Innovation policy change and inclusive agricultural innovation in South Africa

By

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Abstract

Agricultural innovation by both commercial and smallholder farmers is useful to economic growth and sustainability. In South Africa and many other developing countries, smallholder farmers make up the majority of farmers. The smallholder farmers face different challenges such as water scarcity and climate change. For this reason, farmers engage in different forms of innovation activities at a small scale. This study applied a combination of inclusive growth and inclusive innovation concepts as a lens to explore innovation policy and ways to promote inclusive agricultural innovation in small scale agriculture.

This study adopts a qualitative method to analyse data. The study used primary data and also policy documents analysis. Primary data was gathered through semi-structured interviews which were conducted with smallholder farmers, who serve as the primary participants and key informants for the study. A randomised selection was done to recruit thirty study participants from Limpopo and Mpumalanga. Data analysis made use of a cross-case analysis from the two areas in order to understand the constraints of innovation in the small-scale agricultural sector.

The key findings for the study reveal that small-scale innovators in the agricultural sector are hindered by lack of resources, funding, and access to innovative technologies. These challenges negatively affect up-scaling of innovations and participation in valuable markets.

The implications of the findings suggest that smallholder farmers must be supported in order to successfully execute innovative activities. The support includes having strategies and programs to provide the required resources to improve innovative capabilities of farmers. Policymakers need to revise and redesign policies that enable smallholder farmers to operate. Stakeholders in the NSI should provide interventions that support the specific needs of smallholder farmers to be functional and profitable.

The study aspires to contribute to understanding innovation among smallholder farmers in South Africa through investigating the manner in which changes to the innovation policy in South Africa could promote smallholder farmer agricultural innovations that contribute to food security, job creation, and the burden of diseases in the agriculture sector.

KEY WORDS

Actor networks

National System of Innovation (NSI)

Inclusive growth

Inclusive innovation

Frugal innovations

Grassroots Innovations (GI)

DECLARATION

I, Phatheka Tania Ndzotoyi, declare that this dissertation is my own unaided work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in the field of Innovation Studies at the Wits Business School at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Signature: ……  ……..

On this ……**28**…… day of ……**February**…….2022

Phatheka Tania Ndzotoyi

Name

DEDICATION

This study is dedicated to my employer, the Council for Scientific and Industrial Research (CSIR), and the Department of Science and Innovation, for financial support.

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ABBREVIATIONS & ACRONYMS

AIS: Agricultural Innovation System

CSIR: Council for Scientific and Industrial Research

DSI: Department of Science and Innovation

DST: Department of Science and Technology

FI: Frugal Innovations

GDP: Gross Domestic Product

GI: Grassroots Innovations

HCD: Human Capital Development

IKS: Indigenous Knowledge Systems

IP: Intellectual Property

NGO: Non-Governmental Organisation

NPO: Non-Profit Organisation

NSI: National System of Innovation

OECD: Organisation for Economic Co-operation and Development

RD&I: Research Development and Innovation

RDP: Reconstruction and Development Programme

SA: South Africa

SANSA: South African National Space Agency

STEM: Science Technology Engineering and Maths

STI: Science, Technology and Innovation

TIA: Technology Innovation Agency

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND AND CONTEXT OF THE STUDY

Agricultural innovation is useful in Africa because of the diversity of African countries in terms of culture, political heritage, and the historical association of most African countries with natural resources and raw materials (Juma, 2007). Rural communities are lagging behind in agricultural innovation in comparison to people in urban areas, which is due to the socioeconomic challenges such as a lack of skills and access to technological infrastructure, which prevent the development of agriculture in rural settings. It is stated in Poulton et al. (2006) that innovators in the agricultural sector are faced with many constraints including lack of roads and network infrastructure, limited agricultural research, unreliable energy supply, and a lack of access to water to be able to innovate at scale, commercialise developed innovations, and grow the markets. Challenges and constraints bring about technological opportunities for Africa, however the management of opportunities for development into technological innovations is critical for economic growth and necessitates policy approaches that strengthen partnerships and collaborations to tap into new knowledge to solve Africa's problems (Juma, 2007). Accordingly, policy changes that are inclusive of diverse cultures and heritage are necessary for the advancement of agricultural innovation in Africa.

The agricultural sector in South Africa (SA) is faced with the challenges of urbanisation which compromises food security for the expanding population (Du Toit et al., 2011). Climate change that lead to drought conditions make technological innovations critical to advancing farming practices and realising the full potential of agriculture to grow the economy (Hassan, 2010).

SA's slow job creation, high unemployment levels, and wage disparities affect mostly the poor and marginalised rural communities (Leibbrandt et al., 2010). The poor state of the public basic education system in rural areas, in comparison to urban areas, implies that fewer rural communities participate in the formal labour market and find employment (Christie & Gordon, 1992).

Rural communities in particular face challenges of poverty, inequality, and economic exclusion. This research study proposes an inclusive innovation policy as an approach to including agricultural innovations that will enable the collaboration and integration of poor and marginalised rural communities for an inclusive society. Inclusive innovation speaks to innovating for impact and innovating for inclusive growth, and these are concepts that are supported by the Department of Science and Technology (DST) Draft White Paper on Science, Technology and Innovation (2019) as one of the policy models that has been developed to promote and enable innovation at a national level.

The 2019 White Paper is a policy action plan with a purpose of strengthening and supporting the National System of Innovation (NSI) policy, setting policy direction and ensuring economic development in the part of science, technology, and innovation (STI) towards an inclusive society (www.dst.gov.za). The paper addresses innovation matters and challenges of economic growth, sustainable innovations, and livelihoods by making use of STI to accelerate inclusive growth, develop a competitive economy, and improve livelihoods. It is a catch-up plan aimed at helping SA to benefit from global changes such as global technology developments and global trends. The White Paper does aim to promote innovation for impact in keeping with the "Sustainable Development Goals" and the "National Development Plan Vision 2030" in asserting that measures in the form of investment inputs in STI, outputs such as increased number of graduates, publications, and patents, outcomes of enhanced collaborations between NSI partners, and an augmented strategy coherence for better innovation performance are all critical for the realisation of intended impacts of STI.

This study apply a combination of inclusive growth and inclusive innovation concepts as a lens to explore innovation policy and ways to promote inclusive agricultural innovation in small scale agriculture.

1.2 RESEARCH PROBLEM STATEMENT

The National System of Innovation (NSI) has been highlighted as a significant framework for innovation systems in peer-reviewed literature. It is a national innovation policy model that has been developed to promote innovation that can enhance and strengthen job creation, sustainable livelihoods, and contribution to economic growth

(DST, 2019). As a framework, however, it has faced both implementation and evaluation challenges due to uncoordinated research efforts and a lack of collaboration among the network partners in the innovation system. The gap necessitating inclusive innovation policy in the agricultural sector is linked to innovation policy issues such as (i) the types of innovations required to deliver on job creation and income generation as detailed in the NSI policy, (ii) the availability of technology-enabled platforms which are currently limited due to connectivity challenges, specifically in rural settings, and (iii) the contribution of public and private actors in innovation activities.

Sheikh and Bhaduri (2020) discuss the concept of Grassroots Innovations (GI) in rural settings, which are led by community activists, cooperatives, or non-governmental organisations (NGOs) as intermediaries between stakeholders in the NSI and communities. These are described as innovation by marginalised groups in both Sheikh and Bhaduri (2020) and George et al. (2012). These studies highlight the problem of sourcing the required technological innovations (specifically for developing countries) from formal businesses. Informal innovations such as equipment developed in local settings to solve community issues, such as cracking open the marula nut to get the oil, are largely excluded. The articles conclude that the inclusion of both formal and informal innovations will contribute significantly to job creation, income generation, and economic growth, and that collaboration efforts within the network of institutions in the NSI for skills development, knowledge creation, and experimentation should be taken in partnership with grassroots innovators and their communities.

Based on the researcher's experience in the field and having worked on projects that are based in the rural areas of the Eastern Cape, Limpopo, and Mpumalanga, she has observed that technology-enabled platforms which are mostly developed by research institutions are located far away from rural settings, with universities that are closer to rural communities not having enough technical capacity to assist these communities with innovation development. As such, innovative entrepreneurs have to travel and spend money to get assistance for the commercialisation of their innovations. There is also the challenge of bringing WiFi-enabled technologies to do mapping of agricultural crops and monitor climate conditions in rural settings for sustainable development (Dlodlo & Kalezhi, 2015), and this requires infrastructure development support for inclusive innovation.

The areas of science, technology, and innovation are the main factors of economic growth and competitiveness that can help countries to achieve their socioeconomic objectives. Accordingly, this requires effective policy evaluation in the field of innovation (World Bank, 2010). This view is supported in the Organisation for Economic Co-operation and Development (OECD) Oslo Manual (2018), which provides recommendations for measuring innovation and presents an economic theory of an innovation for inclusive growth policy that is pro-poor, supports economic growth, uses an existing system, and makes the policy work for more people. The manual states that innovation plays an important role in improving living standards affecting people, organisations, the entire industry sectors, and nations in various ways. The development of new opportunities, such as a knowledge-based economy for developing countries such as SA in the form of investments in new technology developments, developing high-technologies firms, and a highly skilled labour force, become key in this regard (Blankley & Booyens, 2010). The article further states that STI policies such as the NSI are directed at transforming SA towards a knowledge-based economy.

Participation of endogenous and exogenous actors of the NSI in innovation activities is critical in ensuring inclusivity, with linkages and interactions among all actor networks supported by collaboration agreements. These agreements boost global competitiveness and trade prospects of organisations in developing economies.

1.3 RESEARCH AIM (PURPOSE) AND OBJECTIVES OF THE STUDY

The aim of this study is to examine the role that inclusive innovation policies can play in improving agricultural innovations in the informal sector. This will be achieved by analysing and reviewing agricultural innovation systems (AISs) and innovation for inclusive development, and demonstrating how rural actor networks bring about innovations, highlighting their challenges with scale-up and commercialisation.

The specific study objectives are to:

I. To explore the constraints and challenges facing innovators in the agricultural sector with a particular interest in small-scale producers.

II. To explore the shortfalls of innovation policies geared at improving agricultural innovation and further identify issues related to the implementation success or failure of small-scale farmer innovation systems.
III. To investigate possible policy changes that promote inclusive agricultural innovation in SA.

1.4 RESEARCH QUESTIONS

The key research question that needs to be answered in this study is:

- What opportunities can be created, through inclusive innovation policy that supports and promotes innovation for social and economic benefit in agriculture, to address societal challenges of food security, poverty, and inequality?

The sub-questions the study wishes to answer are:

I. What are the constraints of innovation facing the smallholder farmers in Nkomazi and Mopani areas?
II. What are the gaps in the policies that support innovation in agriculture in SA?
III. What possible policy changes can be adopted to promote inclusive agricultural innovation in SA?

1.5 SIGNIFICANCE OF THE STUDY

The study is important as it seeks to address the issues related to livelihoods, economic growth, and sustainable innovations in SA. Walwyn (2016) highlights that inclusive policy is important to reduce the inequality gap, whereas in the DST White Paper on Science, Technology and Innovation (2019) it is stated that agriculture is critical in the promotion of innovation at national level.

Agriculture has been identified as an important sector of the SA economy due to the sector's contribution to the GDP. Innovation opportunities in agriculture can address SA's socioeconomic challenges, and the actors, research institutions, and policies in the NSI have to be attentive in addressing the requirements of marginalised and poor

people to promote economic growth. In the review of the DST White Paper, Walwyn (2016) notes that while SA has a strong system of innovation supported by outstanding universities, the state has failed to develop the manufacturing sector in the form of high technology industries to realise the potential of innovation-led growth. The influence over policy of the politically connected economic elites has meant that the uneven distribution of income continues post-1994 (Walwyn, 2016), a factor which becomes crucial to the proposed innovation policy change.

Theoretically, this study investigates innovation for inclusive development focusing on the small-scale agriculture from innovation systems perspective. A combination of inclusive growth and inclusive innovation concepts is applied to explore small scale agricultural innovation systems from a policy point of view. The study contributes empirically as the agricultural innovation studies particularly in small scale agriculture are still in their infancy in SA. In a South African context, most studies (for example Klerkx et al. (2012) and Cozzens and Sutz 2014)) have looked at the adoption of technologies in agriculture. In the current study, the focus is on policy change in agricultural sector that can promote inclusive development through innovation by small scale farmers as well. The research findings will be used to contribute to policy decision-making, formulation, and implementation.

1.6 DELIMITATIONS OF THE STUDY

The sample delimitations of the study entail the researcher deciding to include only two districts in two provinces of SA and excluding the other seven provinces, with the hope that the research findings and learnings are transferable due to the nature of rural settings and entrepreneurship in SA.

1.7 ASSUMPTIONS

This research study investigates the role that inclusive innovation policies can play in improving agricultural innovations in the informal sector by small scale farmers in SA's rural district municipalities.

It is assumed that:

Farmers are innovative however the innovative potential of small-holder farmers cannot be verified. Further studies are required into their graduation from small scale producers to emerging or commercial farmers and can be used to test their innovative potential.

Existing policies have gaps in relation to catering for the small-scale producers in marginalised rural areas characterized by dilapidated infrastructure and poor access to resources to help them innovate.

Agricultural innovation policies can only promote inclusive development if they start to include small scale producers and consider them as innovators and not only as consumers of technologies produced by formal businesses from cities and overseas.

1.8 OUTLINE OF THE STUDY AND STRUCTURE OF THE REPORT

This research study is comprised of six chapters, and a short explanation of the chapters is given here:

Chapter 1: Introduction focuses on the purpose and context of the research study, the problem statement, the significance of stakeholders in the study, assumptions made, and the research question that the study is helping to address.

Chapter 2: Literature Review encompasses the review of theoretical frameworks, the development of a proposed framework relevant to the study, and the hypotheses in relation to the research study.

Chapter 3: Research Methodology focuses on the strategy and design of the study, selecting participants, the methods of collecting and analysing data, limitations, ethical considerations, and reliability and validity of the collected data.

Chapter 4: Findings of the study entails research findings gathered from participants, evaluation of policy documents on ST&I, and a case study review.

Chapter 5: Discussion focuses on the analysis of the data that has been collected and insights gained through literature review.

Chapter 6: Conclusions and Recommendations provide a summary of the research findings and conclusions that can be made based on literature review analysis and interviews.

1.9 CONCLUSION

Chapter one discussed the purpose of the study, which is to examine the role that inclusive innovation policies can play in improving agricultural innovations in the informal sector. The importance of the study in relation to actor networks was discussed, as were the scope of the research and assumptions made when conducting the research. The key terms were defined, and an outline of the conceptual framework and research question was detailed.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The literature review was conducted to gain more knowledge on innovation policy change for inclusive livelihoods in the South African agricultural sector. It will assist to identify previous research areas of other scholars, gaps, inconsistencies, conflicts with previous studies, and questions left for further research.

In line with the core themes emerging from literature review, this study:

- Reviewed agricultural innovation by marginalised rural communities in developing countries that face challenges of poverty and access to resources for innovation which fosters inclusive rural development
- Looked at the role of innovation in promoting inclusive rural development, and how governments in developing countries should drive and support innovative interventions for inclusive rural development through policy
- Reviewed the dynamics of inclusive innovation in the agricultural sector in Africa, and South Africa in particular

Two concepts, inclusive innovation and inclusive growth are combined to develop a conceptual framework. The conceptual framework provides a lens through which the innovation policies will be analysed, and the need for policy change to include smallholder agriculture are explored. A more policy-orientated approach is used to draw linkages between the overarching inclusive growth framework and inclusive innovation for inclusive development. A key consideration is made by combining inclusive growth and inclusive innovation that may enhance economic and social welfare in rural settings in SA.

2.2 THE CONCEPT OF INNOVATION

Innovation is described as the introduction of a novel or enhanced product, good, service or process, a new promotion technique, or a new structural business process in an organisation (OECD, 2009). This definition identifies four types of innovation, namely (i) product innovation, (ii) process innovation, (iii) marketing innovation, and

(iv) organisational innovation, limiting innovation to consumer products and business processes with the exclusion of other economic sectors. Gault's (2018) definition of innovation, however, includes all economic sectors such as financial and non-financial organisations, the public or government sector, non-profit organisations, and households for the statistical measurement of innovation. This extended innovation measurement presents indicators that are useful for the monitoring and assessment of policies that have been applied for a better understanding that occurs when a set of policy problems is compared to others within their own or in other authorities.

Balzat and Payka (2005) discuss the concept of innovation by looking into the physical arrangement of the national innovation system, presenting linkages between the NSI and innovation system divisions. The paper contributes to the structural parallels and differences of national innovation systems, describing the NSI approach as one which concentrates on institutional settings, including their precise location features, and emphasising the interdependencies between historically developed institutional frameworks and forms in innovative undertakings on the national level. The authors further state the wide acceptance of the NSI approach in modern research, as is the case in SA, while enjoying mounting acceptance by legislators in developed economies. Accordingly, the paper employs the NSI as a conceptual framework for a true and all-inclusive study of current innovative undertakings.

Box (2009) draws on existing OECD work on innovation, providing an overview of policy practices for innovation. The paper highlights new changes in innovation practices and forms, defines the growing levels of globalisation, and pulls together early reasoning on the role of innovation in unravelling global challenges linked to the environment. It concludes that theoretical and empirical work on innovation has been done in the form of identifying effective supporting policies, institutions, and framework conditions for innovation. However, further work is still required to evaluate and measure government support for innovation in the form of supporting policies and their impact on innovation. Gault (2011) adds that economic and social impacts of innovation are only realised when the creators of innovation benefit from its use and knowledge is transferred to the wider community of practice.

2.3 INCLUSIVE AGRICULTURAL INNOVATION

An analysis of the literature on agricultural innovation and inclusive agricultural innovation suggests that the deployment of strategies for innovation networks will create changes in the environment for the establishment of a more favourable setting for the realisation and long-lasting embedding of innovation projects (Klerkx et al., 2010). The paper's perspective on AISs is that interaction among innovation systems and their setting is only manageable to a partial degree due to a lack of understanding to create and mobilise support among actor networks and creating connections in the innovation environment. Accordingly, the partial influence that innovation networks have on their environment and the constant reflection thereof imply the need for dedicated government facilitators with effective monitoring and evaluation systems for learning, with agricultural innovation policies that promote support instruments which are flexible and allow adjustable innovation management. Klerkx et al. (2012) see agricultural innovation as a method merging technical, societal, economic, and institutional change, with other aspects such as policy, regulation, substructure, capital, and trade expansions playing a significant role, in addition to manufacturing and the interchange of scientific knowledge. Accordingly, the paper describes agricultural innovation as the implementation of new technologies requiring a balance between new technology platforms and different ways of arranging markets, labour, land occupancy, and supply of benefits. This opinion is reinforced by Hall et al. (2006), who explain that patterns of agricultural development call for renewed thinking to promote innovation in methods that can deal with speedily developing production and market settings.

Agricultural innovations have huge benefits for poor people and low-income countries where markets are underdeveloped, including index insurance, specifically for agricultural enterprises and rural households, against climate-related risks such as drought or flooding which lead to losses in crops, livestock, or property (Skees, 2008). The use of digital innovations in weather stations can be used to measure extreme rainfall with a financial innovation, such as index insurance, against weather risk as an intervention. Skees (2008) cites an example from India, where the rainfall index insurance is accessible to salt and brick producers to whom manufacture could be interrupted by extreme rain. The author further states the importance of developing

successful and maintainable insurance programmes and programmes that require cautious discussion with government legislators and regulators.

Low-income countries also face the challenge of food security as a result of weather variation, affecting mainly poor and marginalised communities. The adoption of AISs becomes critical in response to food uncertainty and climate variation (Brooks & Loevinsohn, 2011). The authors review three cases of systems of innovation. The first one is about management of rice yields and rice grounds in Southeast Asia and looking at the continuation of “parallel systems of innovation”, with partial and irregular movements of data. This is likely to decelerate the stride of agricultural development with reduced contacts between key actors, limiting people’s access to vital information. The second case study is the watershed development in India with its partial success, highlighting the importance of participation and attention to equity. Important to this system of innovation is political commitment, the participation of Indian society innovators in training and skills growth, and the evaluation and review of set standards for continuous improvement. The third case study is on maize-centred varied agriculture in Sub-Saharan Africa, with an innovation system that presents the development of new hybrid varieties through partnerships between private and public sector institutions with IP protection and regulatory systems in place to address private sector concerns for varietal uniformity (Brooks & Loevinsohn, 2011).

2.4 INNOVATION POLICY IN SA

Supporting innovation in the agricultural sector are the NSI and the DST White Paper on Science, Technology and Innovation (2019), both of which demonstrate how policy can help to promote innovation at a national level. The NSI is a national innovation policy framework that has been developed to promote innovation, resulting in the promotion of job creation, sustainable livelihoods, and contribution to economic growth. The DST White Paper on Science, Technology and Innovation (2019) is one of the policy models that has been developed to promote and enable innovation at national level. It is a policy action plan with the purpose of strengthening and supporting the NSI policy, setting policy direction, and ensuring economic growth in the role of STI towards an inclusive society. The White Paper addresses innovation matters and challenges of economic growth, sustainable innovations, and livelihoods

by making use of STI to accelerate inclusive growth, develop a competitive economy, and improve livelihoods. It is a catch-up plan aimed at helping SA to benefit from global changes in the form of global technology developments and global trends. Supporting policies in the agricultural sector are faced with challenges of addressing imbalances and domestic injustices of the past while also having the mammoth task of having to compete globally (Mogajane, 2013). Large-scale commercial farmers make up approximately 40,000 farming units, covering a producing part of about 82 million hectares, and are accountable for more than 99% of SA's agricultural output in retail (Stats-SA, 2007). Small-scale producers, however, make up 1.3 million farming homes with about 14 million hectares of farming land, concerted mainly in the previous homeland parts of the country (Tregurtha et al., 2010). The small-scale growers have low amounts of farming technology asset and production competence, and they participate in agricultural production to complement their domestic food supplies more than trade and income generation.

There are five agricultural policy improvements and support tools which have been introduced to support the sector. The first one is Broadening Access to Agricultural Thrust (BATAT), a programme initiated by the Department of Agriculture in 1995 as the application of the Reconstruction and Development Programme (RDP) within the agricultural sector. The second one is the 1995 White Paper on Agriculture policy, the main objective of which was to give support to the agricultural sector with the values and goals of the then "Interim Constitution of the Republic of South Africa", and to align the sector in attaining the objects of the RDP. The third one, the Strategic Plan for South African Agriculture, known as "The Sector Plan of South Africa", was made public by the Presidential Working Committee on Agriculture in 2001. It was an effort to promote closer partnership between government, the trading farmers' union, Agri South Africa, and the developing black farmers' union, National African Farmers Union (NAFU). The fourth one was the Integrated Food Security and Nutrition Strategy (IFSS), which was approved by Cabinet and is intended to reorganise, integrate, and incorporate the varied food security platforms into one structure. The fifth one, the Comprehensive Agricultural Support Programme (CASP), was launched in 2004 and is now being presented at the provincial level. The purpose of CASP is to improve the delivery of sustenance resources to grow the farming sector. It targets recipients of the Land Reform and Agrarian Reform programmes, handling the provision of

agricultural sustenance to numerous groups of recipients comprised of starving and vulnerable people, and subsistence and household food producers.

There are various programmes that are aligned with the White Paper to support the innovation ecosystem at a sub-national level. One example is the Regional Innovation Support Programme (RISP) that is aimed at increasing the spatial footprint of innovation in SA, improving inclusion, building more linkages across the NSI, adopting a broad concept of innovation beyond Research and Development (R&D), and increasing provision and collaboration with large and small firms. RISP promotes innovation through (i) platforms of innovation, hubs, and provision of access to infrastructure and networking opportunities, particularly for start-up firms, (ii) strengthening collaboration efforts between government, research institutions, industry, and society, (iii) creating partnerships between small and large firms to create tech-intensive companies, and (iv) promoting innovation through the Industry Innovation Partnership Program (IIPP) as a sub-programme.

The presence of strong innovation policy models in SA in the form of the NSI and NDP2030, which are strengthened by the 2019 DST White Paper (which supports innovation for social purpose and the creation of opportunities to promote innovation through the establishment of partnerships and collaborations among public and private segments) is a considerable achievement. However, in the agricultural sector, it is essential to incorporate Indigenous Knowledge Systems-based (IKS-based) informal innovations into formal markets to create employment opportunities, boost income, and create opportunities for sustainable livelihoods.

Previous studies show that agricultural innovation, skills development, and capacity building require government support with the participation of all players in the system of innovation to plan and implement innovative projects with success.

Santiago (2014) proposes a dual economic structure that is inclusive of the formal and informal economic activities, particularly where natural resource industries and cultural industries have a potential to become critical in job formation and income generation for women and the youthful generation. Cozzens and Sutz (2014) reinforce innovation in informal locations as central to the innovation process, calling for a study plan to inform innovation interventions from public and private sectors to enhance linkages between invention, livelihoods, and critical thinking in rural locations towards inclusive

development for sustained livelihoods. Informal settings are described as marginalised communities and households, including formal and informal economies within which the marginalised earn their living (Cozzens & Sutz, 2014). The paper describes inclusive development as the development of marginalised communities and households to enable them to take part in and benefit from economic undertakings, irrespective of their identity, and it is aimed at addressing the rising inequality that affects economic growth.

Sheikh and Bhaduri (2020) and George et al. (2012) discuss GI in rural settings, demonstrating linkages between rural actor networks and other stakeholders in the NSI, and highlighting collaboration and partnership efforts which are central for the upliftment of rural communities that this research study aims to address. Chataway et al. (2014) support this view of the participation of all contributors in the system of innovation to promote inclusive innovation, but also note the weakness in the introduction of policies that target inclusive innovation, identification of innovation opportunities, and the effective deployment and use of resources to develop and grow the economy.

2.5 NSI POLICY IN RELATION TO SOCIOECONOMIC CHALLENGES

The implementation of the NSI policy is significant in relation to the global challenges of poverty, the burden of disease, unemployment, and inequality that affect mostly developing and poor countries which have slow economic growth due to a substantial increase in poverty, unemployment, and inequality. Accordingly, underdeveloped economies face different systemic and infrastructural challenges and problems in comparison to developed countries that are leading in technological innovations. The choices about which technological innovations are best suited for developing countries will need to be addressed to promote innovation that works for poor and marginalised people. Cozzens and Sutz (2014) support the view that innovations need to be inclusive of marginalised people with systems that are pro-poor and require further support from the OECD Oslo Manual (2018), which presents an economic theory of innovation for inclusive growth policy that is pro-poor, supports economic growth, and uses an existing system, making the policy work for more people. Innovation for pro-poor growth is directed at producing products and processes that speak to the needs

of poor people through collaborations between public and private partners to fill gaps in the global system of innovation. Developments such as technological interventions in the global South requiring both public and private sector investment seek to promote inclusivity, to address the global South challenges, and to provide access to new opportunities in the form of income boost and job creation (Chataway et al., 2014). Interventions by TIA, an agency of the DSI, target inclusive innovation through the provision of funding the public and private sectors to promote sales and generate profits. However, because the areas of STI are main drivers of economic development and competitiveness that help countries to achieve their socioeconomic objectives, public sector actors in the innovation space need to play a much bigger role for effective promotion of inclusive innovation. This needs to be done through effective policy evaluation and measuring innovation to realise the impact on jobs, sustained livelihoods, and economic growth.

2.6 THEORETICAL AND CONCEPTUAL SETTING

2.6.1 National System of Innovation (NSI)

Manzini (2012) defines the NSI concept as an action or method at which a country pursues to generate, attain, diffuse, and apply new information that will assist a nation and its society to attain their objectives. The OECD is an early advocate of the NSI concept, a concept that was originally cited in the manufacturing revolution writings in later 1980s (Roseboom, 2004). The NSI has its origin in developed countries, becoming part of the terminology of policymakers in the developed world and slowly falling into policymaking spheres in emerging countries.

In SA, the NSI was introduced in the 1996 White Paper on Science and Technology, that became the basis of administration policy on science and technology. This set the scene for a structure that would concentrate on knowledge generation and application for the societal and economic progression of the country.

The NSI is a national innovation policy model that has been developed to promote innovation resulting in the promotion of job creation, sustainable livelihoods, and contribution to economic growth. There are four major sets of elements of the NSI (Liu

et al., 2011), which are shown in figure 1 below, a conceptual framework derived to study Asian economies. These sets of elements are as follows: (i) *Conceptual framing* includes ideas and policies that shape the complete scope; (ii) *Institutions, industry, technologies, and knowledge* enable the implementation of conceptual framing and policies aimed at building an efficient innovation system; (iii) *Means* such as incentives, investment, and infrastructure that are provided to the institutions; and (iv) *Implementation*, monitoring and evaluation of the first three sets. The first two sets are aimed at fostering collaborations between government as policymakers and providers of inducements, funding and infrastructure, and research organisations, business, technology, and knowledge generators.

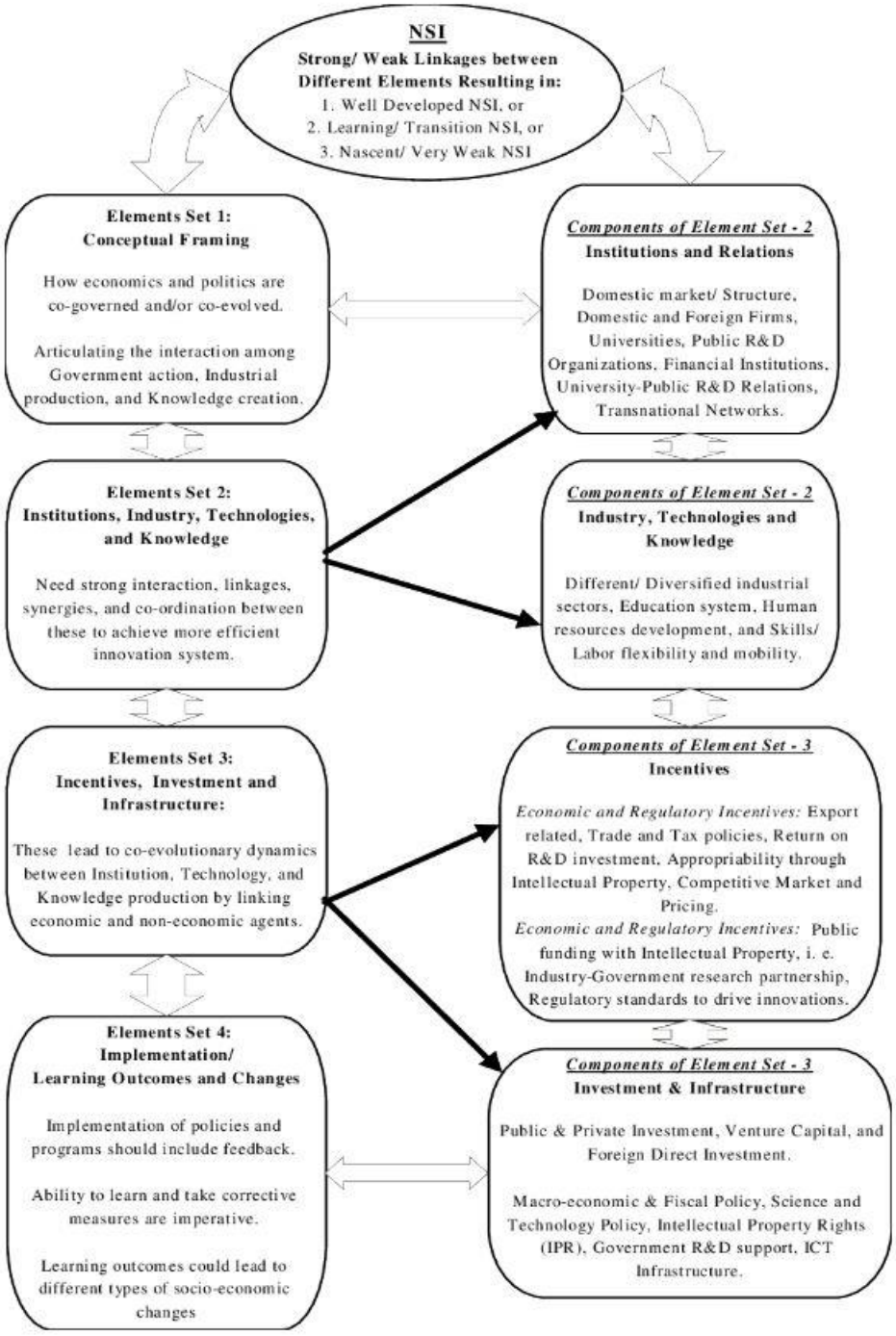

Figure 1: Four Major Sets of Elements of National System of Innovation (NSI)

Source: Liu et al. (2011)

Foster and Heeks (2013b) explain that systems of innovation, such as the NSI, are known to be a fitting structure for the conceptualisation of inclusive innovation. The authors further call for the change of the NSI structure to be inclusive of the nature of

innovation, the actors' involvement and their connections, the learning type undertaken, and the governance structure they operate in. The paper outlines four domains in the NSI that need be effective for the success of inclusive innovation, namely (i) the product, (ii) its trade and support, (iii) small businesses which offer demand side solutions, and (iv) the broader context of novelty.

2.6.2 Agricultural Innovation Systems (AISs)

AISs are viewed as a method that merges scientific, societal, financial, and institutional change (Klerkx et al., 2012). This process is the adoption of new technologies requiring the sense of balance among novel technical applications and different methods of forming marketplaces, employment, land occupancy, and delivery of welfares. Accordingly, knowledge generation and exchange, including policy, regulation, infrastructure, capital, and market developments, are fundamentals for innovation.

With the origins of the NSI concept in industrialised nations and its growing adoption in emerging nations (Roseboom, 2004), the NSI is applicable to the agricultural sector in developing countries, namely the AIS. The AIS provides the following: (i) a focus on the concept of innovation which entails the activities and procedures connected to the formation, supply, modification, and usage of new scientific, organisational knowledge; (ii) the concept of research as an innovation process that identifies actors which form partnerships or collaborations for research; (iii) acknowledging the importance and roles of technology producers and users; (iv) acknowledging the involvement, interests, and outcomes of institutions and organisations involved in promoting the involvement of poor and marginalised people in the fight against poverty; and (v) acknowledging innovation systems as social systems with a focus on the connections between actor networks, learning, and adapting processing for systems to be active and transformational.

AIS is described as a manner in which diverse players such as institutions, government, small businesses, and individuals interact to bring novel products, services, and procedures into financial use from partnerships and collaborations that foster interaction, sharing, accessing, discussion, and usage of understanding

(Harrigan et al., 2006, p. 16). Figure 2 below demonstrates the theoretical framework of AIS.

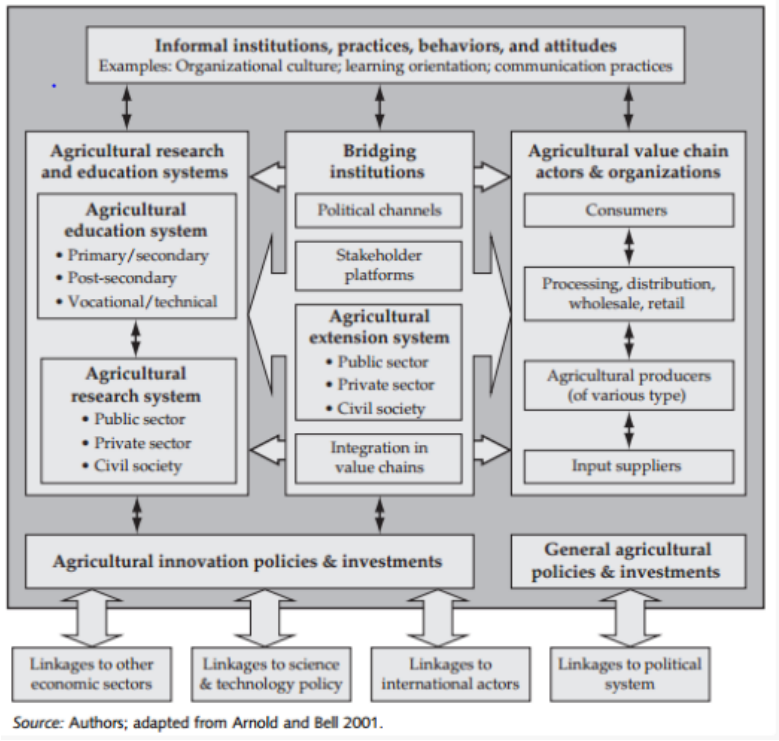

Figure 2: A conceptual diagram of a National Agricultural Innovation System

Adapted from Larsen et al. (2009)

2.6.3 Towards conceptual framework – Innovation for Inclusive Development

The proposed conceptual framework is Innovation for Inclusive Development, with a particular interest in small-scale farmer. This interest is in line with the study objectives of (i) exploring the constraints and challenges faced by innovators in the agricultural sector, (ii) exploring the shortfalls of innovation policies towards improving innovation in the agricultural sector, and (iii) investigating possible policy changes to promote inclusive agricultural innovation in SA.

In OECD (2015), Innovation for Inclusive Development is described as invention that promotes the inclusion of lower income groups to enhance the welfare of different groups in society through the modification of current machineries, goods, or services

to attain the desires of the different categories. To better understand inclusive agricultural innovation policy in resource poor areas, inclusive growth theory and inclusive innovation are adopted.

Inclusive growth theory suggests the active participation of poor people in the economy, resulting in broader entry to sustained social and economic prospects for a larger number of individuals, areas, or nations (Ngepah, 2017).

The focus of this research study is on poor and marginalised groups as innovators and consumers of innovation. These groups are able to produce innovative solutions that are cheaper and affordable for their settings. However, access to capital and infrastructure are key innovation policy interventions that should support innovation by marginalised people.

The OECD (2015) defines inclusive growth as a fair distribution of economic growth across society, creating opportunities for all, and inclusive innovation as the method of producing new products and services in the interest of and by poor and marginalised people who have been excluded from the mainstream economy. Inclusive growth alone is not a sustainable poverty alleviation strategy (Ngepah, 2017), hence the concept of inclusive innovation, particularly for developing countries, becomes a critical intervention in policy development to reduce poverty in the agricultural sector. Relevant to this is George et al.'s (2012) understanding of innovation that is best described using the inclusive growth theory in the evaluation of the relationship between poverty, employment, education, training, and skills development. Poverty in the informal economy is one dominating explanatory variable in both George et al. (2012) and Sheikh and Bhaduri (2020). This constitutes a large number of people deriving their livelihoods from informal economy, and there is no competitive strength to enter formal markets, locally and globally to earn foreign currency, due to regulatory compliance standards and low productivity levels in meeting market demands.

The concepts for innovation systems linked to this research study are the **NSI framework** in relation to its commentary on inclusiveness, and inclusive innovation and inclusive growth theories for inclusive development. George et al. (2012) describes the development of inclusive innovation theory as promoting inclusive growth in rural settings through technology localisation and entrepreneurship, aimed at encouraging the understanding of "**frugal innovations**" in the form of cost-effective

products, business models, and/or services originating from developing countries. Sheikh and Bhaduri (2020) propose informal innovations such as **Grassroots/Inclusive Innovations**, social value, and value of labour as alternatives to generate innovation and achieve sustainable developmental goals but highlight that these are faced with challenges of scalability and large-scale commercialisation in rural settings. Technology innovation and entrepreneurship are both central to the Mopani and Nkomazi case studies, with the main purpose of encouraging entrepreneurship and inclusive growth.

It is stated in George et al. (2012) that inclusive growth theory has been applied to some extent, however methodological challenges hinder empirical work on inclusive innovation. There are other theoretical and methodological paths such as inclusive growth and inclusive innovation that must be considered for future research, hence the interest in the researcher's proposal to establish the extent to which inclusive growth theory has been applied in the two case studies. Changes in policy and business practices, which include the formation or establishment of formal collaboration agreements between public and private partners, must be considered for sustainable livelihoods and enhancing the existence and wellbeing of underprivileged people.

Sheikh and Bhaduri (2020) note the failure to see the value in innovations for social use due to a lack of market presence which leads to a lack of profits. This is attributed to large scale commercialisation of products and services required to meet market demands. However, they further note that a lack of market presence of these innovations does not imply a lack of their social use; this can be attributed to the fact that the preference of social innovators is to distribute them in their surroundings to obtain a response on the effectiveness of the product and thereby making exchanges among community members with mutual benefits. This research study accordingly aims to (i) identify the challenges faced by rural enterprises in entering formal markets locally and globally to earn foreign currency and grow their businesses, (ii) pilot to full scale manufacturing requirements to promote commercialisation by rural enterprise businesses, and (ii) entry to the market and penetration of products and services beyond community settings.

George et al. (2012), Sheikh and Bhaduri (2020), and Cozzens and Sutz (2014) discuss the concept of inclusive growth and its linkages with innovation and entrepreneurship. They highlight issues of innovation for poor and marginalised people in rural settings and the role of innovation in inclusive development, and this will provide insights for the case study analysis for the selected Nkomazi and Mopani areas.

The concept of **Inclusive Innovation** discussed in George et al. (2012) is in relation to **inclusive growth**, and both concepts are used interchangeably in this study to understand opportunity creating innovations for improved livelihoods of poor and marginalised people. These concepts are concerned about the effect of inclusive innovation on the lives of marginalised people.

Innovation for inclusive development

The inclusive innovation concept in Foster and Heeks (2013a) is illustrated with narratives from the digital phone segment in Kenya that has managed to scale innovations to poor consumers. The paper analyses the role of supporting innovation systems, regulations, and policy implementation on inclusive innovation. The two parts, namely cellular phone supply and mobile cash services (M-Pesa), were examined and the study established that there is policy support for accessing goods and services by the majority of the population in Kenya, with a mix of technology transfer to mobile handsets and technology localisation for mobile money services. The study involved conducting interviews with players in the system of innovation, from government to private and public service providers, and data gathering and analysis in relation to the two sub-sectors. The research found the mobile handset supply sector had the involvement of actors from poor communities which form part of the innovation system, and the process was thus inclusive and ensured goods and services were developed to address the needs of and accessibility to poor consumers. In terms of the mobile money services, the study found the potential of M-Pesa to compete with other commercial banks due to having more people accessing the service, leading to growing demand. Foster and Heeks (2014) provide further analysis of this case and introduce a conceptual model of user-producer interaction in understanding innovation flows and linkages between users and producers. The authors argue for firms localising innovation for low-income groups to promote

profitability and inclusivity, and for actors in the system of innovation to work with localised innovation processes and be inclusive of local innovators. The study found that linkages and connections between producers and users are important to identify the local needs and technologies to be adapted and modified in support of localised innovation that is inclusive.

Effective regulatory frameworks on how firms can match suitable innovation efforts to the desired outcomes and lack of support in the form of government policy programmes for infrastructure and funding support are key innovation barriers in the public sector domain, specifically for the developing economies in Africa. These barriers have resulted in failures in the system of innovation, and they include taxation, which influence the price of commercial undertakings and the effective usage of tax by government to support innovative firms, a lack of leadership to effect change towards inclusive innovation, and the political and economic uncertainty to attract investment. Accordingly, this necessitates the evaluation of policy and its related programmes to assess policy being implemented as planned and its anticipated impact, including the optimal use of funds in programmes supporting policy implementation to reach the expected outcomes together with the efficient allocation of resources. It is therefore important that policies and programmes are evaluated to establish which ones work, key success areas, and learnings from failure that are linked to policy outcomes, in order to determine which policy is needed for inclusive innovation.

The dominant theories applicable to the research topic for this study are inclusive growth and inclusive innovation, shown in figure 3 below. The two frameworks that have been reviewed to illustrate these theories are AISs within the NSI framework and innovation for inclusive development, and these are the focus of this investigation study. Both frameworks are vital in the context of SA, a developing country faced with socioeconomic challenges and challenges to boosting economic growth.

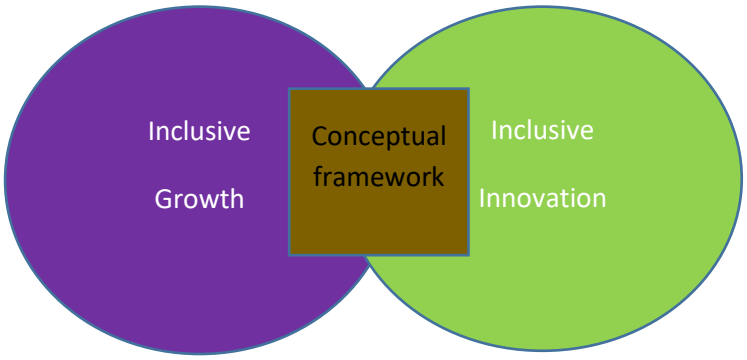

Figure 3: Theoretical frameworks

The theoretical frameworks in figure 3 above form a joint framework shown in figure 4 below, and this is the proposed framework for this study, namely innovation for inclusive development.

Figure 4: Conceptual framework

Klerkx et al. (2012) present a broad view on agricultural innovation, stating that it is understood as an outcome of numerous interactions among parts of agricultural structures, supply networks and financial structures, strategy settings, and social structures. This study wishes to demonstrate that innovation extends beyond

technology, as an inclusive image of forecasting the future requiring changes in numerous spheres of the system of innovation. The biggest consideration for the study will be the drivers of innovation, which are centred on the needs of the people, motivations, and aspirations, and require mind-set changes and shifts from people holding diverse roles in social settings in the manner they perform and live innovation. This becomes an outcome of AIS.

2.7 THE NSI FRAMEWORK IN SA

The NSI is a national innovation policy model that has been developed to promote innovation, resulting in the promotion of job creation, sustainable livelihoods, and contribution to economic growth. Under the policy model, the DST's key innovative initiatives are the building of local innovation systems, development of national science parks, industry innovation partnership initiatives, and the sector-specific innovation funds as stated on the SA government website (http://www.dst.gov.za/). The formation of local innovation systems is intended to provide networking opportunities, promote innovation, act as community of practice, inform regional policies, and initiate the management of funding opportunities. The development of national science parks aims to grow and support the NSI. The website (http://www.dst.gov.za/) further states that the objective of the industry innovation partnership initiative is the formation of an enabling environment wherein government can collaborate effectively with industry to co-fund research development and innovation (RD&I) in key strategic segments of the economy. Lastly, the sector-specific innovation funds initiative is aimed at providing co-investment opportunities between government and industry, to improve competitiveness and promote job creation. These initiatives fall under the Sector and Local Innovation Directorate, with the sole purpose of strengthening the NSI to improve economic growth. Niosi et al. (1993) describe the DST's NSI as a structure that fosters interactions between private and public businesses, and research institutions, and is aimed at producing science and technology inside domestic borders. Interchange among these actors might be scientific, profitable, legal, communal, and monetary, for the growth, protection, funding or rule of novel science and technology.

The DST, as stated on its website (http://www.dst.gov.za), aims to strengthen the NSI through the formation of partnerships between institutions of higher learning and research institutions, and the business to strengthen their participation in the R&D value chain. Freeman (1995); Nelson (1993), and Lundvall (2007) support the DST's strategy in stating that the basic insight of innovation systems is that scientific and technological knowledge require a system of other actors in order to be diffused throughout an economy, society, or nation. It also aims to strengthen the NSI by coordinating and facilitating local innovation interventions.

On the basis that SA is a middle-income country, Lee (2013) views the DST initiative as a policy agenda that aims to build capabilities and create innovations in developing NSI. The specific actors that are part of the DST's "narrow" system of innovation are mainly government agencies, namely the Technology Innovation Agency (TIA), the South African National Space Agency (SANSA), and the Council for Scientific and Industrial Research (CSIR). It is important to note Lundvall et al.'s (2009) definition of the narrow system of innovation as "being inclusive of universities", which are not listed as actors in the DST strategy document as it stands.

The DST website (http://www.dst.gov.za) details the specific actors in the DST's "broad" system of innovation which are critical for the attainment of the desired outcomes. These are the educational system, the financial system, the environmental competition, the policy environment, and the labour market, as indicated in figure 5 below. The desired outcomes of this innovation system are to increase the domestic market demand, to grow indigenous firms with technological capabilities, training and skills development, and learning innovations for products to compete internationally.

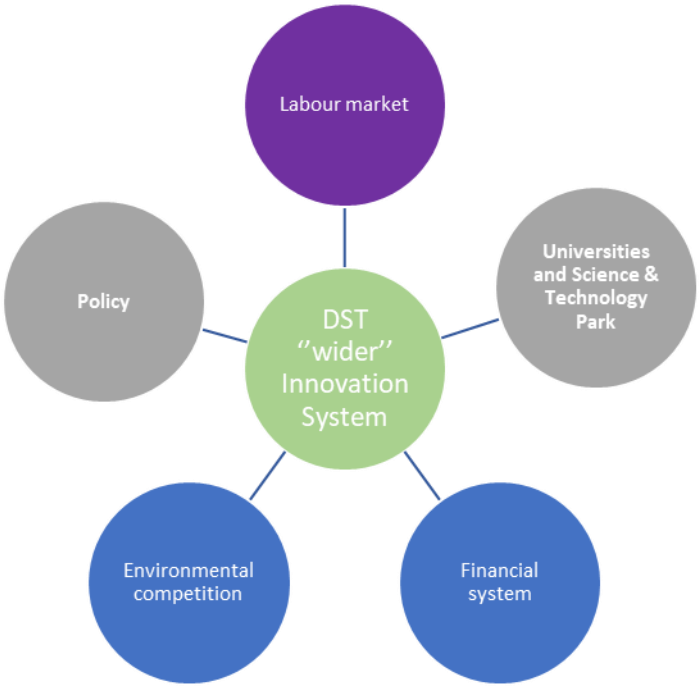

Figure 5: DST actors and institutions in its "wider" System of Innovation

The DST's strategy highlights the importance of effective collaborations between the role players within the bioeconomy if it is to succeed. The department's commitment is to create an enabling environment for all role players in the bioeconomy that include various government departments, industry, the broader public, universities, research institutions, and entrepreneurs. Studies reveal that the NSI can be developed through the formation of meso-level partnerships, sector innovation planning, and innovation programmes. The meso-level partnerships are critical in the bioeconomy, as they focus on delivering the local objectives. An example is the proposal which was submitted by the CSIR and the University of Pretoria to the Gauteng provincial government to establish The Innovation Hub (TIH) complex, which would be used to deliver the province's targets on enterprise development to promote job creation. TIH later assisted the establishment of the Science and Technology Park in East London.

The linkages (that is, partnerships and collaborations) between universities and other knowledge producing institutions are that the bio-economy strategy is designed to have a technology-push approach and a market-pull approach, to address SA's developmental goals and needs as well as its industrial and sector specific competitiveness. A technology-push approach is linear and R&D-focused, while a

market-pull approach is more defined with emphasis on the market (Soumonni, 2020). The universities, research, and scientific institutions will provide R&D measures such as education, training and skills development, production engineering, design, and quality control for the promotion of novel and enhanced goods and processes (Lundvall et al., 2009).

The features of the DST's innovation policy are macro-level innovations to promote economic development, and micro-level innovations to create and grow novel industries that generate bio-based products, services, and innovations. Macro-level innovations require government intervention for policy development and research institutions for efficient technology innovations and diffusion. The challenges at macro-level are making SA to compete globally, to generate maintainable jobs, and to elevate food certainty.

Global competitiveness of products and services is highly dependent on developed technologies, localised innovations that can be borrowed from foreign countries, investment in R&D, knowledge, skills development, and hands-on training in production. This is supported by Soumonni (2014), who describes the NSI framework as showing how the actors such as businesses, institutions of higher learning and research institutions obtain knowledge externally, generate novel understanding, and disseminate knowledge to additional sectors. Global competitiveness therefore requires coordinated efforts among all role players in the NSI with high levels of commitment.

Sustainable job creation can be achieved through programmes such as internships to train and upskill graduates to be absorbed into formal markets and Small and Medium Enterprise (SME) development with the exclusion of micro-enterprises. The reason for the exclusion of micro-enterprise, in this researcher's view, is that they need a lot of funding sustenance in the form of government grants and are measured on innovative products or services developed only. Micro-enterprises should therefore not be expected to create jobs.

The enhancement of food security will require an element of innovation using indigenous foods which are traditionally known to be highly nutritious. The inclusion of IKS-based innovation in the bioeconomy is aimed at providing innovative food solutions for the development of the agriculture, health, and industry sectors.

The upgrade of the DST's own learning and innovation capabilities, through the use of natural resources innovation and processing infrastructure development in rural settings which are near indigenous natural resources, will determine the NSI's strength for success. SA is a late-comer country in this regard, and its learning and technical capabilities are deeply rooted in strong collaborations between public and private research from universities, organisations, firms, and government into policy and regulation, to support the catch-up process (Lee, 2013).

Natural resource innovations in plant biodiversity include food products, health products, and personal care products. Research institutions and universities should facilitate the development of processing infrastructure and training of communities in rural settings for the production of natural ingredients and to promote job creation, while product formulation, development, and production can take place in urban settings that have transport infrastructure for both local and global markets. In this regard, SA will make use of "learning by doing" in the development pilot processing facilities, "learning using" through the training of communities in processing methods, and ''learning by interacting'' to source the plant material from communities and the full-scale production by firms thereof. The country's failure to upgrade its learning and technical capabilities may result in being stuck in the "middle-income trap", which is when the country's economy is failing to advance to high value-added products and is limited to performing low value innovation activities in the global value chain (Lee, 2013).

In order to be beneficial to the wider society, the bio-economy strategy will have to address SA's three-way threats of disparity, deprivation, and joblessness. The proposed IKS-based innovation is novel with endless opportunities for communities to get jobs and generate income. Access and Benefit Sharing Agreements (ABSA) will have to be in place, especially where there is prior knowledge of the indigenous resource by communities in which they must benefit financially. The website of the Department of Forestry, Fisheries and the Environment (http://www.environment.gov.za) describes ABSA as an agreement defining the fair and reasonable distribution of welfares resulting from the usage of hereditary supplies. It is key to note that in this natural resource-based sector, the initial conditions for entry and initial growth may require the government to supply large investment funds. This can be done through government grants to develop the sector.

2.8 IMPLICATIONS FOR INNOVATION MANAGEMENT AND POLICY

In the review of the DST White paper, Walwyn (2016) notes low technology outputs in the form of patents and high-technology exports, while public investment in RD&I has been high, This is due to conflicts and demands between long-term policies such as the NSI supporting the innovation ecosystem at national level and shorter term welfare programmes such as the Regional Innovation Support Programme (RISP) that is aimed at increasing the spatial footprint of innovation in SA. The latter would enhance inclusion and construct more connections across the NSI, adopt a broad concept of innovation beyond R&D, and increase support and collaboration with large and small firms.

Global South challenges facing SA that need to be resolved for the effective implementation of DST plans in STI towards full employment economy include the innovation capability that is not developed, the absence of the relationship between governance structures and innovation, a unionised labour market, entrepreneurship that is yet to be developed to capacity, and human capital development in STEM.

Walwyn and Cloete (2018) note with concern the contribution of science and technology that needs to be strengthened to address SA's socioeconomic challenges. They highlight policy gaps in the Draft White paper on STI such as (i) human capacity that is not developed, (ii) administration of research organisations for knowledge generation, and RD&I outputs such as journals, copyrights, spin-out businesses, agreement R&D, and accomplishments in research, (iii) policy mix and experimentation in innovation studies that take a holistic approach in addressing the socioeconomic challenges towards transformative innovation, and (iv) economic development steered by scientific innovations in the form of the transfer and diffusion of technologies. The authors suggest a clear strategy that links human capital development (HCD) to economic development because investment in STEM yields higher income and contributes to economic growth, public research institutional reform for knowledge generation, transformative innovation that is inclusive and sustainable, measures to increase funding for innovation, and interventions in STI that are directly linked to economic development and employment creation.

The significance of this study to the Ramoroka et al. (in press) paper, that wishes to address an ontological question in showing relations between the NSI concepts within

the rural sector, is on rural agroprocessing enterprises that the study aims to analyse for inclusive innovation. Chataway et al. (2014) argue that the concept of inclusive innovation needs to be understood and developed holistically within the innovation cycle, and there needs to be a clear difference between procedure and invention development with the roles of underprivileged people being equally creators and customers of innovation. The authors, however, note the challenges and problems of poor infrastructure and an unskilled work force that disadvantage poor people from producing products of high-quality standards to meet the needs and requirements of rich people.

2.9 DEFINITION OF KEY TERMS

Inclusive growth – is a performance outcome derived from innovative initiative targeting the poor and marginalized (George et al., 2012).

Inclusive innovation – is a process that seeks to address the inequalities affecting the marginalised through the development and commercialisation of innovative initiatives (George et al., 2012).

Inclusive development – development that includes poor and marginalised people in the socioeconomic, environmental, and political sectors to promote economic growth (Cozzens and Sutz., 2014)

Innovation – is the successful introduction of new products, goods or services in the market (Sheikh & Bhaduri, 2020).

2.10 HYPOTHESES

The NSI is not shaped or formed to work towards resolving the issues of food safety, unemployment, and the burden of diseases in the Farming sector:

Based on research papers and the researcher's experience in this area, the NSI policy is indeed shaped to work towards resolving societal challenges. However, this research study is aimed at analysing the management of the NSI policy and

recommending changes that will yield better policy implementation through monitoring and evaluation.

Technological innovations in agriculture cannot enable better and sustainable farming practices:

This research study will examine the influence of technological innovations, such as reliable electricity supply through wind and solar farms to boost efficiency and reduce food waste, internet connectivity that can open opportunities for market access, and digital technologies to analyse the soil, predict crop yields, and assist growers to monitor climate and vegetation challenges, for agricultural sustainability.

The adoption of inclusive growth policy has no effect on inequality, poverty, and unemployment:

Social inclusivity which provides entrepreneurs with access to opportunities to promote innovation has the potential to reduce the inequalities between rural and urban businesses. This research study will investigate the impact of inclusivity on reducing poverty and promoting employment creation opportunities.

Sheikh and Bhaduri (2020) support the adoption of inclusive growth policy through their concept of grassroots/inclusive innovations and value theories in the informal economy that is faced with challenges of poverty, skills shortages, and unemployment. The article states that these grassroots and value innovation theories make up people-centric values which suggest new understandings in innovation discussions in formal and informal locations, and social beliefs between members of the community that produce value in innovation.

2.11 CONCLUSION

In this chapter, the concept of innovation in relation to marginalised rural communities was discussed, with the NSI approach as a conceptual framework for a true and all-inclusive study of current innovative undertakings. A literature review on farming innovation and inclusive agricultural innovation highlighted that the relationship among innovation systems and their setting is key for AISs.

Innovation policies supporting the agricultural sector in SA are the NSI and the DST White paper on Science, Technology and Innovation, with sector-specific agricultural policy reforms and support instruments, such as CASP, aimed at improving the provision of support services for agricultural development.

Innovation for inclusive development is discussed as a theoretical framework as it promotes the inclusion of lower income groups to improve the wellbeing of different groups in society. Accordingly, this chapter highlights the NSI as a national innovation policy model that has been developed to promote innovation resulting in the promotion of job creation, sustainable livelihoods, and contribution to economic growth. Its role on regulatory and policy implementation to support inclusive innovation is discussed.

The two key frameworks reviewed for the study are AISs within the NSI framework and innovation for inclusive development. These are used to illustrate the dominant theories applicable this study, namely Inclusive Growth and Inclusive Innovation.

The literature review shows that while theoretical and empirical work on innovation has been done in the form of identifying effective supporting policies, institutions, and framework conditions for innovation, further work is still required to evaluate and measure government support for innovation in the form of supporting policies and their impact on innovation.

CHAPTER 3: RESEARCH STRATEGY AND METHODOLOGY

3.1 INTRODUCTION

Chapter three is aimed at describing the study design and methodology that have been accepted to provide answers to the key research problem for this work. The following elements will be discussed: (i) research design, (ii) research methodology, (iii) limitations of the study, and (iv) ethical considerations.

3.2 RESEARCH DESIGN

The selected study approach for this research is a relative narrative method with two case studies from the Mopani district municipality and Nkomazi local municipality. The reasons for selecting this research approach are that agricultural sector activities and innovations occur in rural settings, which face socioeconomic challenges of high unemployment rates, poverty, and inequality. It therefore makes sense to do a comparative study to understand the opportunities that can be created, through inclusive innovation policy that supports and promotes innovation for social and economic benefit in agriculture, to address societal challenges. Qualitative research method is used for data analysis to understand the characteristics of the agricultural sector in Mopani, Limpopo and kaMaqhekeza in Mpumalanga. The study further explores the need for policy change to promote smallholder agricultural innovation, through the investigation of innovation policy gaps in relation to catering for the small-scale producers that hinder innovation in marginalised rural areas. The qualitative method of research is described as drawing data from numerous sources of evidence looking for convergence and validation using diverse data sources and approaches such as documents, interviews, observations, and physical objects (Bowen, 2009). The reason for selecting the qualitative methods analysis is because it is considered a form of social inquiry to explore, collect data, and draw conclusions in a particular area (Ritchie & Lewis, 2003). The method allows for exploring varied viewpoints and to unearth existing connections between the complex levels of the intricate research questions. It is stated in Yin (2003) and Kennedy et al. (2011) that a qualitative research approach is the best model for understanding societal realities as it includes

emotional states, feelings, inspirations, insights, self-described behaviour, and the connections between the social actors involved.

This selected design is an appropriate method as it will yield an in-depth understanding of complex issues in a real-life context. An analysis of the two case studies will determine their uniqueness or if they are representative of other cases, and evidence will be drawn from these two cases based on main and secondary information in the form of documents, websites, in-person interviews, site visits, and participant observations.

This approach will produce insights from policy documents and a set of answers to interview questions. The units of analysis include complete responses to the interview questions together with entries from the research participants or rural entrepreneurs. The questionnaire includes questions about the participants' age, gender, background experience, and level of education.

3.3 DATA COLLECTION

Data collection was included both primary data collection and secondary origins of information. Secondary information was gathered from a document analysis of peer-reviewed articles and case studies, and main data was gathered by in-person meetings making use of participant-observation surveys. Both the secondary and primary data sets were evaluated and then integrated with each other.

3.3.1 Study area

The study was carried out in two municipalities based in two provinces. One is Mopani municipality based in the Limpopo province and the other one is Nkomazi municipalities based in Mpumalanga provinces. The subject of interest in these areas was smallholder farmers that are actively involved in their farming and agricultural operations. The growers were reached through the help from the officers in the municipal and service centres offices of agriculture in both provinces.

3.3.1.1 Description of the study area: Mopani District Municipality

Mopani is a district in the Limpopo province in SA comprising five local towns, namely Ba-Phalaborwa, Greater Giyani, Greater Letaba, Greater Tzaneen, and Maruleng (Figure 6). The municipality website (https://municipalities.co.za/overview/128/mopani-district-municipality) lists the main economic sectors in the area as extraction of minerals (30.1%), public offices (22.6%), commerce (14.6%), economics (14.6%), transportation (8.2%), farming (3.2%), energy (2.8%), and building (2%). It further states that the area faces the challenges of high youth unemployment between the ages of 15 and 34, with the education level of people aged 20 and above being mainly matric.

According to the Mopani government website (http://www.mopani.gov.za/local_economy/agriculture.php), the Lowveld region of Mopani district contributes about 50% of the farm income in the province from horticulture, with citrus, vegetables, and subtropical fruits being the most important crops with respect to monetary value. The website further states that the district has 6.7% arable land with 43% of the land under irrigation. South Africa's agricultural economic environment is very hostile requiring farmers to discover new methods of creating extra income. Myer and de Crom (2013) identified agritourism in Mopani as a potential means to earning income. The key study finding was that agritourism was not used to its full potential in the area, and with tourists go across the district to the Kruger National Park, this presents an opportunity to host agritourism activities such as the sale of fresh produce through farm trails for local farmers to earn income.

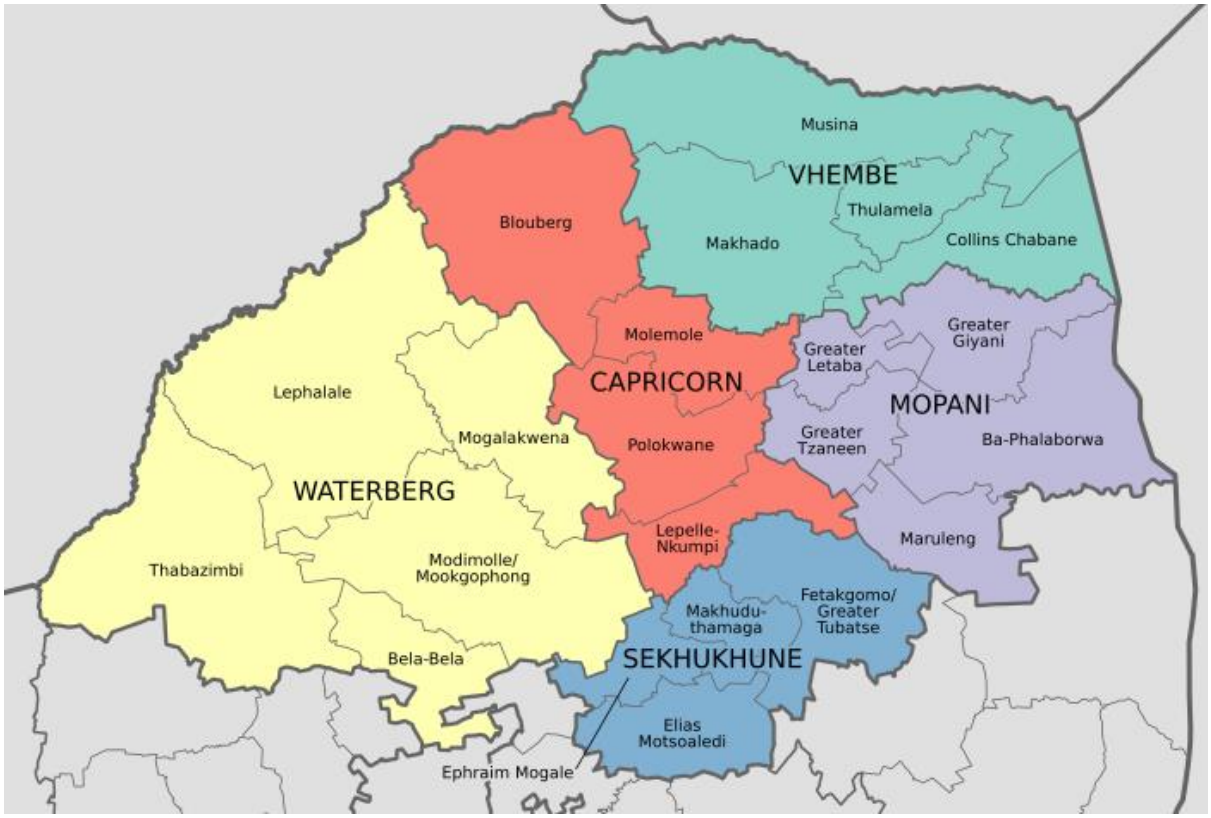

Figure 6: Location of the study: Mopani District Municipality

3.3.1.2 Description of the study area: Nkomazi Local Municipality

Nkomazi is located in Ehlanzeni District Municipality in Mpumalanga, between the northern side of Swaziland and the eastern side of Mozambique, also surrounded by the Kruger National Park (Figure 7). The municipality's main economic sectors (and therefore the main sources of employment) are agriculture, mining, and tourism. The municipality website (https://municipalities.co.za/demographic/1144/nkomazi-local-municipality) states that the area faces challenges of high youth unemployment between the ages of 15 and 34, with the education level of people aged 20 and above being mainly matric. This is very similar to the information presented for the Mopani district municipality.

According to the Nkomazi government website (https://www.nkomazi.gov.za/generalservices.html), agriculture contributes 14% to the economic activities and is recognised as one of the regional sources for economic development and job creation, with communities having the prospective to

manufacture products that can be traded to local community members to reduce deprivation.

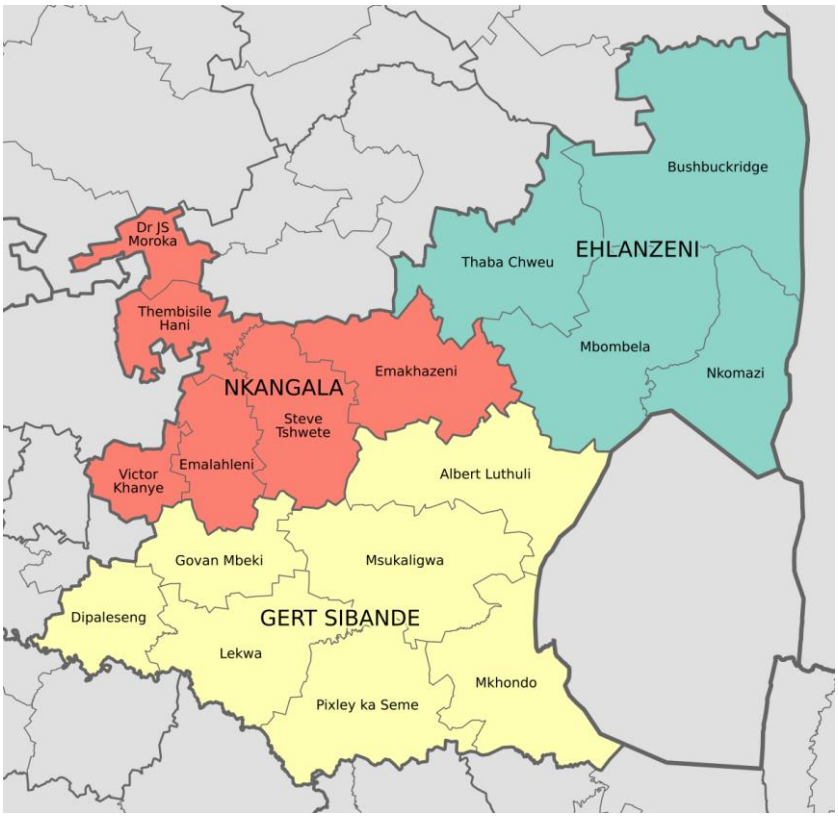

Figure 7: Location of the study: Nkomazi Local Municipality

3.3.2 Secondary data: Policy documents review

The second source of data collection was the review of the NSI policy documents which speak to agricultural sector innovations. This research study evaluated the 1996 White Paper on Science and Technology, the 2008 White Paper on Science and Innovation, and the 2019 Draft White Paper on Science, Technology and Innovation. These papers have been selected for the following reasons: the 1996 White Paper focuses on the use of science, technology, and innovation for the acceleration of inclusive economic growth to develop a competitive economy and improve livelihoods, the 2008 White Paper focuses on science, technology, and innovation as enablers of maintainable and all-inclusive growth in a changing society, and the 2019 Draft White Paper focuses on innovation for inclusive and sustainable economic development.

3.3.3 Primary data collection from participants

The third source of data collection was primary data collection, which was carried out through the selection of participants who then answered a number of questions.

A random sampling method was used for the research, with an over-all of 30 partakers chosen to answer the research questions.

The first part of the questionnaire only asked about variables like the age group, masculinity, background experience, education level, and area of residence of the participants. The second part was comprised of research questions pertaining to the topic.

The interviews were conducted through the answering of research questionnaires by participants. A research questionnaire was prepared and has been attached to the report. There are two sections in the questionnaire: (i) section one asks for personal information about the participants' age, gender, background experience, level of education, and area of residence without identifying the individuals; and (ii) section two contains the research questions related to the topic.

The research questions to be answered are as follows: what problems and challenges of innovation in the agricultural sector are faced by rural entrepreneurs in entering formal markets? What gaps and barriers are there to commercialising and to achieving full scale production?

The sub-question is about the role of the NSI in promoting inclusive innovation through partnerships and collaborations: Do participants feel enough is being done by all parties in the NSI for inclusive innovation, and what are the gaps in the policies that support innovation in agriculture in SA? The proposition is for the adoption of inclusive growth policy to reduce inequality, poverty, and unemployment. Do participants feel policy adoption will make improvements in their livelihoods and what possible policy changes can be adopted to promote inclusive agricultural innovation in SA?

3.4 DATA ANALYSIS

3.4.1 Secondary data analysis

Policy document analysis, namely the 1996 White Paper on Science and Technology; the 2008 White Paper on Science and Innovation; and the 2018 Draft White Paper on Science, Technology and Innovation was used to investigate the secondary data. The analysis involved the review of each policy objective, the type of support it aims to offer, the primary actors and beneficiaries, and the benefit to rural smallholder farmer. The applied exploratory data analysis in qualitative research was used to investigate the constraints of innovation in the small-scale agricultural sector.

3.4.2 Primary data analysis

Interview questionnaires were used to collect primary data, and the analysis entailed descriptive data analysis with the use of self-governing variables to explain the reliant variable. This included the analysis of variables such as inclusive collaboration efforts, the role of innovation theories in uplifting rural enterprises through skills development and training, the commercialisation of developed innovations to earn income, and the opportunities for job creation that will yield to sustainable livelihoods. The reason for the selection of these variables is because they speak to inclusive innovation for economic development.

The inclusive growth theory presents a framework with three building blocks. These are (i) the global challenges for inclusive innovation such as poverty, access to technologies, and skills development, which can either constrain or enable innovation; (ii) the enablers of inclusive innovation, which are firms that need to generate innovation for inclusive growth and socioeconomic growth opportunities; and (iii) inclusive growth which speaks to the collaboration of activities between public and private stakeholders and sharing of resources to promote inclusive and much needed growth. Collaborative efforts need to be intentional, in this researcher’s view, and constitute minor and incremental changes to the current processes among big firms, corporations, and small enterprises.

The methods of analysis are in accordance with the theories of inclusive innovation and inclusive growth. The inclusive innovation framework aims to address inclusive

growth and frugal innovation theories. The analysis of inclusive growth theory in George et al. (2012) illustrates insights into and challenges with resource management, innovation networks, governance and ownership, costs, strategy and marketing, stakeholder relations and IP rights, and innovation adoption. The critical analysis of frugal innovation theory in Sheikh and Bhaduri (2020), in turn, provides direction on inclusive innovation by presenting innovations in the informal economy or GI and the value theory.

Sheikh and Bhaduri (2020) state that the focus of innovation policies, in their current form, is on generating and growing the value of innovations through the promotion of large-scale commercialisation, and this is not enough for community and enterprise development due to challenges related to accessing infrastructure and funding. The authors further state that a framework to boost alternative approaches to innovation is needed to attain the Sustainable Development Goals.

3.5 LIMITATIONS OF THE STUDY

The limitation of this study is that it is a cross-sectional study of 30 smallholder farmers in two areas and therefore cannot be used to generalise about all smallholder farmers in South Africa. The longstanding impact of the findings has not been revealed in the study and this presents gaps for future research. Further studies should consider a larger sample of smallholder farmers and other possible types of innovation in the agricultural sector.

The study had the potential for a number of limitations due to the language barrier and the level of education among some farming enterprises, and this could have negatively or positively influenced interactions with the participants in the study. These limitations include:

- SiSwati and Sepedi are the dialects that are mostly articulated in the Nkomazi and Mopani study areas respectively. The researcher had to rely on the interpreter for information exchange during the questionnaire sessions with farming enterprises.

- Education and literacy levels among farming enterprises might have required the researcher to ask the questions and complete the questionnaires during interview sessions.

3.6 ETHICAL CONSIDERATIONS

The study followed the research ethics process because it involved human interaction, which required consent from the participants and clearance from the ethics committee to conduct the study. The application process started with the completion of the ethics application form to assess the threat of conducting the research. This form was evaluated by the ethics committee and, because the risk was found to be low, the committee granted the certificate for the study to go ahead (Ethics protocol number: WBS/IS1798370/814). The ethics committee considerations included voluntary participation and informed consent forms from either the participants or the organisation(s) to be researched, which were submitted with the application form. This was a critical step to the research to avoid placing participants at risk. No names of participants were used in the questionnaires, the completed questionnaires were handled and stored with strict confidence, and the data was only used for the research study.

3.7 RELIABILITY AND VALIDITY

The qualitative research methods approach allowed for the collection of data and examination, whereas the comparison of the two studies in different areas provided a better understanding of the two cases for contributions to policy decision-making. The three different data collection methods used in the study enabled the achievement of data triangulation to produce case study findings that are convincing and accurate as the result of the different sources of data (Yin, 1999). This opinion is reinforced by Saunders et al. (2013), stating that the triangulation method affords the researcher the opportunity to detect and analyse an occurrence that has been considered by few individuals before. Saunders et al. (2009) describe triangulation as the technique of using diverse data gathering methods in research to guarantee that the data is expressive of what you think it should be telling you.

CHAPTER 4: FINDINGS OF THE STUDY

4.1 INTRODUCTION

This chapter gives out the research detections that have been gathered from participants through participant-observation meetings, the evaluation of policy papers in science, technology, and innovation, and the agricultural innovation case study review. The focus was on investigating the role that inclusive innovation policies can play in improving agricultural innovations in the informal sector. The findings for each research question are presented and illustrated in this chapter.

4.2 DEMOGRAPHIC PROFILES OF PARTICIPANTS

4.2.1 Selected smallholder farmers in Mopani

Fifteen smallholder farmers from Mopani took part in the research study and all interviews were conducted in-person. These meetings were part of the main source of information. A summary of the profiles of the selected smallholder farmers (denoted SHF1 to SHF15) is presented in Table 1 below. The smallholder farmers differ in gender, age, education levels, business activities, markets, and farm sizes. The participants are mostly male, making up 66.7% of the population sample, with the age ranging from 34 years to 69 years. The proportion of female farmers makes up the balance of 33.3%, with the age ranging from 31 years to 64 years. The highest education level of the population sample is secondary schooling, making up 53.3%, with 33.3% having a university qualification and the balance having primary schooling. Agricultural enterprises in the area farm for commercial purposes, with farming as their key source of earnings. The farmers have registered businesses to trade in the formal local markets in Limpopo and the Johannesburg market in Gauteng. The farm sizes range from half a hectare to one hectare to serve current markets, with a potential to plant at large scale if the challenges of farming inputs are addressed. This will enable farmers to explore other markets in the neighbouring Mpumalanga province. Sales are conducted through agencies in the local market, and agency fees, packaging for the fresh produce, and transport to markets have been listed as some of the difficulties the farmers are faced with in terms of innovating and producing at full scale.

Table 1: Demographic profile of the smallholder farmers in Mopani

No.	Code	Gender	Age	Education level	Business activity	Markets	Farm size
1	1SHF	Female	60	Primary school	Fresh produce	Local	0.5ha
2	2SHF	Female	46	High school	Fresh produce	Local	0.5ha
3	3SHF	Female	31	University degree	Fresh produce	Local	0.5ha
4	4SHF	Female	60	University degree	Fresh produce	Local & interprovincial	1ha
5	5SHF	Female	64	University degree	Fresh produce	Local & interprovincial	1ha
6	6SHF	Male	69	High school	Fresh produce	Local	0.5ha
7	7SHF	Male	67	High school	Fresh produce	Local & interprovincial	1ha
8	8SHF	Male	65	University degree	Fresh produce	Local	0.5ha
9	9SHF	Male	65	High school	Fresh produce	Local	0.5ha
10	10SHF	Male	54	High school	Fresh produce	Local	0.5ha
11	11SHF	Male	54	High school	Fresh produce	Local & interprovincial	1ha
12	12SHF	Male	49	High school	Fresh produce	Local & interprovincial	1ha
13	13SHF	Male	46	High school	Fresh produce	Local & interprovincial	1ha
14	14SHF	Male	36	University degree	Fresh produce	Local	0.5ha
15	15SHF	Male	34	High school	Fresh produce	Local	0.5ha

4.2.2 Selected smallholder farmers in Nkomazi

A total of fifteen smallholder farmers from Nkomazi took part in the research study and all interviews were conducted in-person. These meetings were part of the main source of information. A summary of profiles of the selected smallholder farmers (denoted SHF16 to SHF30) is shown in Table 2 below. The smallholder farmers differ in gender, age, education levels, business activities, markets, and farm sizes. The farming enterprises in the area are mostly female led, making up 60% of the population sample

with the age ranging from 48 years to 81 years. The male population sample makes up the remaining 40% with the age ranging from 30 years to 71 years. The highest education level of the population sample is secondary schooling, making up 26%, with the remaining having not attended any form of schooling. About 27% of the population sample farm for commercial purposes with registered businesses to trade in the local markets in Mpumalanga, with the balance farming for consumption. Farm sizes in the area range from half a hectare to one hectare to serve current markets, with the potential to move from home gardens and plant on available land should the challenges of land ownership, water supply, and farming inputs be addressed. Sales are conducted through direct distribution to the local markets with transport costs listed as one of the biggest challenges that the farmers face in terms of producing at full scale.

Table 2: Demographic profile of the fifteen smallholder farmers in Nkomazi

No.	Code	Gender	Age	Education level	Business activity	Markets	Farm size
16	16SHF	Male	34	High school	Fresh produce	Local	0.5ha
17	17SHF	Male	71	No schooling	Fresh produce	Consumption	0.5ha
18	18SHF	Male	58	No schooling	Fresh produce	Consumption	0.5ha
19	19SHF	Male	48	No schooling	Fresh produce	consumption	0.5ha
20	20SHF	Male	52	No schooling	Fresh produce	consumption	0.5ha
21	21SHF	Female	64	No schooling	Fresh produce	Consumption	0.5ha
22	22SHF	Female	81	No schooling	Fresh produce	Consumption	0.5ha
23	23SHF	Female	57	No schooling	Fresh produce	Consumption	0.5ha
24	24SHF	Female	75	No schooling	Fresh produce	Consumption	0.5ha
25	25SHF	Female	60	no schooling	Fresh produce	consumption	0.5ha
26	26SHF	Female	54	No schooling	Fresh produce	Consumption	0.5ha
27	27SHF	Female	60	No schooling	Fresh produce	Consumption	0.5ha
28	28SHF	Female	54	Primary school	Fresh produce	Local	0.5ha
29	29SHF	Female	48	High school	Fresh produce	Local	0.5ha

30	30SHF	Male	30	High school	Fresh produce	Local	0.5ha

4.3 INNOVATION AND POLICY ENVIRONMENT

This section presents the evidence from the participant-observation meetings with farmers in the two municipalities. The focus is on following three themes:

- Nature of innovation activities
- Factors affecting innovation
- Paths to strengthen smallholder agricultural innovation

4.3.1 Summary of evidence of innovation in Mopani and Nkomazi municipalities

4.3.1.1 Nature of innovation activities in Mopani

The small-scale farmer sector faces a number of challenges: poor access to inputs, cost of pesticides, and limitation of water abstraction, among others. Simultaneously, the agricultural land is small or limited. The small-scale farmer sector in Mopani includes the production, packaging, and sale of vegetables and maize.

In the in-depth interviews, the farmers shared that they opt for different ways and activities to improve the production and sales of crops. In all the interviews, it was reported that innovation activities take place as a result of the challenges the farmers encounter in primary agricultural activities. They listed the washing and packing of fresh produce, and cutting in a few cases, as some of the innovation activities they were involved in.

4.3.1.2 Factors affecting innovation in Mopani

The participants were asked to share their innovation landscape and state the factors that affect innovation efforts by smallholder farmers. The participants were asked to report factors affecting them at an individual farm level. Farmers reported that issues like water rights and shortages, the absence of resources such as agroprocessing facilities to innovate, a lack of access to developed innovative technologies by tertiary and research institutions, a lack of capital for equipment hire, a shortage of farming

inputs, and a lack of security or fencing affected Mopani farmers' innovation efforts. The results of the interviews with smallholder farmers are presented in Table 3.

Table 3: Smallholder farmers' views on factors affecting innovation in Mopani

Smallholder farmer	Water rights & shortages	Lack of capital for equipment	Shortage of farming inputs	Lack of security	Market access
SHF1	X	X			
SHF2		X			
SHF3	X				
SHF4			X	X	
SHF5	X	X			
SHF6	X	X	X		
SHF7				X	
SHF8		X			
SHF9					X
SHF10		X			
SHF11	X				
SHF12			X		
SHF13				X	
SHF14				X	
SHF15	X			X	

The majority of the farmers reported water rights and water shortages as the biggest factor affecting innovation, together with a lack of capital to purchase farming equipment. As a consequence of water challenges, growers were unable to farm at scale and produce innovative products, with some citing that they had to harvest water from the river. Farmers shared that a lack of capital for farming equipment meant that they had to hire at cost due to high demand and some had to use manual labour. A lack of fencing around the farm land was the second factor affecting innovation for most farmers, and this caused damaged crops in farm fields as a result of animal straying. In interviews, farmers reported that a shortage of farming inputs meant that they had to take loans to sustain their farming activities. Market access was stated by only one farmer as a factor affecting innovation, and this farmer had to trade in the

local market as opposed to other markets further away due to escalating packaging and transport costs.

4.3.1.3 Paths to strengthen smallholder agricultural innovation in Mopani

During the interviews, smallholder farmers shared that innovation activities can only be explored with support at both the primary and processing levels of agriculture by the players in both the civic and private segments. They further reported that developed technologies from research institutions should be made available for commercialisation as this will assist to develop and sustain their businesses.

4.3.1.4 Nature of innovation activities in Nkomazi

During interview sessions, the majority of the smallholder farmers in Nkomazi stated that they were not involved in innovation activities at all as their main focus was producing for consumption. The few farmers that produced for commercialisation reported that they had interest in agricultural processing due to the value it would bring. They listed cutting and dicing in very few cases as some of the innovation activities they were involved in.

4.3.1.5 Factors affecting innovation in Nkomazi

The participants were asked to state the factors that affect innovation efforts by smallholder farmers. Farmers were asked to report factors affecting them at an individual farm level, and they reported that factors such as a lack of water supply, equipment supply, an absence of processing services, and a lack of security and fencing affected their innovation efforts. The results of the interviews with smallholder farmers are presented in Table 4 below.

Table 4: Smallholder farmers' views on factors affecting innovation in Nkomazi

Smallholder farmer	Lack of water supply	Lack of capital for equipment	Lack of farming inputs	Lack of fencing & security
SHF16	X	X		X
SHF17		X	X	
SHF18	X	X		
SHF19	X		X	X
SHF20	X	X		
SHF21	X	X	X	X
SHF22	X	X		
SHF23	X	X	X	
SHF24	X	X		
SHF25	X			
SHF26	X	X		
SHF27	X			
SHF28	X	X		X
SHF29	X			
SHF30	X			X

The majority of the farmers reported a lack of water supply as the biggest factor affecting innovation. Farmers further stated that they had to rely on rainwater for their produce and cannot farm at scale to produce innovative products. They listed equipment supply as the second biggest factor affecting their innovation efforts, stating that access to capital to purchase farming equipment or sharing of properly functioning equipment would also work for them. Some farmers reported a lack of security and fencing around the farm land as a factor affecting innovation as this led to damaged crops. Other farmers stated that a lack of farming inputs meant that they had to farm for consumption only as they have no means to support farming for commercial purposes.

4.3.1.6 Paths to strengthen smallholder agricultural innovation in Nkomazi

Smallholder farmers shared that innovation activities can only be explored if they had access to processing facilities in their area, as their main interest was cutting and dicing the fresh produce to supply formal markets. They further mentioned that innovation activities in agriculture can only be explored if the challenges affecting agricultural activities at primary level were addressed.

4.3.1.7 Agricultural innovation improvements in Mopani and Nkomazi

The participants were asked about their thoughts on improvements that are required to support agricultural innovation, and these included the challenges in both the internal environment and external environment. They reported that access to innovative technologies, resources to innovate, access to processing facilities, and sharing of farming equipment are the major challenges affecting agricultural innovation. The results of the interviews with smallholder farmers are presented in Table 5 below.

Table 5: Smallholder farmers' views on improvements needed to help increase agricultural innovation in Mopani and Nkomazi

Smallholder farmer	Access to innovative technologies	Resources to innovate	Access to processing facilities	Equipment sharing
SHF1		X	X	X
SHF2		X		X
SHF3	X	X		
SHF4	X	X		
SHF5	X	X		X
SHF6		X	X	
SHF7		X	X	
SHF8				X
SHF9		X	X	
SHF10				X
SHF11		X	X	
SHF12	X	X	X	
SHF13		X	X	
SHF14		X	X	
SHF15		X	X	
SHF16	X	X	X	X
SHF17		X	X	
SHF18			X	X
SHF19		X	X	
SHF20		X	X	
SHF21			X	X
SHF22			X	X
SHF23		X	X	
SHF24		X	X	
SHF25		X	X	

Smallholder farmer	Access to innovative technologies	Resources to innovate	Access to processing facilities	Equipment sharing
SHF26			X	X
SHF27		X	X	
SHF28	X	X	X	
SHF29	X	X	X	
SHF30	X	X	X	

The majority of the smallholder farmers from the Mopani area (SHF1-SHF15) indicated that the supply and access to the resources to innovate could help to improve agricultural innovation, including access to processing facilities on a sharing basis. Participants also mentioned that the sharing of equipment to support primary farming would help improve agricultural innovation. Farmers further stated that access to innovative technologies, especially by universities in the area, was another factor that could help to improve innovation in agriculture.

The majority of the smallholder farmers from the Nkomazi area (SHF16-SHF30) reported that access to processing facilities on a sharing basis could help to improve agricultural innovation. Participants also mentioned that the availability of resources to innovate would help to improve innovation in agriculture, including equipment sharing and access to innovative technologies by the University of Mpumalanga.

4.3.2 Comparison between the two case studies

The intention of the farmers in Mopani is to farm for commercial purposes. The farmers have a presence in their local markets and in Gauteng. They are involved only in washing and packing their fresh produce, with no means to process it further and add value for a better income. Agricultural innovation in the area is faced with challenges of both access to innovative technologies and issues affecting primary agriculture.

The intention of the farmers in Nkomazi is to farm for commercial purposes, despite the fact that the majority currently farm for consumption. The farmers have a presence in their local market with very few involved in cutting and dicing their fresh produce,

which would add value for better earning potential. Agricultural innovation in the area is faced with both challenges of access to processing facilities and the issues affecting primary agricultural activities.

Smallholder farmers in the Mopani district municipality have a commercial mindset and are able to earn a good income at an average of R29 867.00 per farmer per season. Farmers in the Nkomazi Local Municipality, however, mostly farm for consumption, with less than 30% of the population sample farming for commercial purposes with an average income of R2 625.00 per season per farmer. Challenges of a lack of capital and farming inputs, water shortages, and security and fencing are evident in both cases, and these hinder agricultural innovation as smallholder farmers cannot guarantee consistent and sustainable supply to markets in order to earn income and contribute to food security. Water rights are cited as the biggest challenge in Mopani, while in Nkomazi it is land ownership.

Paths to promote inclusive innovation policies in the agricultural sector include providing access to both technologies and resources to innovate. Farmers in both studies mentioned that local institutions and agencies in the NSI have contributed less to promote agricultural innovation. Accordingly, partnerships and collaborations with all actors should be promoted in developed policies to ensure inclusivity.

4.4 POLICY DOCUMENT ANALYSIS

The agriculture and farming sector in SA is supported by programmes and policies such as Broadening Access to Agricultural Thrust (BATAT), the 1995 White Paper on Agriculture, the Strategic Plan for South African Agriculture (known as “The Sector Plan of South Africa”), the Integrated Food Security and Nutrition Strategy (IFSS), and the Comprehensive Agricultural Support Programme (CASP). However, the focus of this research study is strictly on STI policy documents.

4.4.1 The 1996 White Paper on Science and Technology

The 1996 White Paper on Science and Technology introduces the concept of innovation which is developed from the concept of the NSI, with the aim of promoting

industrial competitiveness and social innovation. Its origins stem from the fact that science and technology (S&T) are the critical parts of the government's plan to create a better SA for the future. The policy document came into being as an innovation plan to make use of S&T that will enable SA to economically compete globally and to provide essential services for all South Africans.

The main objectives are to promote economic activities and to empower all South Africans to participate in socioeconomic activities using the country's diverse resources in the arts, culture, and heritage. The primary actors that the paper wishes to support are mainly the institutions that are active in the NSI such as government agencies, research and academic institutions, State-Owned Enterprises (SOEs), and NGOs.

4.4.2 The 2008 Ten-Year Innovation Plan

The Ten-Year Innovation Plan was published in 2008 by the Department of Science and Technology, and it is a plan aimed at driving SA to a knowledge-based economy through innovation and entrepreneurship. It came into being after the identification of five key areas that were critical in creating a sustainable SA for the future: (i) life science and health, (ii) planetary science and technology, (iii) electricity security, (iv) worldwide weather change, and (v) human and societal changes.

The objectives of the policy document are to use STI for inclusive economic growth, and to create a competitive economy and improved livelihoods. It is aimed at promoting an inclusive NSI with actors from government, business, and civil groups that could benefit from the fast-changing global technological improvements and advancements. Accordingly, the adoption of inclusive innovation is aimed at supporting Small, Medium and Micro Enterprises (SMMEs), rural enterprises, and cooperatives, which benefits smallholder farmers through social and grassroots innovation.

4.4.3 The 2019 Draft White Paper on Science, Technology and Innovation

The 2019 Draft White Paper on Science, Technology and Innovation focuses on inclusivity, transformation, and partnerships with the aim of building new approaches for the adoption of creativity, learning, and entrepreneurship in the NSI. The policy document came into being after the review of progress made in the NSI between 1996 and 2016, noting the expansion of the institutional landscape of the STI and the significant growth of the number of scientific publications.

The paper is aimed at supporting and strengthening collaboration efforts between the NSI actors to promote a coherent and inclusive NSI. The objectives of the document are to address inconsistencies in the policy, increase human capital development, expand science-based knowledge, evaluate the performance of innovation, and improve investment. The actors are inclusive of the government, business, research institutions, civil groups, and rural innovators. Accordingly, the promotion of an inclusive NSI extends support to more SMMEs that could benefit through grassroots and social innovation.

4.4.4 Policy documents analysis

This section maps out and analyses how small-scale farmer innovation systems feature in key STI in SA (summarised in Table 6 below). The policy documents include the 1996 White Paper on Science and Technology, the 2008 Ten-Year Innovation Plan, and the 2019 Draft White Paper on Science, Technology and Innovation.

The 1996 White Paper on Science and Technology emphasises the requirement to encourage industrial competitiveness and social invention with the view that all citizens of SA will benefit from sustained livelihood, become active participants in the economy through employment, and become part of the democratic society. Accordingly, the paper does not mention any support specifically for smallholder farmers to promote small-scale farming systems of innovation which may contribute to job creation and food security.

The 2008 Ten-Year Plan on Innovation policy acknowledges that investments in STI to drive economic growth and competitiveness have managed to help developing

countries to achieve their socioeconomic objectives. However, countries such as SA that have invested in these areas have not achieved the intended outcomes which are reduction of poverty, creation of employment opportunities, and reduced inequality gap. This can be attributed to the exclusion of the informal economic sector to produce and provide goods and services. The paper is aimed at strengthening collaboration efforts between actor networks and promoting sustainable and inclusive growth.

The 2019 Draft White Paper on Science, Technology and Innovation aims to innovate for impact in line with the Sustainable Development Goals and the National Development Plan Vision 2030 in stating that investments in STI, growth in degree holders, journals, and copyrights, and better collaborations among NSI players, together with improved policy consistency for a better innovation presentation, will be measures for the realisation of intended impacts of STI. This has been realised in the DSI programmes, such as the industry innovation partnership portfolio (IIPP), which has managed to secure co-investment between public and private partners with an increased number of graduates at postgraduate level to support innovation initiatives at the CSIR, for example.

What is missing in the three policy documents is innovation for inclusive growth. A few good examples of inclusive innovation are as follows: the incorporation of cooperatives and communities which are not explicitly listed as actors in the NSI, informal innovations such as grassroots not forming a big part of innovation activities considering that most parts of SA are rural with so much potential for innovation, linkages between actor networks not being coordinated to work efficiently, with some working in silos (for example, The Innovation Hub, EgoliBio, and CSIR BIDC, all within the same geographic area doing similar work), and the enabling structures to support innovation types from formal to informal innovations.

The concepts of township and rural economy strategies are key in inclusive innovation. There are activities and programmes which have been implemented by the Department of Agriculture, Land Reform and Rural Development in the form of Agri-Parks to boost the rural economy and Gauteng's developed township economy strategy. These interventions present possible scalability options to various parts of SA to deal with the challenges of food shortage, joblessness, and disparity. However, the analysis of these strategies presents opportunities to learn from possible success

areas through observing and assessment in order to support and motivate for scalability.

The important aspects of policy or strategy evaluation are whether the policy being is implemented as planned and whether it has its anticipated impact. It is also important to evaluate the programmes supporting the policy, for example, the Regional Innovation Support Programme (RISP) which makes use of public funds to support the implementation of the NSI policy objectives. The optimal use of funds to reach the expected outcomes together with the efficient allocation of resources will need to be evaluated in this case. It is therefore important that policies and programmes are evaluated to determine which policies and programmes work, and the key success areas and learnings from failure that are linked to policy outcomes. In the World Bank (2010) Innovation Policy, it is stated that measuring the impact and benefits of policy is difficult because of the complexity of innovation systems with outcomes that are not easily measured as they differ between short term, medium term, and long term with regards to realising the desired impact. This therefore necessitates an effective evaluation of policy.

The contribution of knowledge channels or universities in rural settings to supporting rural innovations is a good demonstration of inclusive innovation. Universities in rural settings, like the University of Venda, University of Fort Hare, University of Mpumalanga, and Walter Sisulu University, are perfectly located to support GI. However, they are not capacitated well enough to make the desired contribution and impact to local communities with respect to rural innovations, as community members are having to reach out to research institutions and innovation hubs that are outside their areas of residence for innovation support.

Table 6: Policy analysis summary

Item	Policy 1 1996 White Paper on Science and Technology	Policy 2 2008 Ten-Year Innovation Plan	Policy 3 2019 Draft White Paper on Science, Technology and Innovation
Objectives	To make use of the varied features of S&T through the numerous institutions where they are developed, practiced, or used in order to promote **industrial competitiveness and social innovation.**	To improve and strengthen collaboration between the NSI actors for an **inclusive NSI**, transform NSI institutions, develop human capital, build an allowing setting for invention, and improve funding across the NSI.	To improve and strengthen collaboration between the NSI actors, transform NSI institutions, develop human capital, generate an allowing setting for invention, and improve funding across the NSI to promote a **coherent and inclusive NSI**.
Type of support	To make the settings that will provide both originality and innovativeness in the social order.	Making use of STI to promote sustainable and inclusive economic growth, creating an economy that is more competitive, and improving people's livelihoods. Investment in STI	Building and developing the NSI, strengthening partnerships and collaborations among actors. Innovation for inclusive development, including social and GI.
Primary actors and beneficiaries	ACTORS People and groups involved in the creation and use of information base to shape a better SA and would establish the NSI. These will be stakeholders: government, agencies,	ACTORS Businesses, research organisations, government, and the community sector. Civil society is acknowledged as a connection between the official and informal fragments of	ACTORS Businesses, government, institutions of higher learning, and community groups.

	research institutions, SOEs, and NGOs BENEFICIARIES Research institutions, private sector, and civil society	the NSI to strengthen collaboration efforts between the actors. BENEFICIARIES Businesses, SMEs, institutions of higher learning and civil society with improved demonstration of black society and females and persons with incapacities across all sectors.	BENEFICIARIES Private sector, SMEs, research institutions, rural innovators
Small rural farmer benefit	None, however, the paper states that through the Innovation Fund, funds will be assigned to projects that are dealing directly with the wants of underprivileged people.	The adoption of an inclusive innovation system which supports enterprises in spontaneous settlements, rural settings, and collectives. Support innovation for social and grassroots innovation: development of grassroots innovators.	Scaling up the existing framework that provides broad-based support to enterprises to guarantee that additional SMEs can gain from facilities and implements, and assist commercialisation efforts.
Shortfalls	Funding allocation which excludes direct funds that need to go to rural farming enterprises to support the commercialisation of their innovations.	The inclusion of innovation from rural enterprises and cooperatives is not clear in the paper, especially about how it will be included for the benefit of the rural parts of SA.	Monitoring and evaluating methods are not in place to ensure that SME innovations are supported and integrated in the formal economy.

4.5 CASE STUDIES: AGRICULTURAL INNOVATION

This section looks at three case studies around the world to assess how agricultural innovation has succeeded through policy support or failed due to limited support. The

aim is to draw lessons that can be used to develop and promote inclusive agricultural innovation policy to strengthen small-scale farmer innovation streams in SA.

Hall (2007) looks at innovation ideas that have failed to change institutional settings and policy with respect to both public and private sector investment that is meant to promote and develop innovation. The paper links AISs characterised by the past of false contrasts to innovation practice and policy learning. The cases in point are that of food production in Asia using high yielding cereal, a system which failed in Africa, and privatising seed supply systems which improved client orientation in India, but which failed to do so in Bangladesh. The paper further recommends that collective networks and intelligence on innovation be entrenched in the concept of innovation systems as a result of the rapidly changing agricultural sector market, technological advancements, and unpredictable social and environmental circumstances. The proposed collective intelligence structure will be composed of properly organised interactions and collaborations between the different knowledge sources across the global agricultural and rural development communities that include researchers, policymakers, consumers, and entrepreneurs. These will replace the centres of excellence in order to use generated knowledge collectively and share experiences in response to the global advancements. The paper argues for innovation diversity that is aimed at developing innovation practice and policy learning to enable a stronger AIS for the attainment of the Sustainable Development Goals. Agricultural innovation is accordingly placed at the centre of stimulating institutional settings and policy change by the responsible students in the NSI.

Adekunle et al. (2012) reviewed 21 case studies in Sub-Saharan Africa in order to evaluate the practicality of innovation systems approaches for investigation agenda setting and knowledge generation in improving food safety and nourishment, deprivation reduction, and income generation for constrained settings. The paper found that (i) institutional structures of innovation are weak due to very little to no contact between stakeholders and (ii) stakeholder composition between the public sector, private sector, NGOs and community-based actors for partnerships and collaborations was effective in some cases where the public sector took a leading role in providing research and other support, with farmers, NGOs, and private companies taking an active part in the early stages of invention. The case studies demonstrated that successful innovation depends on a range of factors and interventions, and these

include establishing a network of research for training and skills development, strengthened partnership and collaboration efforts, the participation of farmer organisations, and access to existing research and new knowledge. Eleven cases were found to be sustainable in the long term while ten cases addressed governance issues.

Goldman (1993) examined technological innovation in agriculture in three regions in Kenya, namely, Kigumo Division, Makueni Location, and Mbita Division. The research advises that factors such as scarcity and marketing opportunities determine technological change in a region. Market infrastructure development has been helped by the presence of non-food export cash crop economy in Kigumo Division, which subsequently provided access to new technology. Accordingly, the production of non-food export crops is the key constituent of the AIS in the area. Land availability is intense in Kigumo and infrastructure for trade is highly developed. Makueni Location was found to have no significant land constraints for agricultural households, and infrastructure is good in the area but not as developed as Kigumo. The Mbita Division is mostly dry with crop growth supported by one rainy season with no major land issues affecting agricultural production capacity. Infrastructure for trade is the least developed in Mbita out of the three regions that were surveyed. The study found that land abundance in the high-density area of Kigumo presents high demand for yield-increasing technologies such as fertilisers and pesticides, and this facilitates innovation, while Makueni and Mbita are low-density areas with low demand for innovative technologies. However, market access and cash crop infrastructure in these areas present opportunities for new technologies. Accordingly, good market infrastructure in Makueni has the potential for a high demand for yield-increasing technologies. The institutions and infrastructure providing new technology and non-food cash crops which bring new agricultural income, including the dissemination of farmer knowledge, play important roles in the adoption of new agricultural innovations in this research study.

CHAPTER 5: DISCUSSION

5.1 INTRODUCTION

This chapter centres on the analysis of the data presented in chapter four and the insights gained through the literature review in chapter two. The discussion covers innovation landscape in Mopani and Nkomazi, factors affecting innovation in the small-scale agricultural sector, shortfalls of innovation policies, and pathways of promoting inclusive agricultural innovation policy.

5.2 INNOVATION LANDSCAPE IN MOPANI AND NKOMAZI MUNICIPALITIES

Thirty participants in the interviews reported that they are actively using innovation, however, given the challenges they are facing, they largely introduce minor innovations to keep themselves out of difficulty and to keep operations going. Examples of such innovations included a process of collecting water from nearby rivers, using rainwater harvesting techniques, searching for cultivars that do not require more water, and borrowing some farming equipment from neighbours, and these were prominent among smallholder farmers. There was evidence of marketing innovations, however a large emphasis was based on product and process innovation shortage in the sector, which would improve production outputs and quality of products that would be acceptable in profitable markets. Younger farmers were more forward looking and more willing to participate in profitable markets than their older peers. Farmers relied on their resources and some collaborative activity through informal information sharing activities, borrowing, and hiring equipment and machinery from their peers. They also reported that interaction was necessary for direct or indirect learning, imitation, and adaptation acts. Consequently, for the greater number of product innovators, the business depends on its own resources. Some collective undertaking was noted.

5.3 FACTORS AFFECTING INNOVATION IN THE SMALL-SCALE AGRICULTURAL SECTOR

The literature suggests that the availability of resources for technological innovations in agriculture plays a significant part in economic growth and expansion. According to Barbier and Homer-Dixon (1996), policy and institutional failures, natural resource degradation, and institutional instability prevent developing nations from developing or making use of novel scientific innovations to gain better economic prospects. Accordingly, resource scarcity in developing countries can lead to social unrest which disrupts the necessary environment for successful innovation, and this is a constraint that has produced poor economic performance. Furthermore, Giordano et al. (2005) link resource scarcity and insufficient institutional capacity to the highly likelihood of social conflicts. They recommend the establishment of effective resource management institutions for resource allocation to (i) change environmental conditions for innovation, (ii) provide solutions to resource problems, and (iii) include conflict resolution instruments that are structured.

5.3.1 Mopani municipality

The results of the interviews in Mopani district municipality show that farmers have limited available resources to bolster innovation. It has been reported that farmers have no access to innovative technologies that have been developed for commercialisation either from the University of Limpopo or University of Venda in the province or science councils such as ARC and CSIR. With Limpopo being one of the poorest provinces in SA and according to Barbier and Homer-Dixon (1999), resource scarcity is directly linked to poor economic growth in developing countries. Farmers have to rely on crop rotation for income supply, which is not sustainable as they do not even have low technology to cut and dice the crops to explore retail markets in the formal sector. The main crops are green beans, cabbage, butternut, tomatoes, spinach, maize, pigeon peas, baby corn, chillies, onions, beetroot, sweet corn, sweet potatoes, and okra, bringing an average income of R29 867.00 per season per farmer. He et al. (2021) suggest that crop rotation systems neither guarantee high incomes in the temporary nor societal profits in the distant future, and recommend agricultural diversity such as potato-rice rotation for high profits and increased socioeconomic benefit. Furthermore, Dury et al. (2011) recommend different crop management options such as farmer support models for increased smallholding output and success

temporarily and in the distant future. There is heavy reliance on equipment hiring in the area, which comes at a cost, and also reliance on rainwater in some villages due to water shortages, including the unavailability of boreholes. Heemskerk and Wennink (2004) argue that rural and poor farmers face challenges of social capital for innovation and this remains a stumbling block for agricultural innovation in local settings.

Innovation efforts in agriculture are characterised by the link between expenditure and production outputs. According to Viaggi (2015), efforts to advance the environmental performance of the farming sector and the great influence of the innovation policy agenda could improve productivity in order to realise the influence of RD&I in agriculture.

The farmers listed these factors affecting their innovation efforts:

- Water rights and shortages
- Lack of resources such as agroprocessing facilities to innovate
- Lack of access to developed innovative technologies by tertiary and research institutions
- Lack of capital for equipment hire
- Shortage of farming inputs
- Lack of security or fencing

Agricultural innovation has to do with a need to improve the quality of farming outputs, productivity, and the necessary growing conditions, including increasing the production of agricultural products (van der Veen, 2010). The small-scale farmers in Mopani indicated that interventions such as grant support to purchase equipment, the supply of farming inputs, water rights, access to developed technologies and markets, and training and skills development can help them to innovate, increase productivity, and commercialise at full scale, all of which will enable them to enter new markets. Accordingly, these interventions are needed and necessary for the farmers to adapt existing technologies and explore new ones.

5.3.2 Nkomazi municipality

The interview results in the area suggest that farmers have no means to innovate, with some farmers mentioning interviews held with representatives from the University of Mpumalanga in a study on primary agriculture and nothing on processing

technologies. According to Kachru (2010), agroprocessing includes all operations in the agricultural sector from harvesting until the final products reach the end user, and the value added through the adoption of processing technologies enables better earnings and sustainable livelihoods for the farmers. Farmers have a huge interest in having a facility to process and pack the fresh produce, further stating that this will allow them access to sell in retail shops. Access to processing facilities presents opportunities for income generation, and Mhazo et al. (2012) state that access to processing creates job opportunities and training and skills development. The farmers rely on planting different crops to ensure that there is enough food supply, using mostly crops that do not require lots of water. While crop rotation enhances agricultural sustainability, He et al. (2021) recommend agricultural diversity for better social and economic benefit. The main crop used by all farmers is maize, which they use to produce maize meal for consumption. Crops such as chillies, maize, lettuce, green beans, kale, beetroot, and okra bring an average income of R875.00 per week per farmer, making up 26% of farming enterprises that were interviewed. Accordingly, there is low-income generation for most farmers, who are not able to farm at large scale for commercial purpose in the area, which means ongoing poverty. Agricultural income is therefore necessary to address the challenges of inequality. Adger (1999) explores income inequality in rural Vietnam and concludes that income that is not derived from agriculture, particularly from aquaculture, and salary and payment increase inequality above any other basis of income. The balance of the farmers produce maize, nuts, and green beans for consumption. Farmers in the area rely heavily on rainwater due to water shortages and the unavailability of boreholes. According to Donatti et al. (2017), the disposal and availability of water exacerbated by weather change is a major challenge for agriculture, and this requires policy formulations that provide strategic direction in ensuring that smallholder farmers are well equipped to adapt to climate changes.

The farmers in Nkomazi cited the following factors hindering their innovation efforts:

- Lack of water supply
- Equipment supply
- Lack of access to processing facilities
- Lack of security and fencing

The small-scale farmers in Nkomazi think that interventions such as financial support for farming inputs and equipment, the availability of processing facilities, market access support, water supply through boreholes, and the provision of security or fencing can help them to improve agricultural innovation to full scale and enter formal markets. Innovation efforts in agriculture are necessary as means to promote inclusivity and sustainable livelihoods. Accordingly, collaboration efforts between research institutions, the private sector, government, and society are enablers of sustainable agricultural innovation goals (Yost et al., 2019).

Small-scale farmers in the two areas are characterised by a lack of resources to support and grow their businesses, in addition to a lack of resources to innovate for better income potential, all of which affects their innovation potential. In addition to resource unavailability in the Mopani area, a lack of access to innovative technologies means that the smallholder farmers cannot be innovative and uplift their communities. The farmers make use of a crop rotation system which is not sustainable, and interventions such as the supply of farming inputs will enable farmers to adapt and explore technological innovations. The farmers revealed that factors such as the lack of (i) water, (ii) access to agroprocessing facilities, (iii) access to developed innovative technologies, (iv) capital, (v) farming inputs, and (vi) security affect their innovation efforts in that they cannot think about income-generating opportunities beyond primary agriculture.

Similarly, in the Nkomazi area, where smallholder farmers lack the means to innovate, the literature reveals that interventions along the entire value chain of agriculture, which includes processing, are necessary for income generation and sustained livelihoods. Agricultural diversity is also suggested as this will enable farmers to root out poverty in the area. Agricultural income is critical in the area and can be achieved if the challenges of farming inputs are addressed. The farmers revealed that factors such as the lack of (i) water, (ii) equipment, (iii) access to agroprocessing facilities, and (vi) security affect their innovation efforts.

The factors affecting innovation efforts in both areas suggest that there is a relationship between the profile of the farmer and innovation, in that if the issues of water shortages, access to developed technologies, and the availability of farming inputs are addressed, then the farmers will be able to innovate with success.

5.3.3 Cross-case analysis: The constraints of innovation in the small-scale agricultural sector

Agriculture is the main source of income among the smallholder farmers that were interviewed in Mopani. Farmers produce butternut, tomatoes, cabbage, baby corn, maize, spinach, sweet potatoes, green beans, onions, pigeon peas, chillies, sweet corn, beetroot, and okra for income generation. All farmers produce for commercialisation in formal markets and innovate through the collection of rainwater and water from the river, uptake of loans to purchase farming inputs, hiring of equipment, and making use of manual labour to pack and store fresh produce for the markets. These measures are put in place to ensure that market demand and supply are met.

The results from Mopani revealed that a lack of coordination efforts from all actors in the NSI hinder innovation efforts by small-scale farmers as they cannot gain access to developed innovative technologies. This highlights the serious need for inclusive agricultural innovation policy. Existing research on the role of actor networks in agricultural innovation aims to support the inclusion of rural actors in the NSI to promote inclusive innovation. Ramoroka et al. (in press) explore the nature and composition of eight actor networks for innovation in rural Mopani in trying to understand the compositional dynamics of rural actor networks of agro-processing enterprises based in rural SA, and also show relations between the NSI concepts within the rural sector to stimulate innovation. Accordingly, the article suggests that the NSI recognise different actors as important innovation actors and encourage participation of institutional actors in rural networks.

The study notes the limitations in the literature as being related to the composition and content of innovation and learning linkages, including the support of enterprise-level innovation by the different actors in the NSI.

Agriculture is the crucial source of food supply and income among the farmers that were interviewed in Nkomazi. The majority of smallholder farmers, about 73%, produce green beans, lettuce, maize, and nuts for consumption, while the remainder produce green beans, green peppers, chillies, okra, lettuce, kale, beetroot, and maize for income generation. Farmers that produce for commercialisation in formal markets innovate by employing more workers to produce on a bigger piece of land, collecting

rainwater, and making use of manual labour to cut, dice, and pack fresh produce. These measures are put in place to ensure that market demand and supply are met.

The results in Nkomazi revealed that heavy reliance on rainwater to support farming cannot guarantee sustainable income as this means that farmers cannot harvest enough produce during dry seasons, implying that climate change has a direct effect on livelihoods in the area. This is also revealed in Ubisi et al. (2019), which looks at the impact of climate change on rural smallholder farmers in Nkomazi and its effect on livelihoods as a result of the farmers' dependency on climate sensitive resources. According to Ubisi et al. (2019), climate change directly affects food security for rural smallholder farmers because it brings about a drop in harvests, crop failure, and a loss of assets and livelihood opportunities for the farmers. The study investigates the effects of excessive temperatures, prolonged droughts, and floods on smallholder farmers in Nkomazi local municipality and the role of indigenous knowledge in their agricultural systems. The paper suggests that rural smallholder farmers have relied on indigenous knowledge systems (IKS) for decades to maintain their cultural identity and to sustain their livelihoods. Mapara (2009) defines IKS as local knowledge that is unique in culture and tradition to a specific society, and Magocha et al. (2020) refer to IKS as local, farmer, traditional knowledge, or African farming systems.

To investigate indigenous weather and climate indicators, Ubisi et al. (2019) use different methods for data collection, namely qualitative methods, focus group discussions, and interviews. The findings are that the farmers observed plants, wild fruits, animal behaviour, climate indicators, and human illnesses to predict weather. Accordingly, reliance on IKS instead of scientific weather forecasts by smallholder farmers in the form of indigenous climate indicators plays a key role in assisting farmers to prepare for scheduling and supply in their agricultural practices. From a total of 90 smallholders that participated in the study, a large number of participants stated that they had used indigenous knowledge as part of their agricultural systems for at least three decades, with farmers having to put adaptive measures in place to manage climate change effects. The paper established the use of IKS as an innovation system by smallholder farmers in Nkomazi, recommending the need for access to timely and accurate climate information. The authors suggest the integration of IKS with modern climate sciences and information such as precision agriculture and mobile applications to help the farmers by providing them with indigenous information in a

context and format that is easily understandable, acceptable, and familiar to local people. The authors further recommend the sharing of information that has been generated from both indigenous and modern agricultural climate change science.

Magocha et al. (2020) review the application of IKS innovation systems in crop production, and challenges faced in its adoption related to the perception that IKS is outdated and lacks institutional focus in promoting and preserving indigenous knowledge, including poor government support in the incorporation of IKS into agricultural policy frameworks. The paper proposes future work that looks at determining the link between IKS and the western technology with the value of indigenous knowledge being maintained.

Onyango et al. (2021) review the existing opportunities for the adoption of precision agriculture technologies to increase productivity among smallholder farmers in Sub-Saharan Africa. They find that the use of soil and plant sensors for nutrient and water management, and satellite imagery, GIS, and crop-soil simulation models for site-specific management are the most promising precision agriculture technologies for supporting sustainable agricultural development.

A study by Krell et al. (2020) examines the factors that affect the likelihood of Kenyan farmers' adopting mobile services (m-services) that are related to agriculture and livestock information. The authors establish that 98% of respondents own a mobile phone, which increases the likelihood of m-services use, including membership to farmer organisations. The authors further support the need for m-services providers to design phones with features that enable phone users access to better dissemination of agro-meteorological information.

The key factors constraining agricultural innovation among small-scale producers in both areas are thus a lack of coordination efforts that will promote collaboration and partnerships among actor networks, inclusivity of all actor networks, and the challenges presented by climate change.

5.4 THE SHORTFALLS OF INNOVATION POLICIES IN PROMOTING AGRICULTURAL INNOVATION

Policy analysis has been conducted to evaluate the current landscape of innovation policies which establish opportunities that can be created to promote innovation for socioeconomic benefit in the agricultural sector, and to address societal challenges of food security, poverty, and inequality. Some of the challenges in our institutional context include innovating for impact and for inclusive growth.

Policy findings suggest there is a lack of direct funding that needs to be allocated to smallholder farmers to support agricultural innovations and a lack of inclusive innovation that incorporates rural enterprises and cooperatives. They also suggest that policy implementation is not a challenge in SA; however, the absence of monitoring and evaluating methods means that SME innovations are not supported and integrated in the formal economy.

Existing policy documents that are meant to support the small-scale agricultural sector fail to support interactions and collaborations with all key players in the NSI, and this is supported by Ramoroka et al. (2014) on innovation networks. The paper explores the nature and composition of eight actor networks for innovation, making use of the NSI framework for innovation and citing the absence of recognised knowledge generators, such as universities and science councils, from rural network systems. The study reveals that limited participation of external actors in the NSI has been shown to reduce the impact of network interactions and therefore the implementation of the NSI policy. It argues that network interactions strengthen the NSI with the active participation of all actors to address societal challenges such as food shortages and disease burden. Furthermore, the paper advocates for inclusive technological innovations to address societal challenges.

5.5 PROMOTING INCLUSIVE AGRICULTURAL INNOVATION IN SA

The learnings from the interviews in both areas and literature findings suggest that resource availability, an enabling policy environment, and functional institutions play an important role in technological innovations in the agricultural sector. In turn, this enables economic growth.

The challenges that the agricultural sector is facing in exploring agricultural innovation include the lack of access to innovative technologies, resources to innovate, access to processing facilities, and capital. This is evident in both study areas of this research. Interviewees in both areas recommended (i) strengthened collaboration efforts and partnerships with all actors in the NSI, (ii) support with resources to innovate, and (iii) access to innovative agricultural innovations as possible solutions to strengthen agricultural innovation.

Existing research (Hart et al., 2014) suggests that the composition of actor networks in the NSI promotes inclusive agricultural innovations, which recognises the knowledge generated in research institutions and also rural actors to address socioeconomic challenges. This research further reveals that climate change effects mean that smallholder farmers have to rely on IKS instead of scientific weather forecasts for their agricultural practices, and the integration of both systems to predict weather is suggested for the promotion of inclusive agricultural innovation in respect to precision agriculture. The suggestions are based on existing knowledge on collaboration efforts, and because existing innovation policies face the challenge of promoting innovations that impact communities positively for the benefit of poor and marginalised people, Hart et al. (2014) recommend supportive research structures and studies for a better understanding of integrating and strengthening rural innovation value chains for the benefit of poor communities.

It is evident from the analysis of the three policies that inclusive agricultural innovation which supports poor and marginalised people should involve the direct funding of rural farming enterprises to promote innovation, that rural innovation is to be specified and included in policy documents, and that the integration of SME innovations in the formal economy must be supported.

In relation to support with resources to innovate, AISs focus heavily on modernisation and commercialisation initiatives, leaving behind small-scale farmers in rural areas who farm to support livelihoods, which does not promote inclusive and sustainable innovation. A study by Eidt et al. (2020) in Eastern Kenya reviews the influence of power dynamics between stakeholders and the influence thereof by AIS initiatives, finding that access to resources and control over resources between smallholder farmers and other stakeholders result in big irregularities, further marginalising

smallholder farmers. These findings necessitate the need for maintaining power relationships and complexities associated with the promotion of a transformed AIS.

Access to innovative agricultural technologies requires a strengthened agricultural innovation capacity that is supported by policy to stimulate learning and experimentation. Policies that support innovation for inclusive development in the global South face the challenge of an execution plan in that policies are not aligned with the objectives and plans of the government entities that are responsible for the promotion of inclusive development. Peterson and Kruss (2019) suggest effecting a strategic change to promote innovation for inclusive development in a manner that is not only ambitious and verbal, but also implementable.

5.6 CONCLUSION

The study suggests that the innovation landscape in both areas is almost non-existent, as farmers are not able to derive much value from their current innovation practices. Resource availability and access to innovative technologies have been cited by farmers in both areas as the major factors affecting agricultural innovation.

Policy analysis suggests the major shortfalls in promoting agricultural innovation are the lack of direct funding to smallholder farmers, the exclusion of rural enterprises and cooperatives in agricultural innovation, and the absence of monitoring and evaluating methods, which mean that SME innovations are not supported and integrated in the formal economy.

The promotion of inclusive agricultural innovation in SA incorporates addressing the constraints and challenges faced by rural smallholder farmers. This includes the provision of the means to innovate, which incorporates access to resources and technologies.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This study explored the role that could be played by innovation policies to improve agricultural innovations in the informal sector. Through analysis and review, it attempted to examine the AISs and innovation for inclusive development. The purpose of this chapter is to provide a summary of the findings and conclusions that can be reached based on the literature analysis and interviews.

6.2 PROFILE OF SMALL-SCALE INNOVATORS IN AGRICULTURAL SECTOR

Small-scale innovators in the agricultural sector are characterised by differences in gender, age, education levels, business activities, markets, and farm size. These characteristics in both the study areas influence innovation capabilities, in that older farmers were not keen to explore new agricultural practices and are happy to continue with old farming methods. Farmers with higher formal education were open to exploring agricultural innovation and expressed an interest in studying further to understand the best farming practices.

Farmers in the Mopani area farm for commercial purposes, with agriculture being their main source of income. The farmers have registered businesses to trade in the formal sector. The presence of these farmers in the commercial space presents the potential for them to become innovators due to market pull. Only 27% of the population sample in the Nkomazi area, however, farm for commercial purposes, with sales conducted through direct distribution to the local markets and transport costs listed as one of the biggest challenges that the farmers face regarding producing at full scale. This presents a major challenge for most farmers in Nkomazi to innovating, as their main focus is farming for consumption to address the issues of food shortages in their local settings.

6.3 ISSUES FACING AGRICULTURAL INNOVATION

The study findings confirm that small-scale innovators in the agricultural sector are faced with issues such as a lack of resources to innovate. The smallholder farmers in both study areas reported that they are faced with the following issues when it comes to agricultural innovation in order to improve production and participate in high-value markets: water rights and shortages, a lack of agroprocessing facilities to innovate, a lack of access to developed innovative technologies by tertiary and research institutions, a lack of capital for equipment hire, a shortage of farming inputs, and a lack of security. Farmers are innovating less as a result of these challenges. The farmers reported that government programmes such as farming inputs support and the development of processing facilities would help them to improve their innovation efforts.

The analysis of the three innovation policies reveals that funding allocation to commercialise innovations excludes rural enterprises, beneficiation by rural smallholder farmers, and the monitoring and evaluation systems needed to ensure the integration of local innovations in the formal economy are the major policy gaps that need to be addressed in order to support agricultural innovation in SA. Funding allocation is the biggest challenge hindering agricultural innovation by smallholder farmers, as a lack of funding support affects both primary and secondary agricultural processing that leads to the promotion of innovation.

The study shows that smallholder farmers are not supported enough to encourage agricultural innovation, by both the public and private sectors. The findings reveal that smallholder farmers are less likely to succeed in pursuing agricultural innovation due to barriers to entering formal markets, in addition to the socioeconomic challenges they are faced with. This implies that there are very small chances of smallholder farmers succeeding in catching up with established farmers if support and interventions are not provided promptly.

6.4 INCLUSIVE AGRICULTURAL POLICY

The development and adaptation of ways to accommodate different types of farmers is necessary to promote policy change towards a more inclusive agricultural policy. Innovative technologies such as the use of vertical farming, drones, artificial intelligence, and the Internet of Things should be inclusive of all types of farmers and are needed to transform the agricultural sector. These technologies will assist farmers with best farming practices, identifying suitable areas to plant crops, smart ways of irrigating the fields, the use of the right equipment, evaluation of product performance, and pest control.

The drivers of policy changes towards the promotion of innovation in the agricultural sector include research and development (R&D), systems of innovation, and transformative change. Although R&D exists in the NSI, it is not inclusive of smallholder farmers due to the amount of research required in precision agriculture, which in turn requires funding, and only established farmers have the means to invest in the development of innovative technologies. Innovation policy changes are necessary to move the NSI towards transforming the agricultural sector to promote inclusivity.

Innovation policy changes that will promote inclusive agriculture include infrastructure developments, funding supply, access to markets, quality compliance, training and skills transfer, and access to and supply of farming inputs. These interventions are necessary to increase productivity as this will enhance the capabilities of smallholder farmers.

6.5 CONCLUSION AND RECOMMENDATIONS

The findings have implications for all stakeholders in the NSI, specifically those interested in the promotion of inclusive agricultural innovation. Based on this, the researcher recommends the adoption of policy changes to promote inclusive agricultural innovation in SA that include the following:

- (i) innovation for inclusive growth with agricultural cooperatives and community enterprises incorporated as actors in the NSI

- (ii) existing township and rural economy strategies that have been developed are to be evaluated for scalability in order to address socioeconomic challenges
- (iii) monitoring and evaluation of existing innovation policies to track progress and identify gaps
- (iv) the contribution of knowledge generation channels such as previously disadvantaged universities in rural settings to support inclusive innovation.

The proposed policy changes will create opportunities such as the sharing of existing knowledge, and allow for the exploitation of new knowledge by all actors of the NSI for the benefit of society at large. They will also allow for the evaluation of developed economic growth strategies that will assist to address the challenges of poverty, inequality, and unemployment, for the identification of policy gaps in order to modify and adopt policies that work towards inclusive innovation, and for shared knowledge to uplift rural communities that will ensure sustained livelihoods.

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ANNEXURES

ANNEXURE 1: INTERVIEW PROTOCOL FOR SMALLHOLDER FARMERS

Preamble

Smallholder farmers are faced with various issues and challenges to innovate. The aim of this study is to investigate the role that inclusive innovation policies can play in improving agricultural innovations in the informal sector. Data collection from participants, which forms part of the primary data, has been used as one of the selected data collection methods.

Could you please give me the profile of your farm?

1. Your age, gender, education level and location of your farm

Could you please give me the background of your business?

2. How much income do you generate?
3. What types of crops do you plant?
4. What difficulties have you had or currently overcoming and how?
5. What are the problems and challenges of innovation in the agricultural sector faced by rural entrepreneurs to enter formal markets?
6. What are the gaps and barriers to commercialise and produce developed innovative products and services to full scale?
7. What do you think is role and capacity of South Africa's government to innovate for socioeconomic growth in promoting inclusive innovation?
8. Do you feel that enough is being done by all parties in the National System of Innovation/government agencies and universities to promote inclusive innovation process in agriculture?
9. Do you think there are the gaps in current policies that support innovation in agriculture in South Africa? If yes, please mention the gaps.

10. In your view, do you think the adoption of inclusive growth policy to reduce inequality, poverty and unemployment will make improvements in the livelihoods of South Africans?
11. What possible policy changes do you recommend, that can be adopted to promote inclusive agricultural innovation in South Africa?