they receive support from the public sector. The South African government has put in place a number of incentive and support mechanisms to help businesses innovate. However, Figure 10 illustrates that only about 38.1% of innovation-active businesses were aware of government support, while 30.9% of non-innovation-active businesses were aware of government support. More of the very small number of South African agribusinesses with ongoing or abandoned innovations tended to be aware of government support (42.9%). This may point to the fact that a large proportion of businesses (whether innovation-active or non-innovation-active) are not aware of government support for innovation, which has important implications. Low levels of awareness of government support may translate into low access of the support on offer, and hence constrain higher levels of innovation in businesses.

Figure 10: Businesses that were aware of government financial support for innovation activities from various sources



Source: Appendix A21

PART 2: SUB-SECTORAL INNOVATION PROFILES

Part 2:

- **Compares** the innovation rates of specific types of farming within the agriculture sub-sector
- **Develops** coherent profiles of innovation in the fisheries and forestry sub-sectors by mapping innovation challenges and trends
- **Shows** what policy evidence can be gained from disaggregated analysis, and how evidence can be used to identify spaces for policy intervention

INNOVATION RATES IN THE AGRICULTURE SUB-SECTOR 2016-2018

Crop farmers were most likely to be innovation-active in the farming sector followed by mixed crop and animal faming. Trends suggest the need to strengthen innovation activities in animal husbandry. Understanding why innovation is highest in crop farming may provide useful insights for the sub-sector.

The agriculture sub-sector in context

Agriculture contributed 2.5% to GDP in 2014 (The World Bank, 2016) but if the entire value chain is taken into account, the agricultural sector contributed up to 12% of GDP (DAFF, 2015). South Africa has 96 841 000 hectares of agricultural land, of which nearly 12 913 000 is arable land and the area under permanent crops. The main agricultural activities are crop production, mixed farming, cattle ranching and sheep farming, dairy farming, game ranching, aquaculture, beekeeping, and winemaking (GCIS, 2010).

The South African agriculture sub-sector can be divided into distinct farming regions, and farming activities range from intensive crop production in winter rainfall and high summer rainfall areas, to cattle ranching in the bushveld and sheep farming in the more arid regions (Goldblatt, 2011). Agricultural production falls broadly into three categories:

- **Commercial agriculture** covers about 46.4 million hectares made up of about 40 000 farming units, and produces about 99% of the country's formal marketed agricultural output. Commercial agricultural land comprises mainly grazing land (36.5 million hectares) and arable land (7.6 million hectares). Grazing land is used for livestock and game farming, and arable land is used for crop production (Stats SA, 2020).
- **Smallholder agriculture** covers an estimated 14 million hectares, involving between 300 000 and 400 000 predominantly black farmers. It is mainly located in the former homelands, which lack good soil, water and infrastructure. Production efficiency is generally low.
- **Subsistence agriculture** is practised by about 2.3 million households (Stats SA, 2016).

According to the recent census of commercial agriculture (COCA), the province with the highest number of farms in 2017 was Free State (7 951 farms or 19.8% of the national total), followed by Western Cape (6 937 or 17.3%), North West (4 920 or 12.3%) and Northern Cape (4 829 or 12.0%). The provinces with the lowest number of farms in 2017 were Gauteng (2 291 or 5.7%), Mpumalanga (2 823 or 7.0%) and Limpopo (3 054 or 7.6%).

Table 13: Number of commercial farms and percentage contribution to agriculture sector in 2017

Type of activity	Number of commercial farms	% contribution
Growing of cereals and other crops	8 559	21.3
Horticulture	4 643	11.6
Farming of animals	13 639	33.9
Mixed farming (growing of crops combined with farming of animals)	12 458	31.1
Agricultural services and fertiliser production	823	2.1
Total	**40 122**	**100**

Source: Adapted from Stats SA (2020)

Agriculture as a sector remains an important contributor to employment in South Africa's rural areas, with the total number employed by commercial agriculture at 757 628 people. Of the total number of employees, 268 740 or 35.5% of the total were employed by the horticulture sub-sector, followed by mixed farming (185 863 or 24.5%) and farming of animals (162 116 or 21.4%) (Stats SA, 2020).

Table 13 shows that commercial farms were most likely to focus on animal husbandry, followed by mixed farming, crops, and horticulture.

Snapshot of innovation rates of different types of commercial agriculture, including crop, animal and mixed farming

Businesses in the agriculture sub-sector were slightly more likely to be innovation-active than the total sample (64.3% versus 62% respectively). The profiles of innovation of those farming crops or animals are likely to be very different, and the data confirm this trend. Table 14 uses a simple threefold classification system to provide insight into the relative innovation rates for different kinds of farming activity.[5]

Table 14: Innovation rates across the agriculture sub-sector

Breakdown of businesses	Total	Crops	Animals	Mixed	Not classifiable[6]
Number of businesses					
All businesses	**4 159**	2 274	678	442	765
Innovation-active businesses	**2 674**	1 727	314	312	322
Non-innovation-active businesses	**1 485**	547	365	130	443
Percentage of businesses (%)					
All businesses	**100.0**	100.0	100.0	100.0	100.0
Innovation-active businesses	**64.3**	75.9	46.2	70.6	42.1
Non-innovation-active businesses	**35.7**	24.1	53.8	29.4	57.9

Source: Appendix Table B1.6

The largest proportion of the businesses (55%) focused on crop farming, and they were most likely to be innovation-active (75.9%). The 16% of businesses focused on animal husbandry were much less likely to be innovation-active (46.2%). The 11% of businesses engaged in a mix of crop and animal farming were also very likely to be innovation-active (70.6%).

Comparing innovation rates at this level of disaggregation can provide valuable information for innovation and agricultural policy makers, and for agricultural support organisations. For example, the trends suggest the need to focus on strengthening innovation activities in farming businesses focused on animal husbandry. The data also suggest the need to investigate the relatively high patterns of innovation in crop farming, to identify what facilitates or constrains these, so that insights can be gained to promote innovation in other types of farming activity.

Further disaggregation would of course be useful, to establish innovation rates and patterns of innovation activity for different kinds of crop farming, such as wheat, wine or fruit. Unfortunately this is not possible for the agriculture sub-sector with the current data set, and must remain a key task for future surveys.

In the next two sections, we show how the data can be used to analyse patterns of innovation in a single sub-sector, to provide more sector specific policy insights, by focusing on the fisheries and forestry sub-sectors.

[5] The classification was undertaken by recoding the main economic activity data. Unfortunately, 18% of respondents did not provide this data, which makes it impossible to use this disaggregation for further in-depth analysis.

[6] These businesses did not provide information on their main economic activity and hence it was not possible to reclassify them.

PATTERNS OF INNOVATION IN THE FISHERIES SUB-SECTOR 2016-2018

Much of South Africa's fisheries industry is young, reflected in the patterns of innovation in the sub-sector, with a very high proportion of innovation-active businesses. Innovation is both technological, driving new products and processes, and non-technological, contributing to organisational, management and marketing changes.

The fisheries sub-sector in context

Globally, 'wild capture' fisheries and aquaculture are vital contributors to food security, employment and livelihoods. Economic performance depends on a delicate balance between the quantity and price of the catch and harvesting costs, while at the same time, ensuring sustained biological productivity of fish stocks (World Bank, 2009). The innovation challenge is to harness technology to address over-exploitation and depletion, and support recovery of stocks (FAO, 2010).

In South Africa, 'wild capture' takes place in commercial fisheries (DAFF, 2016; WWF, 2013)—through both highly industrialised offshore operations and more traditional near-shore fisheries—as well as recreational and subsistence fisheries (Nthane, 2020). Offshore operations require high levels of capital investment, skill and technology. The industry was historically dominated by foreign-owned businesses, until government policy-driven attempts intervened to strengthen the domestic industrial base, ensure transformation of ownership, and build local capabilities (DAFF, 2010a, 2010b).

The status of fishing stocks in South Africa is a key focus of research to inform management of national resources through assigning catch allocation rights (DAFF, 2016). For businesses engaged in 'wild capture', whether large or small, the innovation challenge highlighted above relates to the sustainable and responsible management and exploitation of stocks, and building the required skills and technology for large-scale operations. The significant impact of environmental challenges and the effects of climate change on the sector cannot be underestimated (see Notes to Guide Readers).

Aquaculture involves breeding stocks in a controlled environment, and in South Africa, focuses on high-value species such as abalone, mussels and oysters. Aquaculture was only relatively recently targeted as a potential growth sector and policy priority (DAFF, 2010a, 2010b). A National Aquaculture

NOTES TO GUIDE READERS

The significance of climate change

According to South Africa's Ocean and Coasts Annual Science Report 2019, 'Approximately half of the research and monitoring report cards presented here are directly or indirectly concerned with detecting or understanding climate-related changes or climate change effects in the marine environment'. (DEFF, 2019: 3)

The value of the fisheries sector in 2018

The commercial and recreational fishing industry (including primary and secondary industries) has been valued at between R4 billion and R5 billion annually, and provides employment for an estimated 27 700 individuals, both land-based and sea-going. http://www.fao.org/fishery/facp/ZAF/en

Policy Framework was released in 2013, with an Aquaculture Development Enhancement Programme, which aimed to grow jobs and promote competition through grants to purchase machinery, equipment, infrastructure, commercial vehicles and boats. The priority and potential of the sector was affirmed by its inclusion in the Operation Phakisa Oceans Economy process (DAFF, 2018). For aquaculture businesses, the innovation challenge relates to developing the technologies and skills to promote sustainable and responsible aquaculture.

What were the profiles of innovation and non-innovation-active businesses in the fisheries sub-sector?

The sample for the South African Agricultural Business Innovation Survey, 2016-2018, included only South African commercial fisheries, whether wild capture or aquaculture, and as such is the focus of this analysis. It excludes very small businesses and subsistence fisheries. A very high proportion of businesses in the fisheries sub-sector (85.6 %) reported that they were innovation-active. What kinds of businesses are these?

The majority of businesses in the sample were small (63%), while 30% were large, and 7% were medium-sized. Table 15 reflects that all of the medium-sized and small businesses reported that they were innovation-active, in contrast to just over half of the large businesses (51.7%).

Table 15: Business size in the fisheries sub-sector

Number of businesses	Total	Large	Medium	Small
All businesses	**181**	54	13	114
Innovation-active businesses	**155**	28	13	114
Non-innovation-active businesses	**26**	26	0	0
Percentage of businesses (%)				
All businesses	**100.0**	100.0	100.0	100.0
Innovation-active businesses	**85.6**	51.7	100.0	100.0
Non-innovation-active businesses	**14.4**	48.3	0.0	0.0

Source: Appendix Table B.15

Most of the businesses were relatively young, with 79.8% established for nine years or less (Appendix Table A5).

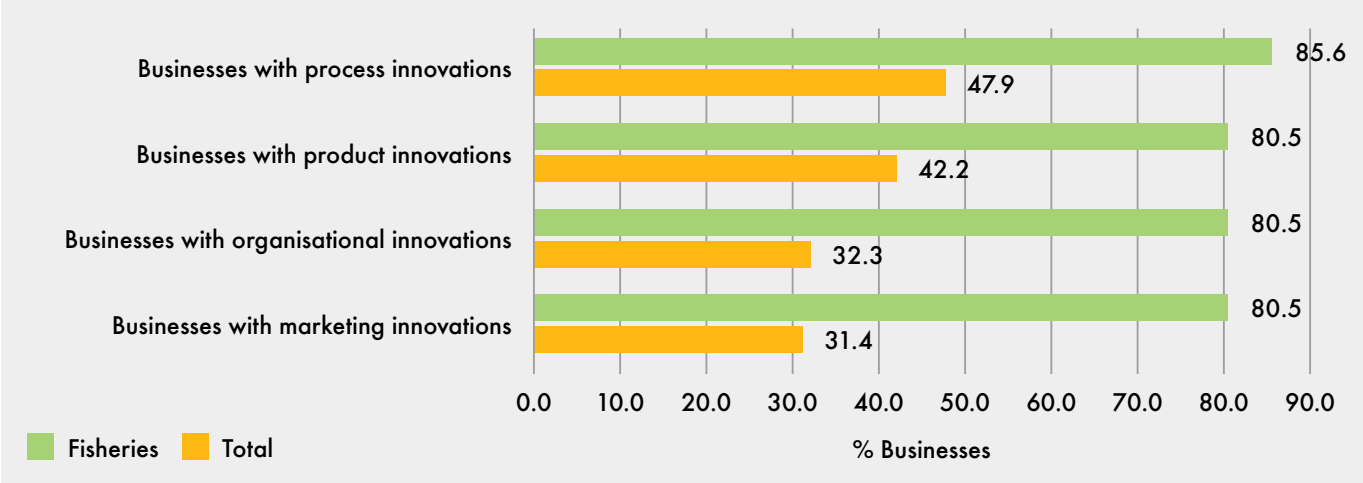
In terms of organisational structure, only 12% of innovation-active businesses reported that they owned subsidiaries outside South Africa, and only 8.2% were part of a larger group, in contrast to none of the non-innovative businesses (Appendix Table A4.2). Evidence provided on the nature of the innovations brought into use suggests that the survey sample included a larger proportion of aquaculture businesses than may be found in the fisheries sub-sector overall.

How did businesses in the fisheries sub-sector innovate?

Bearing these business characteristics in mind, we can investigate the distinctive patterns of innovation in the fisheries sub-sector, driven by the sectoral competition and innovation challenges.

What stands out, relative to data for South African agribusinesses as a whole, is that the innovation-active fisheries businesses reported very high levels of both technological—product and process—and non-technological—organisational and marketing—innovation (Figure 11). A single business may report multiple combinations of these technological and non-technological forms of innovation, and fisheries businesses reported all four types of innovation to an almost equal extent, suggesting an integrated innovation response.

Figure 11: Innovation-active businesses in the fisheries sub-sector



Source: Appendix Table A9

South African fisheries businesses were innovating to 'catch up' through building the technological capabilities required to compete locally. That is, new goods and services, processes, organisational or marketing innovations were most likely to be new to the market (84.9% of innovation-active businesses), and in a small proportion of cases, only new to the business (12.8%). None of the businesses reported innovation that was new to the world (Appendix Table A14.2).

The types of innovation strongly reflect the strategic challenges typical to the fisheries sector, in terms of achieving a balance between profit and sustainability. So, for the 85.6% of innovation-active businesses that reported **process innovation** (Appendix Table A10), these were primarily aimed at new or improved processes to improve yields (100%). An example of this type of innovation, provided by one large aquaculture business, was the introduction of automated sorting machines to improve sorting capability and accurate data recording, as well as the introduction of self-cleaning tanks that use a siphoning technology. A medium-sized deep sea fishing company claimed that glazing of the product improved with better quality equipment and training, enhancing yields.

Process innovations also aimed to ensure sustainability—to deal with the effects of climate change (91.8%) and to reduce negative environmental impacts (79.8%). An example of innovation to deal with the effects of climate change was the use of better filtration

sequences and processes, to guard against the negative effects of red tide that had significantly damaged the industry in previous years. An example of innovation to reduce negative environmental impacts was to farm an indigenous species in salt water, to reduce pressure on fresh water sources, and avoid the introduction of alien species. Nearly three-quarters of innovation-active businesses also aimed to introduce process innovations to improve logistics (73.8%). For example, a business explained that it had found a good market for an indigenous species in the local informal sector, which greatly reduced logistics and packaging costs.

The fisheries businesses surveyed recorded a very specific type of **organisational innovation**, which in all cases was accompanied by other types of innovation. Only 15% introduced new or improved business processes to enhance internal organisational functioning. Rather, all of the 80.5% of innovation-active businesses reported activity related to pursuing external linkages to access knowledge and technology from other businesses or organisations (Appendix Table A11.2). Linked to this trend, most innovation-active businesses (91.8%) reported external R&D as one of their main forms of innovation activity (Figure 12).

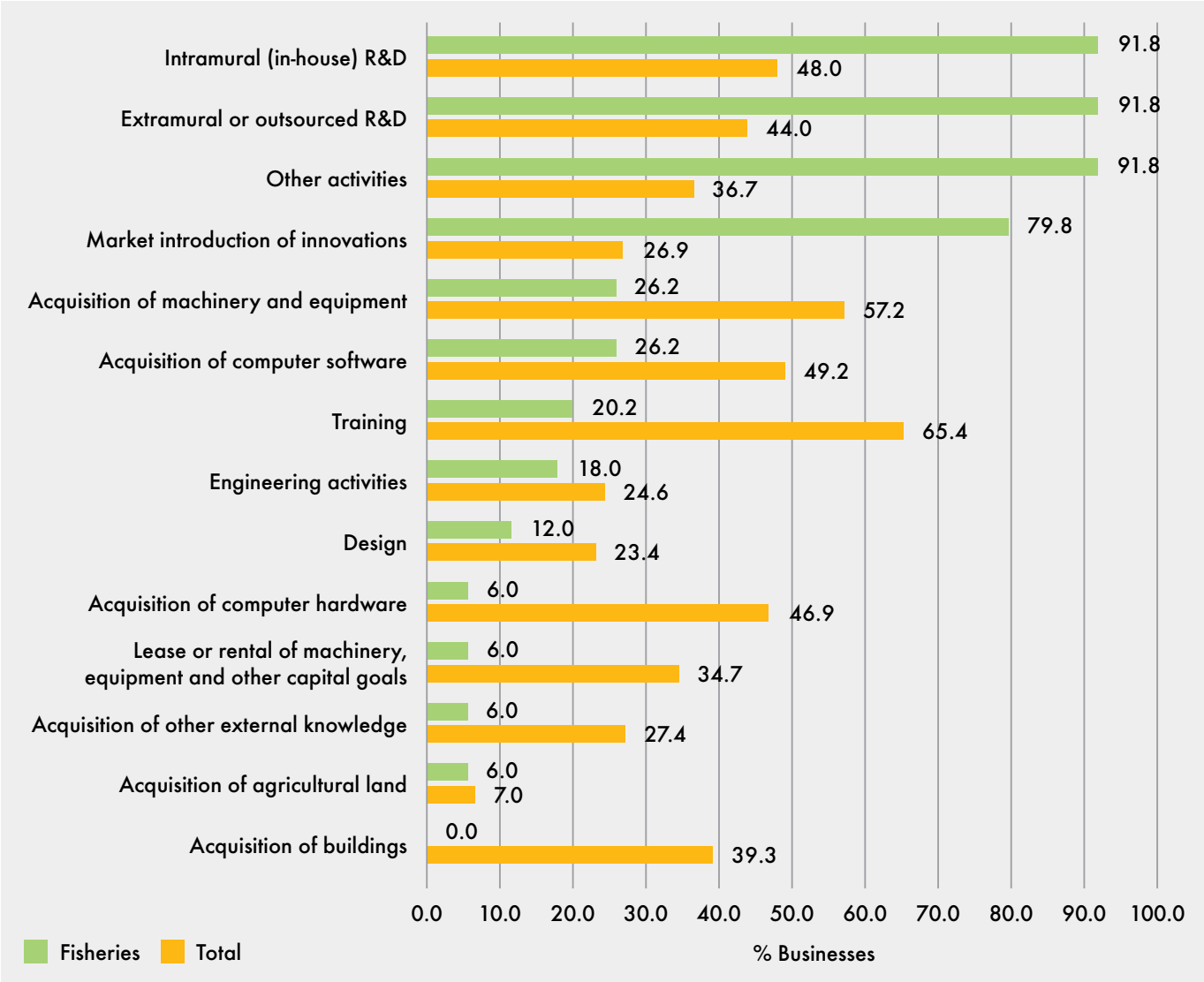
All of the 80.5% of innovation-active businesses that reported **marketing innovation** reflected new strategies to reach new markets, but a low 15% reported new methods to improve positioning, promotion and pricing of products (Appendix Table A12.2). Figure 9 reflects that 79.8% of innovation-active businesses reported the market introduction of innovations as an innovation activity.

Product innovation was more likely to be in relation to goods than services, or a combination of goods and services (Appendix Table A8.2). Businesses innovating goods reported this was in relation to 'entirely new goods only' (84.9%). Similarly, for those who reported both goods and services product innovation, 100% reported that their innovation took the form of an entirely new and improved good and/or service. We have noted that this innovation was more likely to be new to the market or to the business.

The pattern of activities reported in pursuit of these types of innovation is distinctive, in that a lower proportion of innovation-active businesses reported the acquisition of machinery and equipment, ICT hardware and software, and training that were prevalent in other sectors (Figure 12). Instead, almost all businesses reported in-house (91.8%) and outsourced R&D (91.8%), followed by market innovations (79.8%) (Appendix Table A15.2).

It is likely that internal and external R&D was focused on advanced technologies to control fish stocks, given the challenges of the sector, and the fact that 73.8% of the innovation-active businesses reported that they were developing and using capabilities for livestock biometrics (Appendix Table A18.1). A small number of businesses reported the use of air sensors, robotics and smart animal breeding (6% each). One example given of advanced technological capabilities harnessed for innovation was the use of 'water quality sensors and warning alerts to come together in an Internet of Things approach'.

Figure 12: Proportion of innovation-active businesses that engaged in specific innovation activities



Source: Appendix A15.2

How did businesses in the fisheries sub-sector benefit from innovation?

Innovation in the fisheries sub-sector primarily leads to process outcomes related to the sustainability of fish stocks. For 73.7% of the innovation-active businesses, a highly successful outcome of their innovation was increased biodiversity preservation and increased water preservation (Table 16). However, very few businesses reported that financial outcomes such as increased revenue or reduced unit production costs were highly important (6%), and very few reported marketing outcomes as highly important (Appendix Table A16.2, Table A18.1).

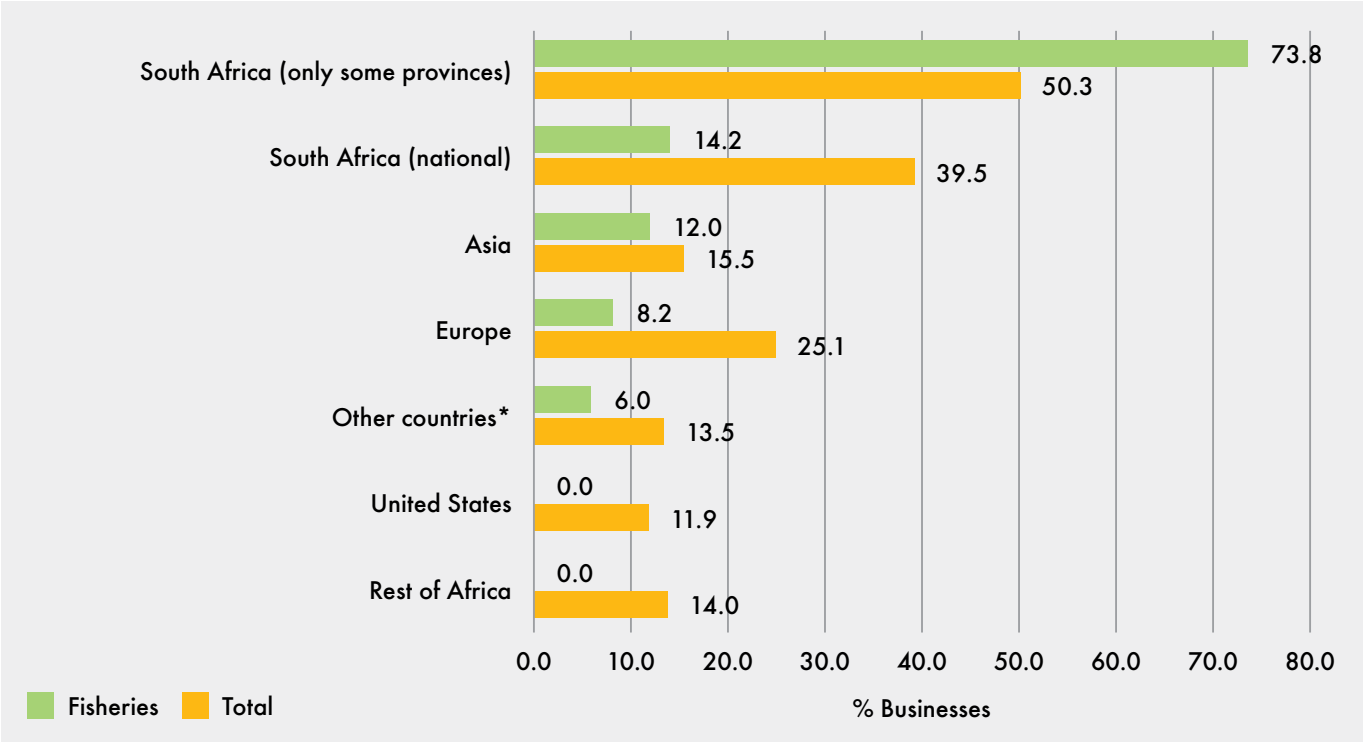
Table 16: Highly successful outcomes for product and process innovation-active fisheries businesses

Product outcomes	Total	Fisheries
Increased varieties (e.g. cultivars)	20.2	0
Increased yield (crop) / livestock / farmed birds (turkeys, chickens, pigeons, geese), fish, etc.	4.2	6.0
Strategic / marketing outcomes		
Reached new markets	13.2	6.0
Developed new intellectual property (IP)	18.4	6.0
Entered new export markets or increased export market share	7.5	
Process outcomes		
Increased biodiversity preservation	8.1	73.8
Increased water preservation	9.5	73.8
Improvement in soil fertility	23.1	0.0
Financial outcomes		
Increased revenue	5.3	6.0
Reduced unit production costs	11.8	6.0
Other outcomes		
Reduced greenhouse gas emissions	10.7	8.2

Source: Appendix Table A16.2

Markets remain localised, with most innovation-active businesses (73.8%) selling to only some provinces in South Africa, and 14.2% selling to national markets (Figure 13). Global markets remain limited, with a relatively low 12% exporting to Asia, 8.2% to Europe and 6% to other countries. Innovation is not yet strongly enabling access to global markets.

Figure 13: Geographic markets for innovation-active fisheries businesses



Source: Appendix Table A7.2

What were the enablers or constraints to innovation in the fisheries sub-sector?

We conclude that the businesses in our sample in the fisheries sub-sector have a knowledge-intensive pattern of innovation that requires strong linkages, and shapes a distinctive set of factors that facilitate or constrain innovation.

Given that R&D is a critical innovation activity, the **main sources of information** for innovation that businesses rated as highly important were external institutional sources (Appendix Table A17.2), most specifically, universities (85.8%), with a few businesses drawing on government and private research institutes and consultants (6% each). Scientific and technical journals were also significant sources of information for a large proportion of businesses (79.8%). Internal resources were not highly important for many businesses, nor were external market resources, such as suppliers (12%) or clients (18%).

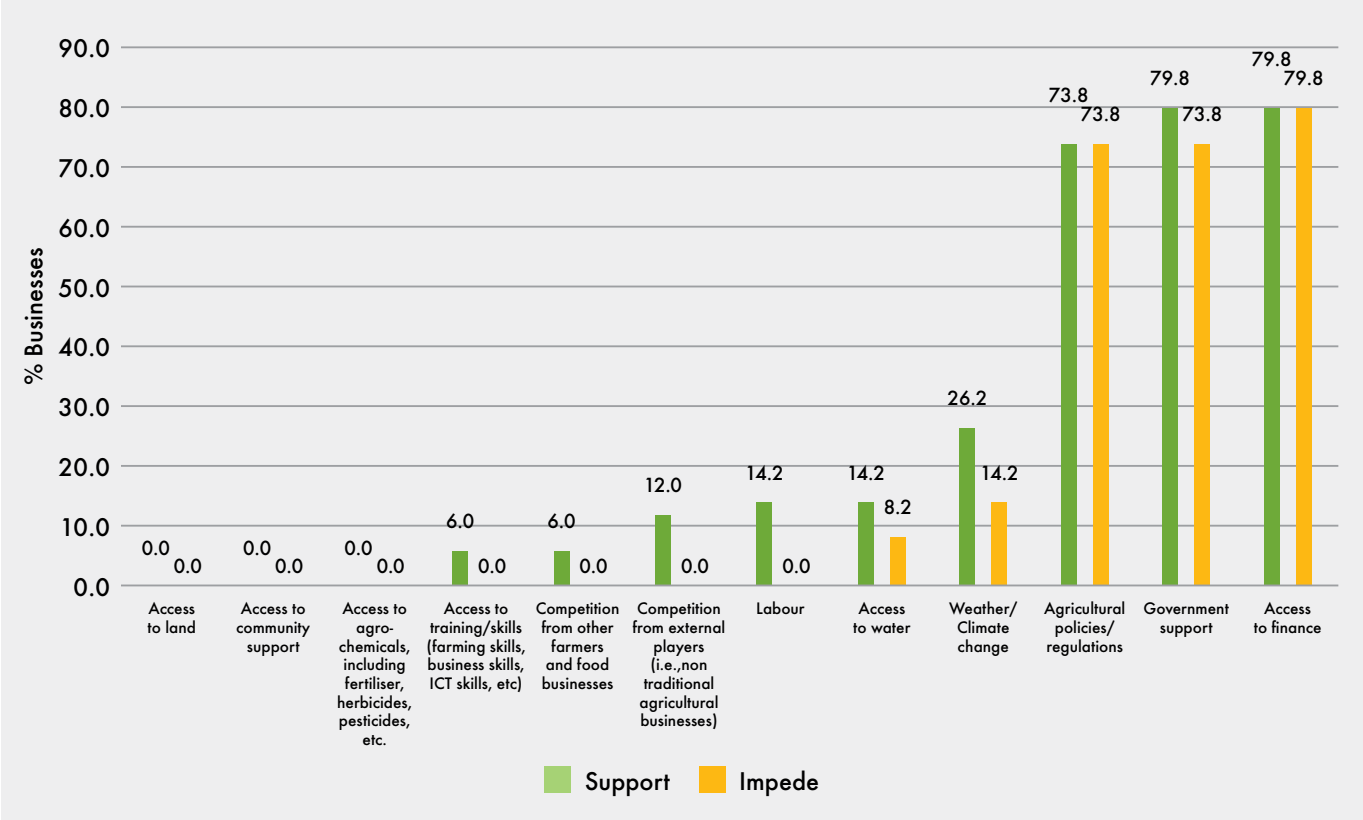
Fish stocks are a type of public good, not privately owned, with catch allocations determined by government through the issuing of licenses. Hence, two of the factors that innovation-active businesses rated as highly important to **support and promote their innovation** (Appendix A19.4) were government support (79.8%) and agricultural policies and regulation (73.8%). Conversely, where these are absent, 73.8% of businesses identified them as the most important barriers to innovation (Figure 14).

Access to finance was equally important for most innovation-active businesses, both as a facilitator and where it is absent, as a barrier to innovation (79.8%).

Almost all (94%) of innovation-active businesses were aware of the **support for innovation offered by government**, in contrast to none of the non-innovative businesses (Appendix A21). Weather and climate change were less frequently identified as highly important facilitators of innovation (26.2%), as were factors such as labour and access to water (14.2% each).

Likewise, a low 14.2% of innovation-active businesses identified weather and climate change, and 8.2% identified access to water, as highly important barriers (Figure 14).

Figure 14: Factors that impeded vs supported innovation in the fisheries sub-sector



Source: Appendix Table A19.2, Table A20.2

Where are the spaces for policy intervention?

Innovation is critical to the achievement of government's strategic goals for the fisheries sector for the period of the survey (see Notes to Guide Readers).

The businesses in our sample in the fisheries sub-sector reported high levels of innovation activities that are new to the market or the business, strongly driven by R&D types of activity and harnessing relevant advanced technological capabilities, drawing on external knowledge partners in relation to ensuring sustainable fish stocks and reducing negative environmental effects. Given the nature of the sample, these trends are more likely to reflect the activity of the aquaculture businesses than deep sea fishing businesses.

The outcomes and benefits of innovation are to increase yields and mitigate negative environmental impacts. Further policy efforts may deepen these benefits and extend them to more businesses, for greater impact.

There is space for innovation to contribute more effectively to profitability in more businesses, and to support the growth of national and global markets to a greater extent. To do so, businesses in the fisheries sector highlighted government support, the correct regulatory framework and finance as key facilitators or constraints to innovation. Coordination and support for R&D, whether conducted internally or out-sourced, and strengthening linkages with knowledge institutions such as universities, public and private research institutes is also vital. The question is whether—or how well—the existing Operation Phakisa processes of institutional support and sectoral alignment facilitate these (DAFF, 2018).

NOTES TO GUIDE READERS

DAFF strategy statement for the fisheries sector 2014-2019

'During the next five years we also aim to facilitate investment in production and to support infrastructure for aquaculture and fisheries, increase growth, income and sustainable job opportunities in the value-chain and increase market access, to improve our compliance, monitoring and enforcement efforts, maintain the productivity of fish stocks and ecosystems, rebuild prioritised fish stocks through the implementation of the stock recovery strategy for hake, abalone, west coast rock-lobster and line-fish and in all, to make fisheries services more accessible to our clients.' (DAFF, 2014: 1).

PATTERNS OF INNOVATION IN THE FORESTRY SUB-SECTOR

A very different pattern of innovation is evident in the forestry sub-sector. This points to the need for very different kinds of policy intervention.

The forestry sub-sector in context

While the forestry and forest products sub-sector contributed just 0.90% to GDP in 2018 (GCIS, 2019), it contributed 12% to manufacturing GDP (Sithole, 2017), and provided direct employment to 160 000 people (Sithole, 2017). The forestry sub-sector also contributed significantly to agricultural GDP—35.5% in 2017 (Sithole, 2017). Globally, the shift towards environmental consciousness and sustainability of the environment impacts significantly on the forestry sub-sector, in terms of demand and supply of goods and services. The global rise in energy prices coupled with government regulations to reduce greenhouse gas emissions have created challenges, but also opportunities, to innovate to meet demand while staying environmentally friendly (Weiss, 2011). In South Africa, the forestry sub-sector faces a number of challenges that significantly affect growth, including the challenge of accessing new markets (DAFF, 2012). It must tackle supply constraints, by increasing productivity from declining resources to meet growing demand. In addition, it is required to respond to socio-political and regulatory issues, including constant changes to environmental regulations.

There are three types of forestry producers in South Africa (DAFF, 2012):

1) **Commercial forestry** where 57% of the total area belongs to corporate growers, 25% to private producers, 14% to the state, and 4% to emerging farmers (DAFF, 2012).
2) **Smallholder forestry** consists of mainly small growers.
3) **Subsistence forestry** consists of smaller independent growers who mainly produce woodlots, woodlands and non-timber forest products.

A comprehensive technological innovation response is required in the South African forestry sub-sector to address the risks and challenges.

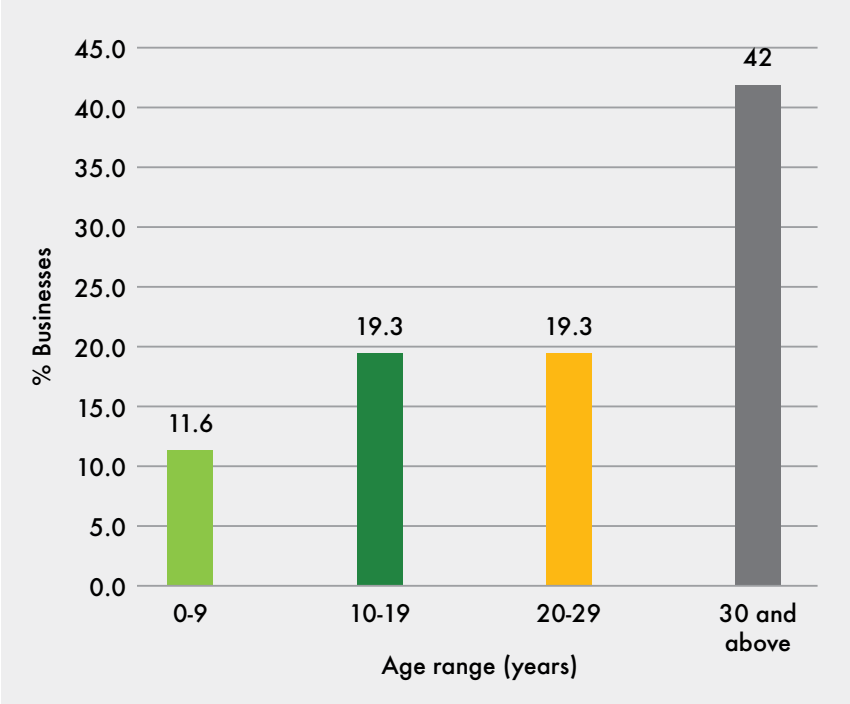
Innovation measurement can inform better policies and evidence-based policy instruments to allow for a balanced trade-off between the use of scarce resources and mitigation of resource-use conflicts to meet rising demand for forestry goods and services, as well as environmental regulations. Moreover, the management of natural resources such as natural forests and woodlands requires innovation from all actors in the forestry innovation system: forestry businesses, knowledge producers such as universities, and government institutions. Investment in innovation to build strong human capital and a strong knowledge base is critical to economic growth and sustainability.

What was the profile of innovation-active and non-innovation-active businesses in the forestry sub-sector?

In stark contrast to the fisheries sub-sector, and to the agricultural sector as a whole, a very low proportion of businesses in the forestry sub-sector, only 17.7 %, reported that they were innovation-active.

Forestry in South Africa is typically characterised as a mature, 'low-tech' industry, which is reflected in the age of the businesses in our sample (Figure 15). A large proportion of businesses (42%) were mature, and over 30 years, and a total of 61.3% were older than 20 years.

Figure 15: Age of innovation-active businesses in the forestry sub-sector



Source: Appendix Table A5

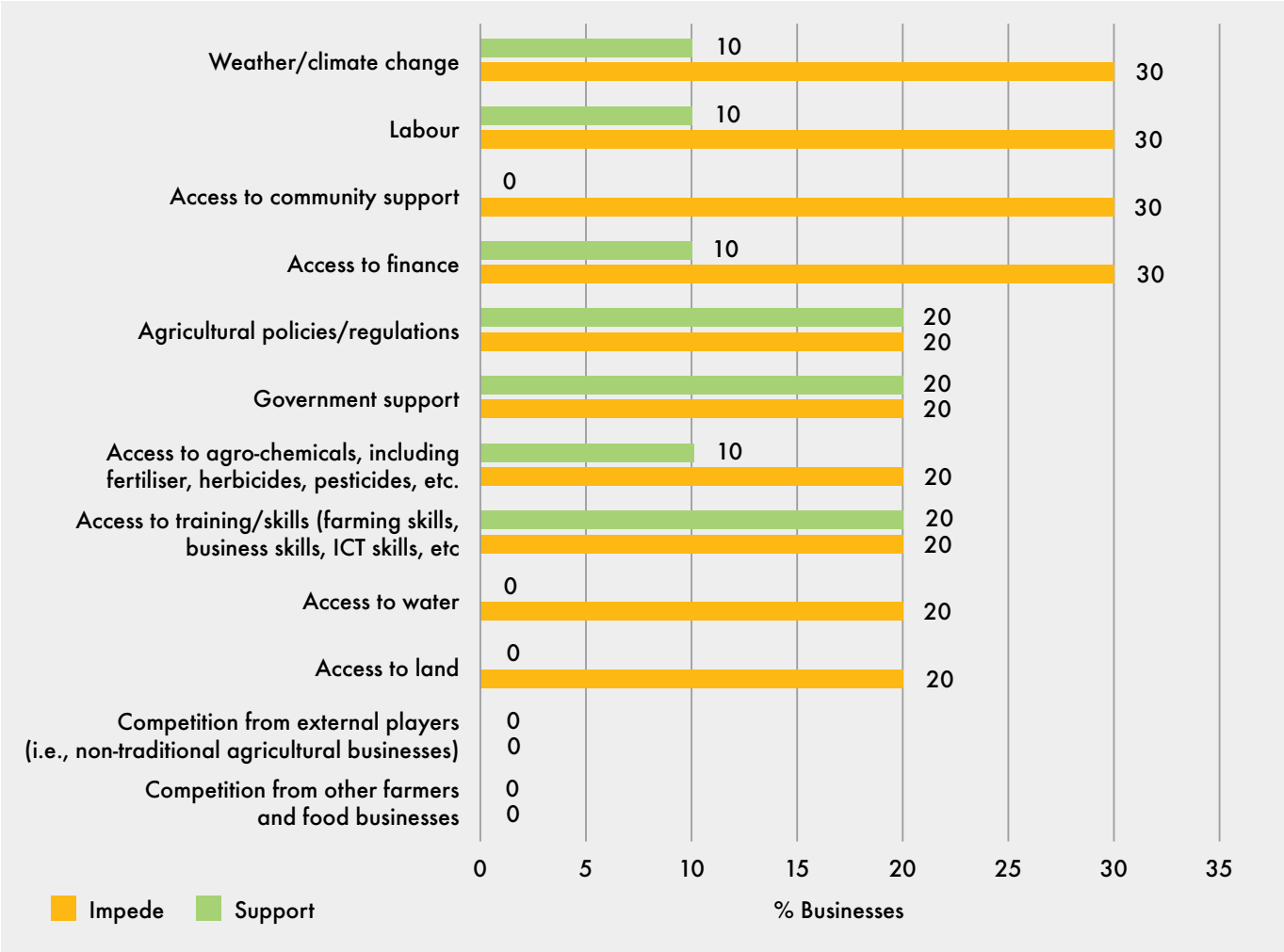
The majority of businesses in the sample (93%) were large, but large businesses were less likely to be innovation-active. While all of the small businesses reported that they were innovation-active, a small proportion of the large businesses, only 11.1% (Appendix Table B1.4), reported that they were innovation-active.[7] Small businesses (42%) were over-represented in the very small group of innovation-active businesses, with only 58% being large businesses.

What were the enablers and barriers to innovation in the forestry sub-sector?

A high proportion (82.3%) of forestry businesses reported that they were not innovation-active. For policy purposes it is essential to understand why businesses do not innovate by analysing the factors that non-innovation-active businesses report as impeding or supporting innovation. Understanding why non-innovation-active businesses do not innovate can help shape policies that may remove the impediments to innovation in businesses. As such, Figure 16 shows the different factors that non-innovation-active businesses rated as highly important, to either facilitate or impede their innovation. What stands out is the generally low proportion of businesses that rated any of these factors as highly important, particularly in comparison with the innovation-active businesses (Figure 17). Another feature that stands out is that fewer of these factors were rated as highly important barriers, with five factors not rated highly important at all. Most significantly, competition, which is typically a driver of innovation, was not a highly important facilitator or constraint at all, whether competition from farmers or non-agricultural businesses. In contrast, 57.4% of innovation-active businesses rated competition as a highly important barrier to innovation (Figure 17). This trend points to business dynamics that require further investigation.

[7] Due to missing data, a comparison could not be drawn between larger and smaller businesses.

Figure 16: Factors that supported vs impeded innovation in non-innovation-active forestry businesses



Source: Appendix Table A19.4 and A20.4

The non-innovation-active businesses rated a mixed set of factors as highly important to promote or support innovation, ranging from finance to weather, labour and community support (30% each).

Finance is typically understood to be essential to innovation, but the data suggest it was not the most important barrier or facilitator. Like the 30% of non-innovation-active businesses, a smaller proportion of innovation-active businesses considered access to finance as a highly important factor promoting (31.0%) or impeding (27.1%) innovation.

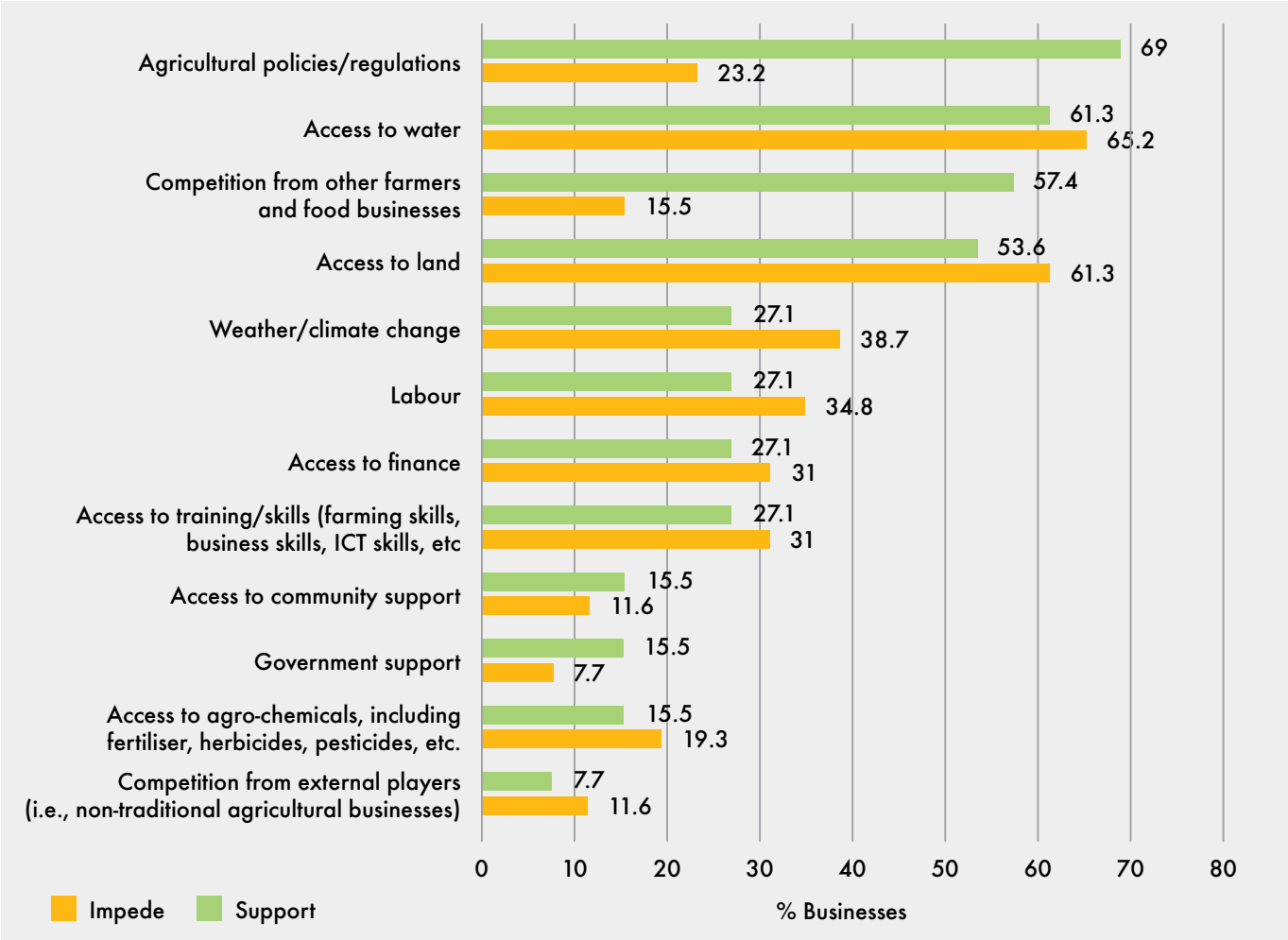
Responding to environmental issues is a potential driver of innovation for non-innovation-active businesses. The data reflect that 30% of non-innovation-active businesses rated weather and climate change as highly important factors that could promote innovation, while 10% of businesses rated these as highly important barriers to innovation. Again, a similar proportion of innovation-active businesses rated weather and climate change as a potential facilitator of innovation.

Agribusinesses in general depend on two main resources—access to land and access to water. Some 20% of non-innovation-active businesses rated these two factors as potentially promoting innovation (Figure 16). In contrast, 61.3% of innovation-active

businesses rated access to water (61.3%) as a highly important factor impeding their innovation (Figure 17), and 65.5% of innovation-active businesses rated access to water as a highly important factor that promoted innovation (Appendix A19.2).

Knowledge factors (access to training and skills, whether farming, ICT or business) were seen as important impediments to and promoters of innovation for 20% of non-innovation-active businesses (Figure 16). The pattern for innovation-active businesses was similar (Figure 17). Institutional factors (government support, and agricultural policy and regulations) were more likely to be highly important, as both barriers and potential facilitators, for some 20% of non-innovation-active businesses (Figure 16). The continuous change in government environmental regulatory policies was reported to impede innovation in innovation-active forestry businesses. This was identified as the most important barrier for 69% of innovation-active forestry businesses (Figure 17).

Figure 17: Factors that supported vs impeded innovation in innovation-active forestry businesses



Source: Appendix Table A19.2, Table A20.2

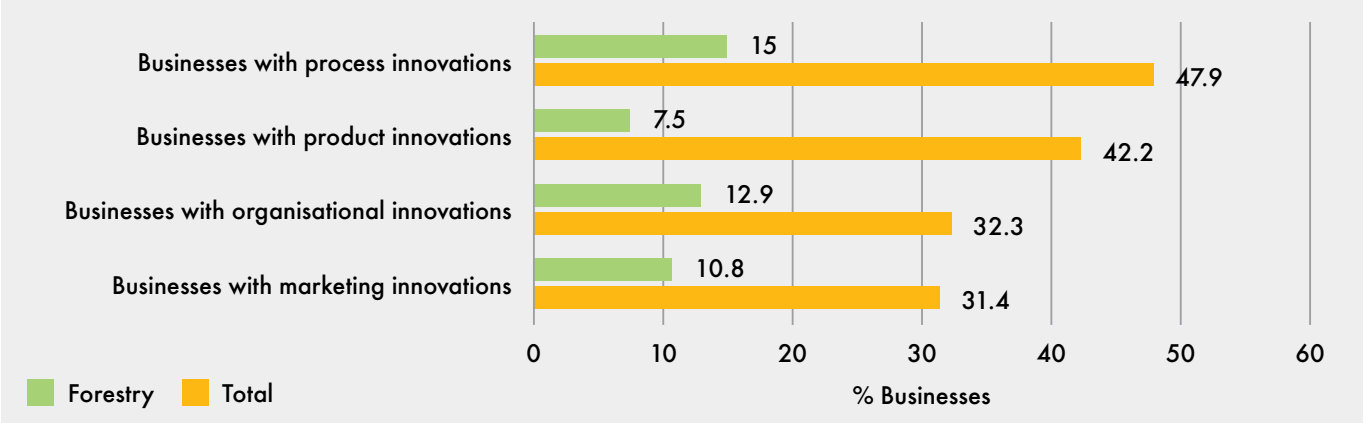
The South African government supports innovation in businesses through mechanisms such as funding and tax incentives, but there was a strong lack of awareness of these in the forestry sub-sector. Very few innovation-active businesses were aware of the **support for innovation offered by government** (15.5%), though a larger proportion of the non-innovative businesses (30%) were aware of what was on offer (Appendix A21). If businesses are aware of what support government offers, but are not innovating, this raises questions about the fit between the innovation needs of businesses and the support instruments offered.

How did businesses in the forestry sub-sector innovate?

Only a low 17.7% of forestry sub-sector businesses were innovation-active, but further insight may be gained from analysing the patterns of innovation that do exist. Innovations in forestry typically occur within the first phase of the value chain, that is, forest management activities, and this shapes the patterns of innovation (Weiss, 2011).

Both technological and non-technological innovation activity were quite low in the forestry sub-sector, relative to all agribusinesses surveyed (Figure 18). Where it does take place, the most prevalent innovation type is process innovation, performed by 15% of all businesses, in contrast with 47.9% of all South African agribusinesses (Appendix A9).

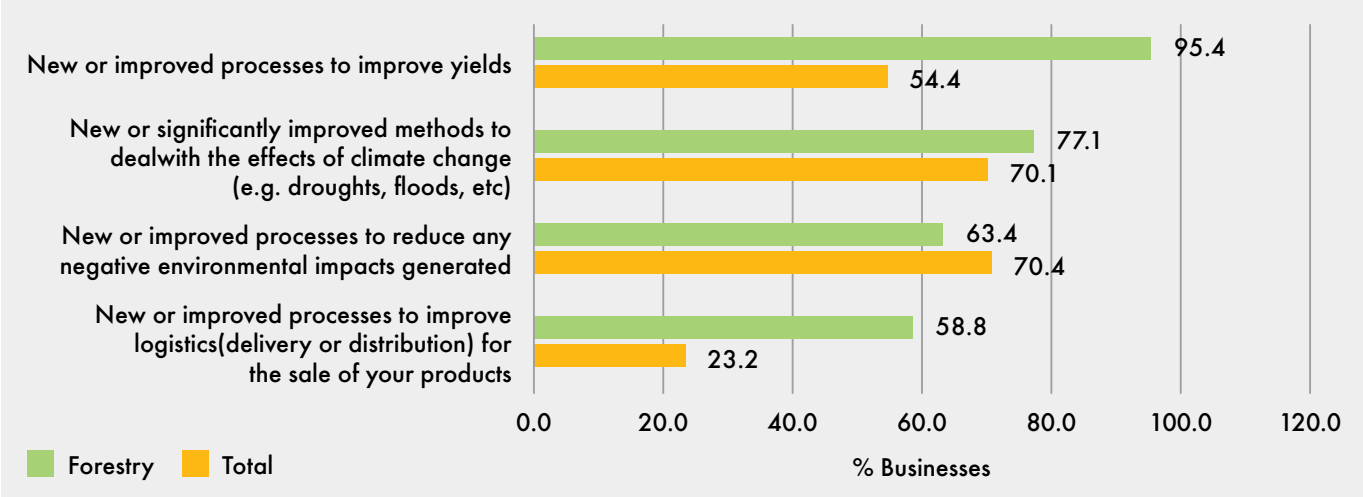
Figure 18: Different types of innovations in the forestry sub-sector



Source: Appendix Table A9

Of the low 15% of businesses that reported **process innovation**, most activity was aimed at new or improved processes to improve timber yields (95.4%), to deal with the effects of climate change (77.1%) and to reduce negative environmental impacts (63.4%) (Figure 19).

Figure 19: Businesses with specific process innovations (as a percentage of all process innovators)



Source: Appendix Table A10

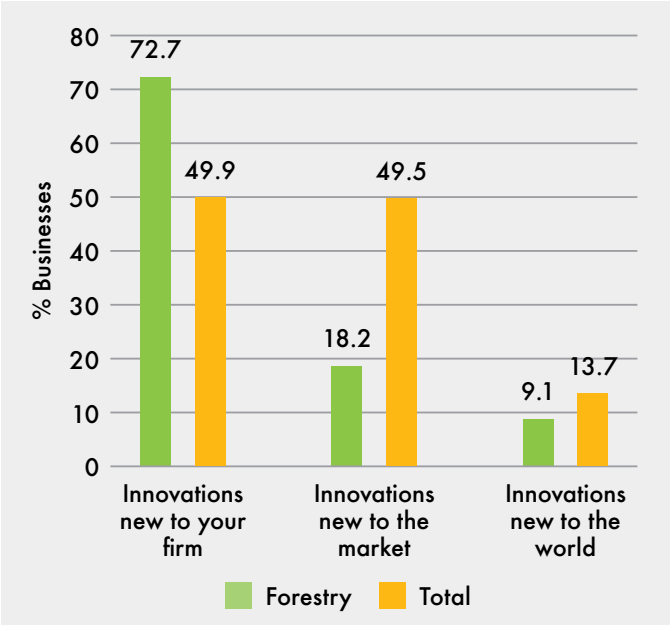
The examples of the process innovations businesses performed (see Notes to Guide Readers) reflect the focus on improving yields and reducing negative environmental impacts in the forest management phase.

Only 12.9% of the small group of innovation-active businesses introduced **organisational** innovations and, as in other sub-sectors, were most typically accompanied by other types of innovation. Most were geared towards the introduction of new or improved business processes to enhance internal organisational functioning (94.7%). For example, one business reported the development of a new integrated system for procurement and electronic approvals to ensure quicker turnaround in order delivery.

Similarly, there was a clear pattern for the 10.8% of innovation-active businesses that reported **marketing innovation**: 93.7% engaged in marketing activities or new methods to improve the positioning, promotion or pricing of their products. Only 25.2% also reported marketing methods to help reach new markets (Appendix Table A12.2). Hence, only 3.9% of innovation-active businesses reported the market introduction of innovations as an innovation activity (Figure 20).

A very small number of innovation-active businesses (7.5%) performed **product innovations**, and of these, 72.7%, were most likely to be new to the business only (Figure 20), while only a handful (9.1%) reported innovation that was new to the world (Appendix Table A14.2).

Figure 20: Novelty of product innovations in the forestry sub-sector



Source: Appendix Table A14.2

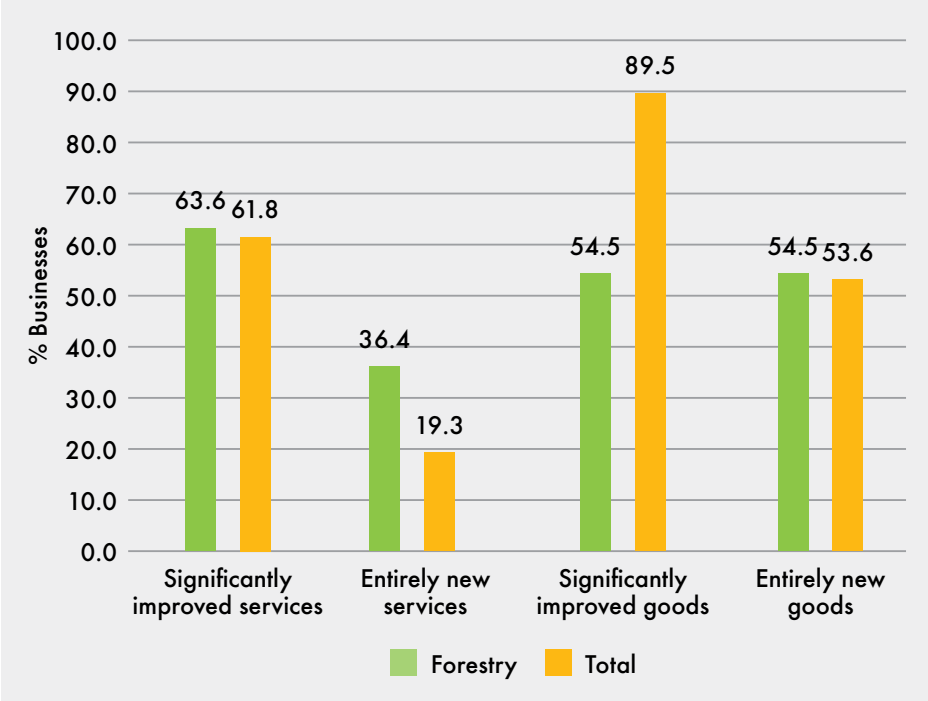
NOTES TO GUIDE READERS

Examples of process innovations reported by forestry sub-sector businesses

- Introduction of mechanical mulching to reduce plantation debris before planting, usually done by hand or removed by means of controlled burning operations
- Introduction of hybrid clonal into timber planting
- Introduction of more cold tolerant clones to produce a higher yield.
- Biomass increased with leaf sampling and combined soil analysis to apply fertigation more precisely
- Mulching planting residues and not burning bush
- High impact grazing with cattle
- Introduction of mechanised planting equipment and weed control equipment
- New clonal materials with higher yields
- Mechanised silviculture operations
- New mechanical harvesters and forwarder
- Minimized waste through better/ improved sawing technology
- Improved boiler efficiency through automated controls

Product innovation in a mature low-technology industry tended to be incremental, primarily taking the form of **significantly improved services** (63.6%) (Figure 21). A simple example is improving the transport of cut logs more quickly to factories, for manufacturing in the next phase of the production value chain.

Figure 21: All product innovations in the forestry sub-sector



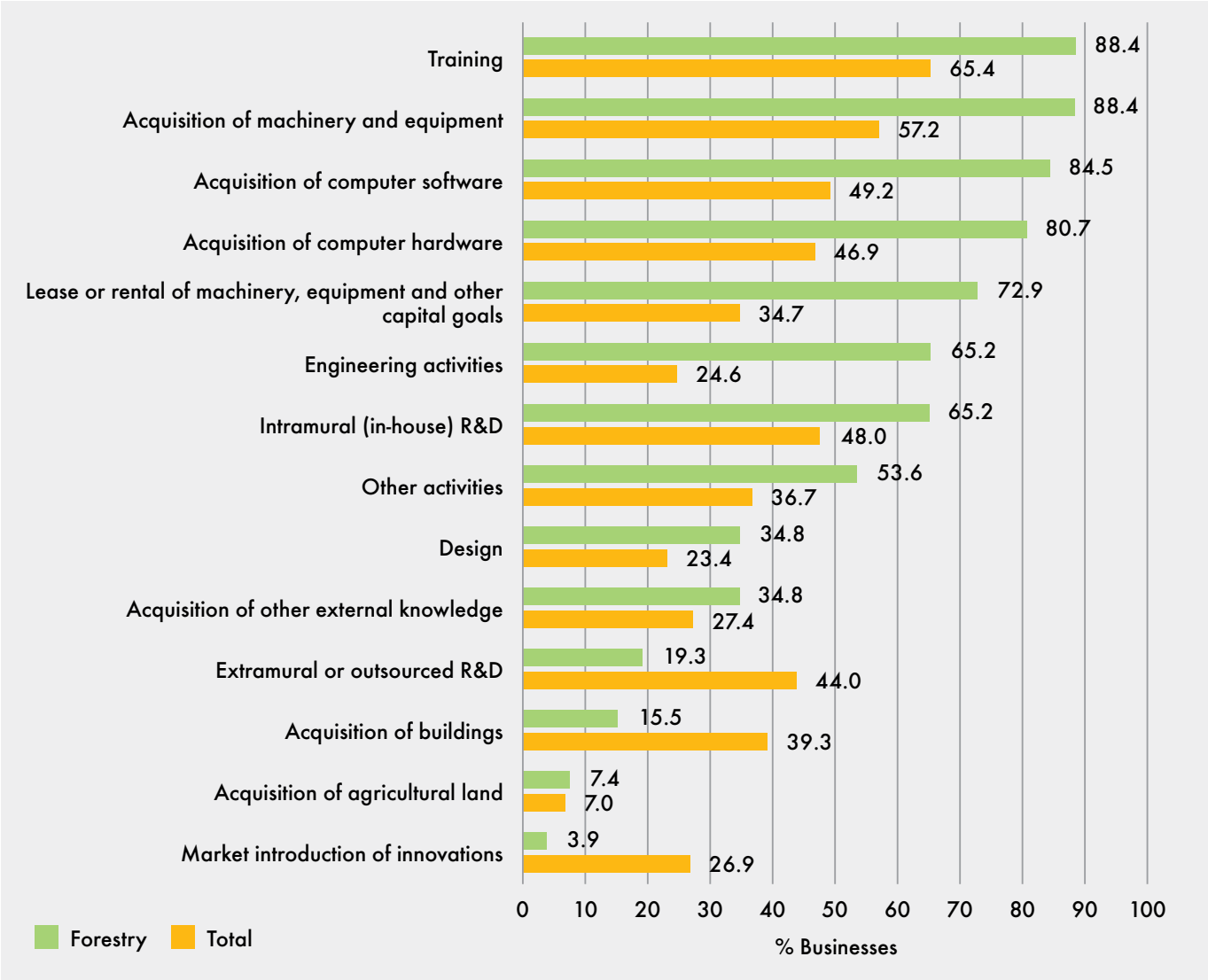
Source: Appendix Table B8.2 in (Additional) B8.1-2

The pattern of innovation activities largely mirrors the pattern of the agribusinesses as a whole, but reflects the fact that forestry businesses were seeking better and more efficient ways of planting, harvesting and processing trees, as well as logistical solutions for advanced manufacturing (Figure 22). Most of the small number of innovation-active businesses reported training of their employees (88.4%), acquisition of machinery (88.4%), acquisition of computer software (84.5%) and hardware (80.7%) as their main activity, but to a greater extent than all agribusinesses surveyed (Appendix Table A1.24). Forestry businesses differed in that lease and rental of machinery and equipment, engineering activities and in-house R&D were also significant innovation activities, to a greater extent than all agribusinesses surveyed. There was relatively little acquisition of external knowledge (34.8%) or outsourced R&D (19.3%), suggesting a sector that largely meets its own knowledge needs.

The development and use of advanced technologies to help with the production of trees and the sustainability of forests has lagged behind the practice in other sectors. For example, less than 20% of the small number of innovation-active businesses reported the use of sensors, drone technologies and smart plan breeding. These trends suggest that in a mature industry, with low levels of technological innovation, only a small number of businesses recognised the need to grow by using high technologies as the source of competitiveness.

Innovation-active businesses in the forestry sub-sector tended to acquire information to innovate from within their own group (almost 50%), given the dominance of a few large businesses with many subsidiaries. External market resources were equally important, for 53.6% of innovation-active businesses, in the form of suppliers of equipment, materials, components or software. This result is to be expected, given a pattern of innovation activity dominated by the acquisition of machinery, hardware and software (Figure 22). Logically, innovation-active businesses would need information from their suppliers to operate the acquired machinery, hardware and software.

Figure 22: Proportion of innovation-active businesses that engaged in specific innovation activities in forestry sub-sector



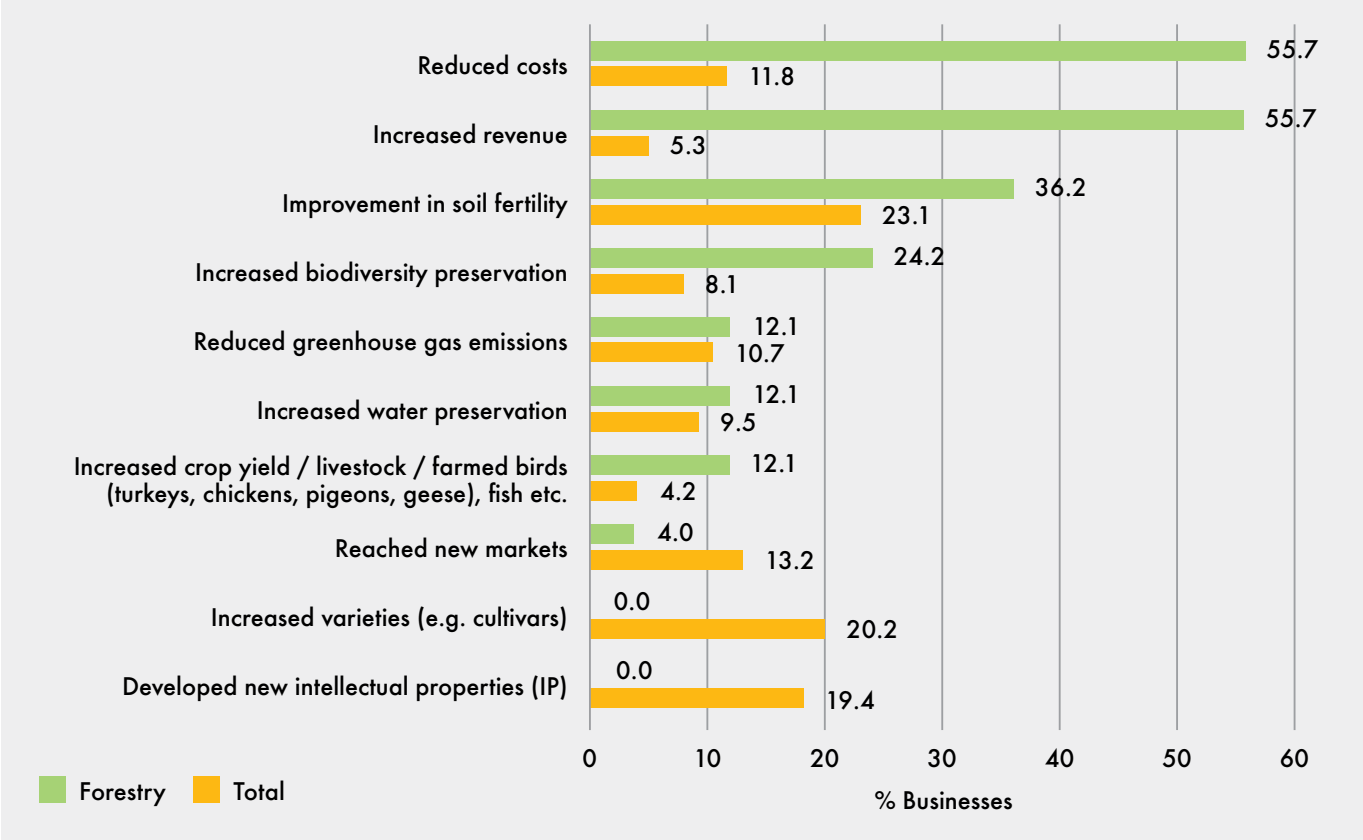
Source: Appendix Table A15.2

How did innovation-active businesses in the forestry sub-sector benefit from innovation?

Most of the small group of innovation-active forestry businesses (84.5%) sold their goods to local markets only in some provinces in South Africa. Almost half of all innovation-active businesses (49.7%) sold their goods and services to national markets (Appendix A7.2). Innovation-active businesses reported very limited access to global markets, with no reported markets in Asia, Europe or the US. Only 6% of innovation-active businesses reported selling goods to other countries.

Innovation in the forestry sub-sector primarily led to highly successful outcomes related to the profitability of businesses, by increasing revenue (55.7%) while reducing costs, as reported by 55.7% of innovation-active forestry businesses (Figure 23). This indicates that, as a result of innovation, forestry businesses were able to increase their profits to a greater extent than the total sample of businesses studied. Innovation also appeared to be contributing to forest sustainability, particularly improvement in soil fertility (36.2%) and preserving biodiversity (24.2%) (Appendix Table A16.2).

Figure 23: Highly successful outcomes for innovation-active forestry businesses



Source: Appendix Table A16.2

Scale: High=3, Medium =2, Low =1, Not relevant =0 High=3, Medium =2, Low =1, Not relevant =0[8]

[8] Only highly successful outcomes were used because the survey is only interested in the most prominent highly successful factors.

What are the spaces for policy intervention?

Less than 20% of forestry businesses innovated, and these were more likely to be small businesses, or long-established large businesses that form part of a business group. The barriers to innovation that were identified ranged from financial and institutional to skills, resource and environmental constraints. As such, it may be difficult to identify which of these are a priority, to focus interventions more effectively and strategically. The significance of regulatory frameworks and government support suggests a key starting point for innovation support. Competition was not viewed as a barrier or facilitator, and perhaps a greater opening up of the sector to new players could be a driver of innovation.

Where businesses did innovate in this mature, traditionally low-tech sector they were more likely to implement process innovations in the early phases of the value chain, to improve yields and ensure sustainability. Forestry businesses sought better and more efficient ways of planting, harvesting and processing trees, as well as logistical solutions for advanced manufacturing. Most investment was in innovation activity to acquire technology, and R&D was largely in-house, suggesting a sector that largely meets its own knowledge needs. The fact that they were less likely to adopt new digital technologies is another potential area for intervention.

PART 3: SPACES FOR POLICY INTERVENTION

Part 3:

- **Presents** the distinctive patterns of innovation found in South African agribusinesses.
- **Identifies** key policy questions for consideration by decision-makers from government, business, research and training institutions, and civil society.

POLICY PATHWAYS

The current economic, environmental and health challenges make it imperative that South African agribusinesses do more of the right kinds of innovation. Support must focus on innovation that harnesses new technologies to enhance yields sustainably for the future.

A distinctive pattern of innovation?

Part 1 of this report analysed trends for all South African commercial agriculture, forestry and fisheries businesses at a high level, and disaggregated the data to reveal patterns of innovation in businesses by sub-sector and size class. It is evident that the nature, outcomes and facilitators of innovation differed between the three sub-sectors. As such, distinctive support interventions and incentives may be needed. The sub-sectoral case studies in Part 2 illuminated the nature of how businesses innovated, and what facilitated and constrained their innovation activity, so that they remained competitive and sustainable. Such evidence is invaluable to inform policy making to strengthen the agricultural innovation system so vital to food security and livelihoods.

A key overall survey finding is that there was a distinctive pattern of innovation in South African agribusinesses in the 2016-2018 period. We describe this pattern in terms of its seven features.

Features of innovation in South African agribusinesses

1. Most innovations were incremental and new to the business or market, rather than radical or new to the world.
2. Most agribusinesses implemented technological (product and/or process) innovations.
3. Most agribusinesses performed process innovations more frequently than product, marketing or organisational innovations, but often these were in combination with one another.
4. Innovation activity most frequently took the form of investment in technology, such as the acquisition of machinery, computer hardware or computer software, and training to enhance process innovation.
5. Agribusinesses innovated by adopting new and advanced digital technologies to enhance yields.
6. Although agribusinesses drew on a wide range of sources of information to innovate, they were more likely to draw on market or internal sources, than institutional sources. Private research institutes and universities were more important than public research institutes.
7. Outcomes related to increased variety and biodiversity, but increased yields or financial benefits were not as prevalent as may be desired, although the importance of intellectual property outcomes points to areas for growth.

Policy questions

A large proportion of businesses in South Africa's commercial agriculture, forestry and fisheries sub-sectors were innovation-active in 2016-2018. The most important outcomes of their innovation were improvements in the environmental conditions for production and sustainability, including, for example, improvements in soil quality and water preservation. Innovation also led to increased varieties and greater yields from farming activities. It enabled some businesses to reach new markets, including for export, reduced unit production costs, and increased revenue. Key policy questions can be crafted from the survey findings, to foster informed discussion and debate on the future of innovation for South African agribusinesses.

Policy question #1: Do our STI policy instruments support existing innovation activity in South African agribusinesses as effectively as they could?

- **How can we deepen business learning so that the acquisition of new machinery, computer hardware and software supports inter-related forms of product, process and organisational innovation on a wider scale?**
- **How can we promote and support the adoption of advanced digital agricultural technologies to more businesses across the agricultural sector?**
- **How can we deepen linkages across the agricultural system of innovation, so that more South African agribusinesses draw on the available institutional sources of information, in universities and public and private research institutes?**

Policy question #2: Are there types of innovation that do not occur on a wide enough scale that we should promote systematically?

- **How can we promote more product innovation of goods and services adapted to the context-specific environmental conditions in South Africa?**
- **How can we promote more marketing innovation to businesses to support the growth of access to new markets, both local and export?**

Our disaggregation of the innovation trends in the three component sub-sectors—agriculture, forestry and fisheries—confirmed that each sub-sector has its own, very different pattern of innovation, shaped by sectoral economic and competitive challenges as well as environmental and social urgencies. To strengthen the value of the policy evidence, it was important to construct profiles of innovation in each sub-sector. Such analysis could lay the basis for more effectively targeted policy strategies.

We found that businesses in the fisheries sub-sector, where there is a recent government-driven attempt to grow an aquaculture industry, were the most innovation-active. Innovation tended to be new to the market or the business, strongly driven by R&D-type activity and harnessing relevant advanced technological capabilities, drawing on external knowledge partners, to ensure sustainable fish stocks and reduce negative environmental effects.

In stark contrast, the forestry sub-sector reflected a high proportion of large, long-established businesses that did not innovate. Where businesses innovated, innovation focused on a very specific part of the value chain, related to the propagation of trees. The challenge is to support the existing demand for process and organisational innovations more effectively, and to promote more product and marketing innovation, to more businesses in the industry, across the entire value chain.

Policy question #3: What are the different strategies required to promote the distinctive patterns of innovation in different agricultural sub-sectors?

- **How can the forestry policy and regulatory framework and strategies foreground and promote innovation more effectively across the sectoral value chain?**
- **How can the agricultural training and skills development system contribute more effectively to busines-level technological capability building in the forestry sub-sector?**
- **How can new forms of innovation that support the growth of national and global markets be promoted to a greater extent in more fisheries businesses?**
- **How can coordination and support for R&D-driven innovation and linkages be strengthened in the fisheries sub-sector?**

Policy question #4: Do we need different agriculture-specific funding instruments to support different kinds of innovation—R&D-led, technological upgrading and non-technological forms—in a more targeted manner, in different agricultural sub-sectors?

Analysis of the data also yielded critical insights from businesses themselves, on the factors that facilitated and constrained innovation. Finances and funding were highly important as barriers to innovation for many South African agribusinesses, both innovation and non-innovation-active. Almost two-thirds of businesses were not aware of government funding support for innovation. Aside from finance, the most important barriers were resource and environment related, such as access to water and climate change. Institutional factors, such as policy and regulatory frameworks and government support, were also important barriers for all businesses, as were knowledge barriers such as labour and training. Market factors related to competition were not highly important barriers for innovation-active or non-innovation-active businesses.

Many of the factors that businesses identified as impeding or facilitating innovation can only be addressed in coordination with other government departments, and other actors in the agricultural system of innovation.

Policy question #5: How can DSI coordinate and align its policy, strategies and interventions with other stakeholders in the agricultural system of innovation, in related government departments, science councils and universities, and industry associations, to address the barriers and constraints?

- **How can the departments responsible for agriculture, forestry and fisheries promote innovation more effectively in sectoral strategies and regulatory frameworks, in collaboration with DSI?**
- **How can agents responsible for environmental conditions work with all South African agribusinesses on strategies to mitigate the impact of climate change?**
- **How can actors responsible for education, training and skills work with South African agribusinesses to promote the needs of specific agricultural sub-sectors?**
- **How can the Department of Trade, Industry and Competition coordinate with agricultural and innovation agencies to mitigate the impact of market barriers and promote competition and access to new markets?**

Way forward

In conclusion, this report experimented with different kinds of descriptive analysis, to illustrate how South Africa's new agricultural innovation data may be used to identify gaps and spaces for policy intervention. There is much more advanced analysis that remains to be done. For example, a critical next step is to conduct econometric analysis to assess the effect of innovation on agricultural productivity. An explanation of the methodology and reflections on ways to improve on the baseline survey in future cycles are included in a methodology section that follows, and the full data set accompanies this report as a downloadable Microsoft Excel spreadsheet. These provide a resource for other users to explore further policy and research questions on innovation in the agricultural sector. We encourage policy makers and business stakeholders to use the baseline 2016-2018 data, and our analysis of innovation patterns, to interrogate how existing policy instruments and funding mechanisms can better promote, support and facilitate the existing—and desired—forms of agricultural innovation in South Africa.

METHODOLOGY

Survey design

The first three editions of the OECD Oslo Manual, on which the South African Business Innovation Survey is based, mainly focus on the manufacturing and services sectors, and largely exclude the agriculture sector. At the time of the design of the survey, the framing of a broader definition of innovation in the new Oslo Manual (2018) was not yet tested in terms of whether it could adequately cover the data requirements to measure innovation in the agriculture sector. Hence, the first step in the design of the baseline Agri-BIS 2016-2018 project was to adapt the Oslo Manual (2005) approach to the purpose.

From the outset, the survey design team drew on the wealth of expertise and experience among multiple stakeholders in South Africa's agricultural sector, including partners in government, universities, public research institutes, industry associations and agricultural bodies. By working closely with these groups at all stages of the research cycle, including research design, data analysis, and dissemination, the survey aimed to be inclusive of and responsive to the needs of the sector.

In its execution, the study supplemented stakeholder knowledge and ideas by assessing previous research studies on agricultural innovation systems from other countries, to adapt the standard Oslo innovation survey design and methodology.

There are precedents for measuring innovation in agriculture in other countries of the global South, particularly Latin America (Ariza *et al.*, 2013; Baraniak, 2018). These studies were interrogated to inform the proposed South African approach. In particular, an analytical framework developed in Colombia by Ariza *et al.* (2013), based on the object-based approach of the Oslo Manual, was used. The Colombian approach was based on the Oslo Manual classification of innovation as product, process, organisational and/or marketing. The purpose was to understand the complex patterns of innovation behaviour by South African agribusinesses better, given that agricultural goods or services, and business processes, cut across multiple sectors. Ariza *et al.*'s framework allowed in-depth profiling of agricultural innovations across multiple agricultural products and processes in selected sub-sectors in the production phase of the agricultural value chain.

Based on existing practice in South Africa, and given limited time and resources, the baseline survey used the subject-based approach of the Oslo Manual, drawing on Ariza *et al.* (2013) to adapt survey questions suitable for the agriculture sector. The approach adopted was to measure innovation at agricultural business level. The benefit of such an approach for a baseline study was the ability to generalise to the entire population.

To take into account the variety and diversity of agricultural activity in Colombian agricultural businesses, innovations were profiled at crop level. The South African approach was different, in that innovations were profiled at a higher level of aggregation: for the agriculture, forestry and fisheries sub-sectors. Profiling at crop-level was not possible, given that this required highly detailed information from respondents, increasing survey burden, and hence, is more suited to investigation using a case study approach at a later stage.

Sampling, collection and response

In terms of coverage, the South African Agri-BIS 2016-2018 included three main sub-sectors at the higher level of aggregation, namely: agriculture (e.g. crop producers, wineries, livestock and poultry farmers, and the like), forestry, and fisheries.

A sample was drawn by Stats SA, using SIC codes 11, 12 and 13, with representative sample sizes of 1 514 for the agriculture sub-sector, 95 for the forestry sub-sector and 81 for the fisheries sub-sector, giving a total sample of 1 690 businesses. The BIS 2014-2016 covered agri-food businesses (food, beverages and tobacco) under the manufacturing sector (SIC 3) and, hence, these were not included in the sample.

Agri-BIS 2016-2018 indicators were adapted from the current set of standardised business innovation indicators. The standard CIS-like survey questions were adapted to be more agriculture specific and relevant, drawing on inputs from stakeholders and the literature. For example, the factors that promote or constrain innovation are distinctive, and new items were designed to assess the adoption of new digital technologies specific to the agriculture sector, such as crop sensors, precision engineering and livestock biometrics. The order of questions was changed, and fewer questions were included than the typical BIS, to accommodate the likely response of respondents in farming businesses.

A process of sample cleaning identified 364 of the initial sample of 1 690 businesses to be invalid. These businesses were either not identifiable or traceable through several methods, duplicates or inactive businesses. Invalid businesses were excluded from the original sample, resulting in a final survey sample of 1 326 businesses.

Online digital tools were used to conduct data collection. In particular, MailChimp was used for dispatch and to direct potential respondents to either:

- an online questionnaire created in the REDCap survey tool licensed by Vanderbilt University to the Human Sciences Research Council
- a downloadable Adobe form (with English and Afrikaans translations available).

MailChimp and REDCap were also used to monitor the status of questionnaires, in terms of whether respondent contacts had opened a survey request email, or whether filing of the questionnaire had been attempted or completed. This enabled informed, targeted, and efficient fieldwork follow up.

In a difficult business climate, 303 businesses responded to the survey over a short and intensive fieldwork period of three months in 2019. On this basis, the survey achieved an overall response rate of 22%.

Non-response survey

A simple random sample non-response survey, covering 15% of all the businesses that did not respond to the survey, was conducted, as recommended by the Oslo Manual (OECD and Eurostat, 2005) for surveys that achieve response rates of less than 70%. The purpose of the non-response survey was to correct for any bias that might arise due to businesses that did not respond to the survey being less or more innovative than those businesses that responded. The non-response survey covered 117 businesses, and achieved a response rate of 74.3%.

Data quality

An assessment of the quality of the survey was conducted using selected quality indicators of the South African Statistical Quality Assessment Framework (SASQAF). Table 17 presents a summary of the assessment.

The correction for bias due to non-response was implemented by adjusting the probability weights that are used to extrapolate the sample results to the target population of businesses. The weights-adjusting methodology, applied here, first adjusts the target population for invalid businesses (businesses that were not traceable or found to have merged or been liquidated), based on the sample results. The results from the survey were then extrapolated to the adjusted target population of South African agribusinesses in the three sub-sectors and size classes of large, medium, small and very small businesses.

Table 17: Assessment of survey in line with SASQAF-LITE quality dimensions

Quality dimension	Survey methodology / quality indicator	Assessment
Selected SASQAF-LITE quality dimensions		
Methodological soundness	Adaptation of questionnaire and review	Guided by the third edition of the OECD Oslo Manual and adapted from the Community Innovation Survey (CIS) questionnaire for measuring innovation in businesses.
	Sampling	Following the Oslo Manual guidelines (OECD and Eurostat, 2005), a stratified random sample by sector and size-class was drawn from the target population of businesses. The Oslo Manual recommends size cut-offs based on the number of employees. However, due to insufficient information on number of employees in the Stats SA business register, size cut-offs were based on turnover.
	Data collection	The guidelines in the Oslo Manual (OECD and Eurostat, 2005) were used to conduct data collection. MailChimp was used to dispatch a link to an online survey questionnaire in the REDCap online survey system. MailChimp was also used to monitor questionnaire status. This fieldwork strategy was efficient and effective.
	Advocacy strategy	An advocacy strategy was used to build relationships with businesses during data collection, to increase the response rate. The strategy included digital marketing to raise awareness about the survey with businesses, as well as individual interactions with businesses by fieldworkers via phone and email.
	Unit response rate	The overall unit response rate of the survey was 22%, following the strategic digitalised fieldwork effort, including a strategy to fill all strata with at least one response. A non-response survey was conducted to adjust the population estimates of innovation indicators for potential bias due to non-response.
Accuracy	Item response rate	The item response rates for a new question on business capabilities were calculated. The response rate for each of these items was very good, with the highest at 90%.
	Unit out-of-scope rate	The unit out-of-scope rate was 21%. This could be lowered by continuously keeping track of the changing status of businesses. In future this may be achieved by working closely with Stats SA during fieldwork, as it updates its business register on a monthly basis.
	Duplication rate	The rate at which units were duplicated in the sample was 0.06%. This indicates that the sampling frame was healthy with respect to duplicates.
	Range error rate	The range error rate for the turnover item in the questionnaire was 3%. This indicates that respondents specified the turnover values for their businesses with relatively low range error.
Comparability and coherence		Collected using international guidelines (Oslo Manual), therefore expected to be comparable to similarly collected data. In terms of coherence, the primary data collected using the survey and non-response survey was analysed together with secondary data on the original population and sample of businesses to adjust the weights for invalid businesses and potential bias due to non-response.
Timelines		The execution of the survey adhered to the survey project plan in the Need, Build, Design and Collect phases of the Statistical Value Chain (SVC). The Analyse phase was extended, which caused delays to subsequent phases of the baseline survey.
Integrity		The survey is free from political interference and conducted with objectivity and professionalism, as it is institutionalised at the Centre for Science, Technology and Innovation Indicators (CeSTII) in the HSRC and conducted on behalf of the Department of Science and Innovation (DSI). The dissemination of the results should follow the 'simultaneous release' SASQAF requirement, to ensure that there is no political interference in the conduct of the survey.

Continues overleaf...

Quality dimension	Survey methodology / quality indicator	Assessment
OTHER SASQAF QUALITY DIMENSIONS		
Accessibility and dissemination		The survey results will be disseminated widely to cover all the stakeholders, including all businesses in the sample, policy makers in relevant government departments and the Presidency as well as researchers in higher education institutions and science councils. The data and results will be made accessible nationally and internationally on the CeSTII website and through the channels specified in the CeSTII data access protocol.

Limitations and recommendations for future surveys

It is important to reflect on the baseline survey, to identify areas for improvement in future cycles. A major limitation of the baseline survey is that the number of unit responses for each sub-sector was low. Therefore, some of the agricultural innovation indicators statistics were either biased, or incalculable, for more fine-grained sub-sectoral or size class disaggregation within the agriculture, forestry and fisheries sub-sectors. This challenge was particularly significant in the forestry and fisheries sub-sectors, as they were smaller in terms of the population size and, by extension, sample size, and hence achieved number of responses. Therefore, the sub-sector and size-class level results were interpreted with this limitation in mind. On the basis of the baseline survey, the following recommendations for future South African agricultural innovation surveys are provided in the boxes below.

Survey design
Continue with survey design based on the Oslo Manual and agriculture-oriented CIS-like questionnaire adopted and used in this baseline survey, to create a data series for the South African Agri-BIS going forward.

SIC codes within the agriculture sub-sector
Include the lower level sub-sectoral codes in the stratification of the sample, to allow further disaggregation of the survey results into the corresponding lower level sub-sectors.

Data analysis
The data analysis should include further disaggregation of the results into lower level sub-sectors within the agriculture sector and size-classes in all the three sub-sectors: agriculture, forestry and fisheries. This will allow for a more policy-relevant interpretation of the results.

Target population and sample
Work with Stats SA, DALRRD and DEFF to determine appropriate sub-sectoral classifications and the appropriate sample size required for meaningful disaggregation.

Fieldwork
Continue using online digital tools such as MailChimp and REDCap for data collection and monitoring fieldwork, to ensure an effective and efficient data collection process. Work with Stats SA throughout the fieldwork period, to receive and incorporate their monthly updates of agricultural business register information, to reduce the number of untraceable businesses, and hence, increase the sub-strata and overall response rate.

Case studies
Since the survey design follows the subject-based approach of the Oslo Manual methodology, it is too cumbersome for both researchers and respondents to also collect detailed crop-level information on innovations, at national level. Therefore, in-depth follow-up case studies should be conducted for a few agricultural businesses in selected sub-sectors, to obtain in-depth information on innovation for specific crops or livestock farming businesses, for example. This will provide a deeper understanding of specific innovations undertaken by agricultural businesses in South Africa and further contribute to the policy-relevant interpretation of the national-level survey results.

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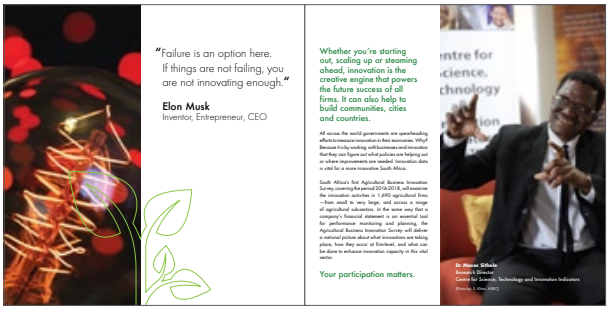
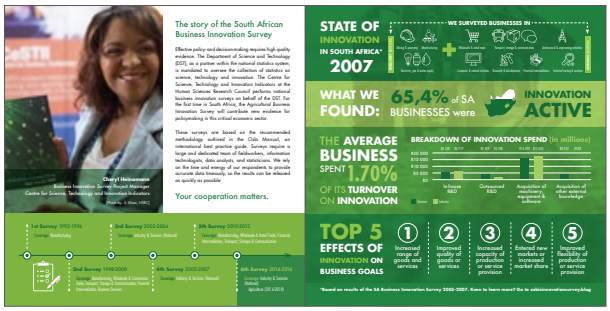
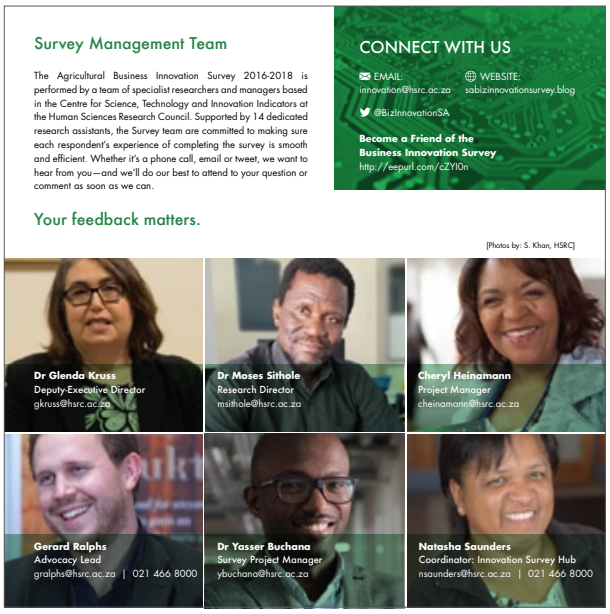
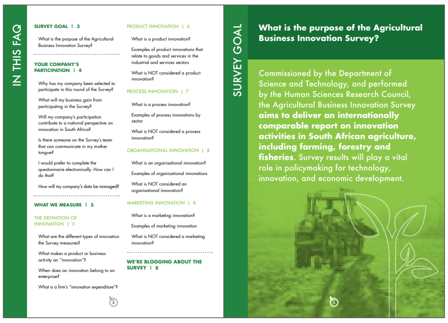
OFFICIAL SURVEY BROCHURE & FAQ (2019)

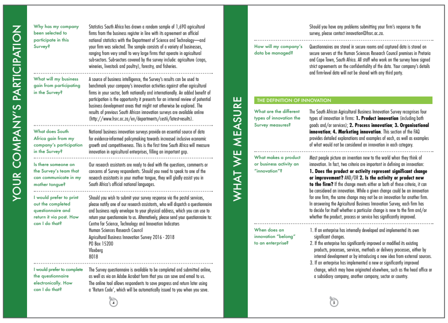


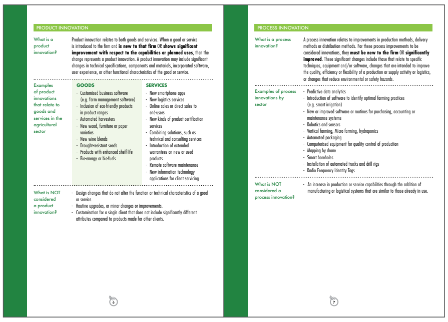





Frequently Asked Questions
AGRICULTURAL BUSINESS INNOVATION SURVEY 2016 - 2018
FOR A MORE INNOVATIVE SOUTH AFRICA
Your company has been selected to participate in the South African Agricultural Business Innovation Survey (2016-2018). Got questions? We'll try to answer them here. You can also call us, send an email, or post your questions online.
Your questions matter.
Call Natasha Saunders, Coordinator: Innovation Survey Hub 021 466 8000
Email us innovation@hsrc.ac.za
Website sabizinnovationsurvey.blog
HSRC
STATS SA


IN THIS FAQ
SURVEY GOAL
What is the purpose of the Agricultural Business Innovation Survey?
Commissioned by the Department of Science and Technology, and performed by the Human Sciences Research Council, the Agricultural Business Innovation Survey aims to deliver an internationally comparable report on innovation activities in South African agriculture, including farming, forestry and fisheries. Survey results will play a vital role in policymaking for technology, innovation, and economic development.


YOUR COMPANY'S PARTICIPATION
WHAT WE MEASURE


PRODUCT INNOVATION
PROCESS INNOVATION


WE'RE BLOGGING ABOUT THE SURVEY
ORGANISATIONAL INNOVATION
What is an organisational innovation?
An organisational innovation is intended to significantly improve the firm's innovative capacity or performance characteristics. This can encompass significant changes in workplace organisation, business practices or external relations implemented in the firm.
Examples of organisational innovations
- A reduction in the number of management levels to create greater flexibility in decision-making.
- Integrated monitoring system for firm activities (e.g. production, finance, strategy or marketing).
- The introduction of an organisational division to support new product development in a specific area.
What is NOT considered an organisational innovation?
- Changes in management strategy not linked to significant organisational change.
- Introduction of new technology that has limited benefits or is restricted to a small division of the firm.
MARKETING INNOVATION
What is a marketing innovation?
The implementation of a significant change in sales and marketing methods would qualify as marketing innovation. "Significant" would include improved product appearance and packaging that is intended to increase product appeal and/or consumer awareness.
Examples of marketing innovation
- Bundling existing goods or services in new ways to appeal to market segments.
What is NOT considered a marketing innovation?
- Routine or seasonal changes.
- Minor updates in the appearance of packaging.
- Advertising, unless based on the use of new media or a new advertising technique.
If you would like to learn more about innovation measurement in South Africa, or interact with our technical team, visit our blog
sabizinnovationsurvey.blog
You can also join our Friends of the Business Innovation Survey mailing list
http://eepurl.com/cZYl0n
@BizInnovationSA

CONTACT US

Department of Science and Innovation (DSI)
Private Bag X894, Pretoria, 0001
Republic of South Africa
www.dst.gov.za

Dr Phil Mjwara
Director-General: DSI
Phil.Mjwara@dst.gov.za

Mr Imraan Patel
Deputy Director-General: Socio-Economic Innovation Partnerships, DSI
Imraan.Patel@dst.gov.za

Mrs Kgomotso Matlapeng-Matjila
Senior Policy Analyst: DSI
Kgomotso.Matjila@dst.gov.za

Centre for Science, Technology and Innovation Indicators (CeSTII)
Human Sciences Research Council
P O Box 15200, Vlaeberg, Cape Town, 8018
www.hsrc.ac.za

Dr Glenda Kruss
Executive Head: CeSTII
gkruss@hsrc.ac.za

Dr Moses Sithole
Research Director: CeSTII
msithole@hsrc.ac.za

Dr Yasser Buchana
AgriBIS Project Lead: CeSTII
ybuchana@hsrc.ac.za

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