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POLICY BRIEF

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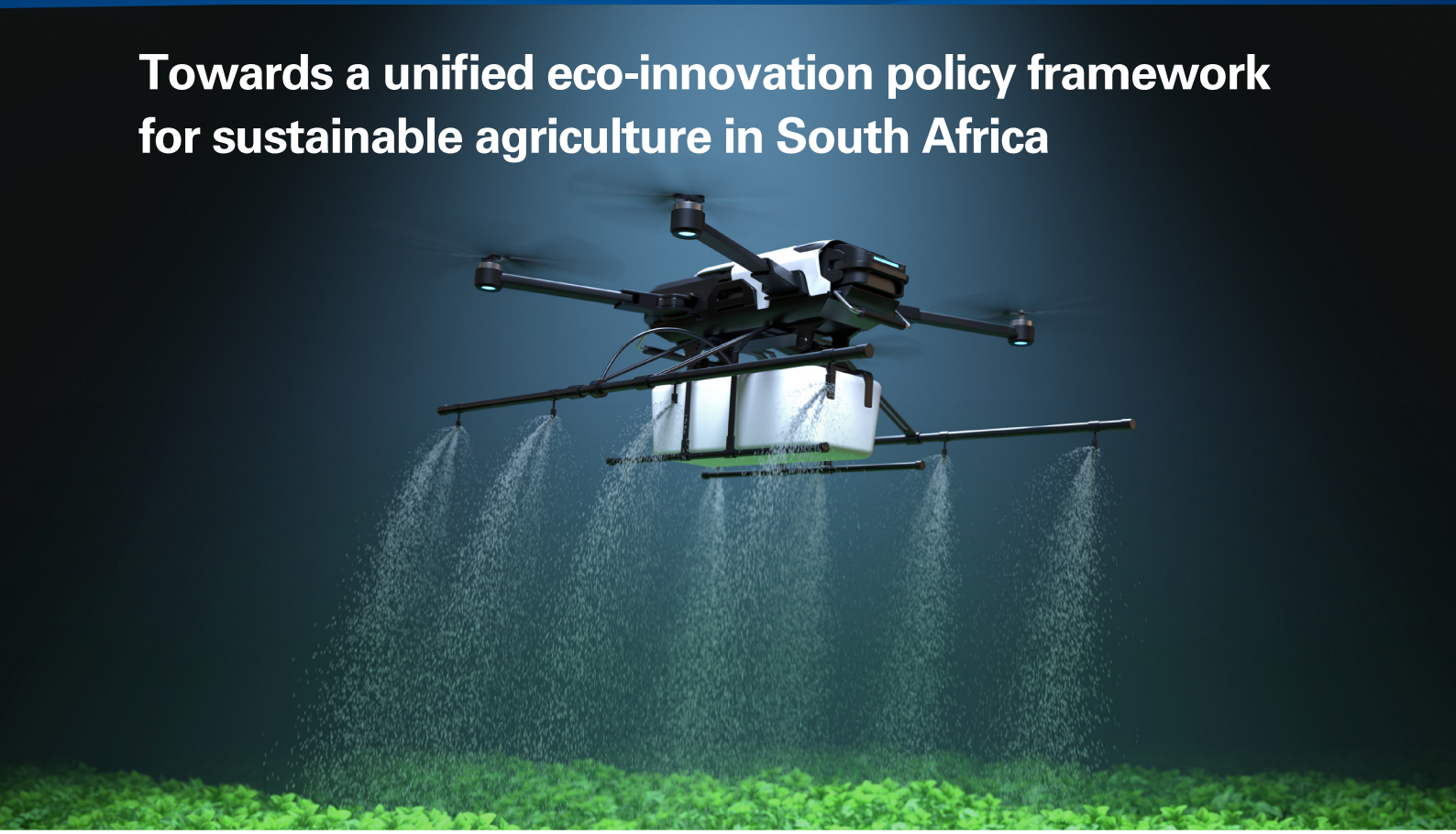
Towards a unified eco-innovation policy framework for sustainable agriculture in South Africa



Key messages

1. Empirical analysis based on the South African Agricultural Business Innovation Survey (Agri-BIS) 2016–2018 highlights the growing levels of eco-innovations (innovations that improve efficiency in natural resource use or reduce environmental impacts) in the agricultural sector, and the positive impact of certain eco-innovations, such as precision agriculture and sensor technologies, on biodiversity preservation, soil fertility, and water preservation.
2. Existing policies aimed at promoting eco-innovation in agriculture are fragmented, lack a clear direction, and are constrained in their efficacy. Implementing policy instruments and programmes effectively becomes more challenging as a result. The lack of sufficient incentives further hinders the development of sustainable agriculture in South Africa.
3. To maximise the full potential of eco-innovation for sustainable agriculture, there is an urgent need for a unified and comprehensive policy framework. This framework should streamline existing policies, ensuring coherence and effectiveness in aligning with global trends for climate change mitigation and environmental sustainability in the agricultural sector.
4. Policymakers are advised to incentivise process innovations, promote advanced ICT integration, and cautiously develop comprehensive eco-innovation strategies, considering challenges and the long-term nature of benefits.

What is eco-innovation and why is it important?

Eco-innovation refers to the development and application of new technologies, farming practices, and processes that enhance the efficient use of natural resources or reduce negative environmental impacts. This includes innovations that conserve water, reduce the use of harmful pesticides and fertilisers, improve soil fertility, enhance biodiversity, and reduce greenhouse gas emissions. For example, precision agriculture, climate smart agriculture and agro-ecology technologies that optimise the use of inputs, enhance crop resilience, and agro-ecological practices that work with nature, rather than against it, all fall under the umbrella of eco-innovation in agriculture.

Eco-innovation is important for several reasons. First, in the context of agricultural innovation in South Africa, eco-innovation can help to improve agricultural productivity and efficiency, which is crucial for ensuring food security and promoting economic development. While there are debates on the potential trade-offs between productivity and the environment, empirical evidence has shown that eco-innovations do have productivity impacts.

Second, by reducing the environmental impact of agriculture, eco-innovation can help to preserve South Africa's natural resources and biodiversity, which are necessary for the country's agricultural and tourism sectors. Third, eco-innovation can help to make agriculture more resilient to climate change, which is increasingly posing challenges for farmers in South Africa.

While policy debates among stakeholders in the agricultural sector have primarily focused on finding a balance between economic growth and maintaining or lowering environmental impact generated by the sector, there is general consensus amongst policy makers that coherent policy interventions are necessary to strengthen the agricultural sector's ability to adapt to climate change, while also raising its productivity and lowering its greenhouse gas emissions (Karakaya, Hidalgo, & Nuur, 2014; Organisation for Economic Co-operation and Development [OECD], 2011).

Understanding the dynamics of eco-innovation in the South African agricultural sector is, therefore, of great practical and policy relevance. It is a critical component of sustainable development, particularly in the context of climate change and conservation of South Africa's natural resources as described in the 2019 White Paper Policy on Science, Technology, and Innovation. However, a crucial policy challenge remains — the absence of a comprehensive and integrated policy framework designed explicitly to promote eco-innovation in the agricultural sector.

This policy brief begins by presenting empirical evidence that sheds light on the relationship between technological innovations aimed at mitigating environmental impact, and innovation outcomes related to environmental sustainability in South African agricultural enterprises. The main focus is to assess the current eco-innovation policy landscape in South Africa with the objective of identifying potential gaps or misalignments. Finally, recommendations for policy action are offered.

This policy brief is guided by the following question – ***How can South Africa enhance its current policies to create a more unified framework and strategy that actively supports eco-innovation in the agricultural sector?***

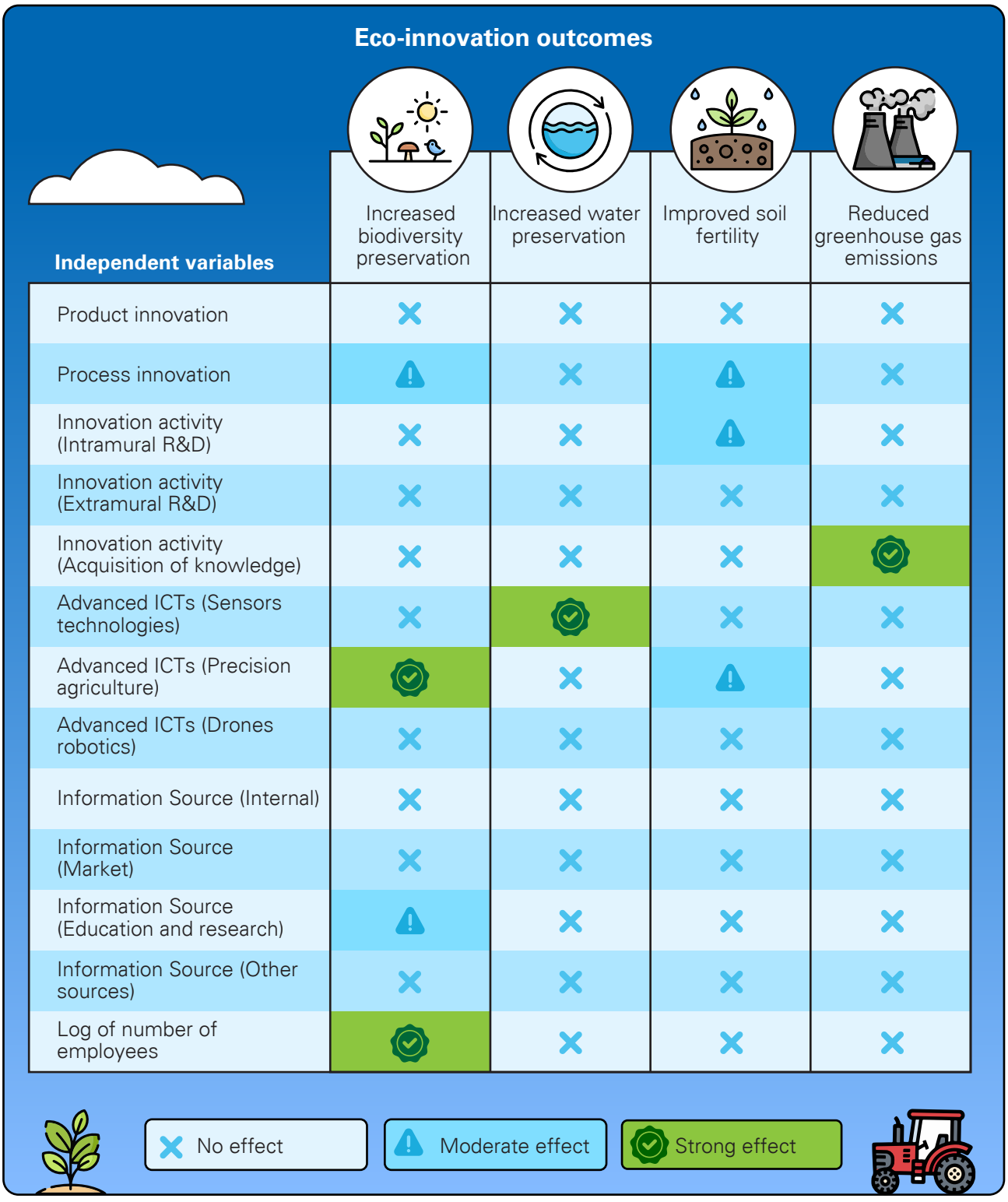
Empirical analysis: Eco-innovation and outcomes in agriculture

Technological innovations in agriculture have the potential to mitigate the sector's negative environmental footprint, making it essential for policymakers to align agriculture with sustainability objectives. The analysis in this section aims to shed light on the relationship between technological innovations and innovation outcomes linked to environmental sustainability in the agricultural sector. Since agriculture is one of the largest contributors to environmental pollution, understanding the relationship between innovations and environmental sustainability allows for the development of

effective evidence-based policy and decision-making that drive positive environmental outcomes. By identifying which eco-innovation strategies yield the most significant results, resources can be targeted where they may have the most impact. In this context, the role of technological innovations intended to reduce environmental impact, commonly referred to as eco-innovations, is critical.

Data from the South African Agricultural Business Innovation Survey (Agri-BIS) 2016-2018 is analysed, with the results in Table 1. The data covers the agriculture subsector (SIC 11) (i.e. animal and crop farming). The analysis did not include the forestry (SIC12) and fisheries (SIC13) subsectors due to insufficient data available for these two subsectors.

Figure 1 Effects of technological innovations on eco-innovation outcomes



The analysis showed that precision agriculture was associated with increased biodiversity preservation. This suggests that technology-driven farming practices may be compatible with circular economy concepts by reducing waste and resource consumption. Process innovation and intramural research and development (R&D) were linked to moderate improvements in soil fertility and biodiversity preservation, respectively. These innovations can play a key role in resource optimisation and sustainability.

Acquisition of external knowledge showed an association with the reduction of greenhouse gases. In particular, information sources from higher education and research institutions, were associated with a moderate improvement in biodiversity preservation. This suggests that access to knowledge from higher education institutions may play a critical role in driving sustainable practices in agriculture.

Sensor technologies showed a strong association with improvement in water preservation. The application of sensor technologies in agriculture could represent a significant innovation in water conservation, which is an essential factor in environmental protection.

Eco-innovation policy landscape in South Africa: Gaps and opportunities

South Africa's policies acknowledge the importance of eco-innovation in agriculture within various frameworks aimed at addressing climate change, promoting sustainability, conserving biodiversity, and ensuring food security.

Recent developments in Science, Technology and Innovation (STI) policy in South Africa, as outlined in the 2019 White Paper on STI and the 2022 Decadal Plan, indicate the government's commitment to embracing renewable energy sources and bio-refining innovations to reduce dependence on non-renewable fossil fuels. According to the 2019 White Paper Policy on STI, the South African government is committed to advancing environmental and agricultural sustainability through STI interventions. This constitutes a significant step towards building a more sustainable future for the country. In an attempt to modernise the agricultural sector and to address the environmental challenges faced by the agricultural sector, the STI Decadal Plan 2022—2032 outlines a number of key interventions, which include new water treatment solutions, sustainable water management practices, precision agriculture, and digital capabilities.

Existing empirical evidence has highlighted the importance of the agriculture sector in achieving environmental sustainability goals (Lankoski & Lankoski, 2023; Yasmeen, Padda, Yao, Shah & Hafeez, 2021). Sustainable agricultural practices may improve efficiency and reduce the negative effects on the environment by making the best use of scarce natural resources like water and land (Norse, 2012). Furthermore, according to the Decadal Plan, sustainable agriculture has the ability to support South Africa's economic and social growth by providing and creating employment opportunities and promoting community participation (DSI, 2022).

The South African Government has committed to intensifying the circularity of the economy as a new model for sustained and resilient economic growth and job creation. The Decadal Plan envisages STI interventions making an accelerated contribution to the circularity of key sectors. The Decadal Plan highlights key STI interventions in support of key sectors, such as manufacturing, agriculture, and mining, that will be developed taking into account the principles of the circular economy, namely, waste and pollution reduction, regenerative systems, and sustainable materials management. The goal will be to reduce resource input dependence and improve resource productivity in the targeted resource-intensive sectors.

While some government policies may collectively advocate for eco-innovation and environmental sustainability in agriculture, there are some notable gaps with existing policies/initiatives.

For example: The National Climate Change Response White Paper highlights the need for climate-smart agriculture, while the National Development Plan 2030 lacks specific measures to achieve this in practice.

Another example is the Green Economy Accord, which emphasises sustainability, but challenges in accessing green financing impede eco-innovation implementation both at the national and sectoral levels. Furthermore, the National Water Resource Strategy calls for water conservation, yet access to water resources remains an important challenge for farmers, which significantly affects sustainable agriculture in South Africa.

Table 2 below presents a summary review of existing policies and government initiatives related to eco-innovation in South Africa.

Table 1 Summary review of eco-innovation related policies and initiatives in South Africa

Policy	Objectives and key highlights	Emphasis on eco-Innovation	Gaps in eco-Innovation in agriculture
National Climate Change Response White Paper	Response to climate change, including agriculture	Investment in research for water, nutrient, soil conservation tech; climate-resistant crops/livestock; climate-smart agri models	Limited funding for eco-innovation research, slow adoption of innovations by farmers, and a need for stronger policy incentives
National Development Plan 2030	Food security, poverty reduction, inequality, sustainable agriculture	Promotion of sustainable agri practices resilient to climate change	Challenge of scaling up eco-innovations, inadequate training for farmers in new practices, and a lack of monitoring systems
National Biodiversity Strategy and Action Plan	Biodiversity conservation and sustainable use	Promotion of sustainable agri-practices to conserve biodiversity	Limited awareness among farmers about biodiversity benefits, insufficient data on biodiversity impacts, and regulatory hurdles
National Water Resource Strategy	Sustainable use and management of water resources	Promotion of sustainable agri-practices to conserve water	The need for efficient irrigation technologies, equitable water allocation, and better enforcement of water conservation measures
National Disaster Management Framework	Reducing disaster risk and impact, including agriculture	Promotion of climate-resilient agriculture practices	Limited early warning systems for farmers, inadequate insurance mechanisms, and the need for improved disaster response plans
Green Economy Accord	Transition to a green economy, emphasising agriculture	Promotion of sustainable agri-practices resilient to climate change.	Gaps involve the alignment of financial incentives with eco-innovation, access to green financing for farmers, and information dissemination
DALRRD Agriculture and Agro-processing Master Plan	Transform agriculture, enhance food security, improve competitiveness through technology, infrastructure and policy support	Refers to need to enhance resilience to climate change and management of natural resources	Lack of an explicit consideration for eco-innovation within its main key objectives
Integrated Growth and Development Plan	Promoting economic growth with focus on agriculture	Emphasis on sustainable agriculture practices that withstand climate change	Gaps consist of market challenges for eco-friendly products, the need for infrastructure investment, and support for agri-business innovation
National Food and Nutrition Security Policy	Ensuring food security with consideration for climate change	Promotion of sustainable agri-practices that are resilient to climate change	Gaps include the lack of access to climate-smart technologies for small-scale farmers, inadequate crop diversity, and limited extension services

While there are pre-existing policies and initiatives that indirectly support eco-innovation, such as those illustrated in Table 1, these policy instruments often lack a clear roadmap for prioritising and driving eco-innovation's role in achieving sustainable development goals. Moreover, these efforts tend to remain fragmented, small-scale, and inadequately incentivised for eco-innovation development. Capacity constraints also tend to hinder the effective implementation of R&D programmes for eco-innovation.

To fully maximise the potential of eco-innovation for sustainable agriculture, there is a pressing need for a unified, comprehensive policy framework that can guide, govern, and integrate these diverse efforts into a coherent and impactful strategy. Therefore, to achieve policy coherence and effectiveness, streamlining of the various fragmented policies is necessary to ensure a unified eco-innovation policy approach that aligns with global trends to fight climate change and to promote environmental sustainability in the agricultural sector. This will help facilitate South Africa's transition to a more sustainable and climate-resilient agricultural system.

The case for a unified cohesive eco-innovation policy framework in South Africa

South Africa currently lacks a comprehensive, unified policy framework and strategy that promotes such eco-innovations, which constitutes a significant policy gap. This sub-section highlights the challenges posed by this lack of a unified approach and substantiates the importance of promoting an eco-innovation policy within South Africa's agricultural sector.

There are several countries that have successfully implemented eco-innovation policies internationally that South Africa could learn from. For example, European countries, such as Denmark and Germany, as well as East Asian countries like South Korea. In Denmark, for example, the Danish government has integrated eco-innovation within its national strategy for sustainable development, focusing heavily on renewable energy and efficient resource usage in agriculture. The Danish eco-innovation strategy states that:

> ***… The strategy sets a clear direction for the Danish green research and innovation effort in order to accelerate the development of technologies and solutions, which can help protect our climate, nature and environment. The goal is to enable greenhouse gas reductions and strengthen the green frontrunner position of Danish industries to the benefit of exports and green jobs in Denmark.***

The Danish government supports these initiatives through funding, research, and collaboration between universities, businesses, and government agencies. The Danish example shows that an effective unified eco-innovation policy is typically characterised by strong government support, active stakeholder engagement, and a clear focus on sustainability goals.

South Africa can learn from the Danish case in developing and implementing a unified eco-innovation policy to enhance sustainability in the local agricultural sector. Furthermore, a unified strategy to consolidate existing fragmented approaches in South Africa can involve combining key elements from various existing policies into a unified cohesive eco-innovation framework. Through the integration of climate change response strategies, promotion of sustainable agriculture practices, and a combination of biodiversity conservation efforts, the framework can aim to create synergies amongst the different objectives.

The integrated strategy could offer numerous advantages by harmonising diverse policy objectives. First, it could facilitate a more streamlined and coordinated approach, and eliminate duplicated efforts seen in fragmented policies as reviewed in this policy brief. Secondly, aligning climate change responses with sustainable agriculture and biodiversity conservation can help to optimise resources, and promote more efficient use of funds. Moreover, this cohesive strategy should promote cross-pollination of ideas and knowledge transfer between the different stakeholders, promote innovation and the development of sustainable agricultural solutions.

Finally, South Africa, which is a signatory to the Paris Agreement on climate change, can position itself as a leader in sustainable agriculture in Sub-Saharan Africa. This can be done by promoting eco-innovation through a cohesive policy framework and strategy, as well as by creating new opportunities for capacity building and collaboration with other African countries. It can also help to improve agricultural productivity and efficiency, which is crucial for ensuring food security and promoting economic development.

Conclusion and recommendations

The Decadal Plan and the 2019 White Paper policy on STI both emphasise how STI contributions can promote the circularity of the agricultural sector by enacting reformative agricultural practices and enhancing resource utilisation through the use of digital and precision tools. These policies argue that with the right policy interventions, the South African economy can reach 9% circularity. The Global Circularity Gap Report 2023 show that the global economy is currently only 7,2% circular. This means that of all the materials used in the global economy, only 7,2% are recycled while the projected global average target is 17% by 2030. Empirical evidence presented in this policy brief suggests that agricultural businesses that invest in developing innovative processes, acquire knowledge from external sources, leverage advanced ICTs, and balance financial and environmental sustainability goals, are more likely to achieve improved environmental sustainability outcomes.

Given that the Department of Science and Innovation (DSI) is responsible for the development, coordination, and management of the National System of Innovation (NSI) in South Africa, its commitment to eco-innovation initiatives should largely be driven by the development of R&D support programmes, with a preference given to supply-side policy measures. The Department of Agriculture, Land Reform and Rural Development (DALRRD) can also play an important role in the development and implementation of policies, strategies, and plans, which encourage eco-innovation in the agricultural sector.

Empirical results, on which this policy brief is based, showed that process innovation positively contributes to increased biodiversity preservation and increased water preservation. As such, policy makers working in the innovation space can:

1. develop policy instruments that incentivise agricultural businesses to invest in process innovations by offering incentives such as eco-innovation tax breaks and subsidies, or eco-innovation grants
2. develop policy instruments that require businesses to publicly disclose their sustainability efforts or establish sustainability standards, which can also encourage process innovation. More process innovation can, in turn, result in more eco-innovation outcomes.

The Decadal Plan mentions that the government plans to implement several STI interventions to achieve agricultural sustainability, including the promotion of precision agriculture and digital capabilities to modernise the agricultural. Empirical evidence showed that enhancing biodiversity preservation and soil fertility in agricultural businesses relies on promoting advanced ICT integration,

particularly precision agriculture technologies. Moreover, the empirical evidence also shows that the use of advanced ICTs, such as sensors, can have a positive impact on water preservation. This is directly linked to the promotion of sustainable water management practices described by the Decadal Plan as an intervention to promote sustainability in the sector. As such, policymakers can:

3. facilitate the adoption of precision agriculture in agricultural firms that are in desperate need of these technologies. This can be done by first assessing the extent of the capacity to adopt and use these technologies, then capacitating farmers with knowledge, training, funding, research, and tech-transfer initiatives for these technologies.
4. help promote stakeholder engagement on various eco-innovation initiatives, both public and private. This can be achieved through the establishment of a multi-stakeholder platform that includes representatives from government, academia, industry, and civil society. Such a platform should aim to facilitate open dialogue, share best practices, and coordinate policies to ensure that eco-innovation initiatives are collaborative and not operating in silos. Moreover, such a platform could use participatory decision-making processes to ensure all voices are heard and integrated into policy development. This approach will help align various policies supporting eco-innovation and ensure a comprehensive, inclusive strategy that makes use of the different expertise to drive sustainable agricultural practices and environmental preservation.

Nevertheless, caution should be exercised while implementing eco-innovation policies. First, eco-innovation often involves a shift from established practices and technologies, which can encounter resistance from various stakeholders. Second, the benefits of eco-innovation are often long-term and societal, while the costs are immediate and accepted by specific actors, which can create a mismatch of incentives. Third, eco-innovation often requires interdisciplinary and cross-sectoral collaboration, which can be difficult to achieve in practice.

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