# The South African Agricultural Innovation System – Stakeholders, Structure and Process

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**Abstract**

This study makes a contribution to the research about the emergence and functioning of innovation systems in the agricultural sector in developing countries. It determines the current status quo of the South African Agricultural Innovation System and its limitations and shows possible solutions to overcome these. The agricultural sector in South Africa faces many challenges. Water scarcity, climate change and increasing resource pressure are just some of the obstacles, which need to be overcome. Agricultural activity is very diverse and ranges from highly efficient farming operations to food gardens and subsistence farming. Furthermore, the South Africa's population will continue to grow, and food production will need to increase significantly. In order to meet these challenges and to ensure and improve food security, new solutions need to be found and innovations need to be implemented. This study explores the ability of the South African Agricultural Innovation System to support the emergence and implementation of innovative solutions and to enable long lasting change of the agricultural sector and the overall food system. The research used a variety of methodologies, such as literature review, qualitative interviews, social network analysis and content analysis. A first journal article seeks to portray the South African Agricultural Innovation System. Based on innovation system theory and its application in agriculture as well as qualitative interviews with various stakeholders, a social network analysis was performed and the results are presented in a visual form. The maturity of the innovation system and its ability to face and meet the existing challenges are discussed. The second journal article describes the ability of the South African agricultural sector to support a long-term transition towards more sustainability. The concepts of transition theory, the multi-level perspective and strategic niche management are presented and discussed. Limiting factors for a transition towards a more sustainable agricultural and food system in South Africa were identified during interviews with various parties involved in agricultural innovation. Potential solutions to overcome these limitations are described and reviewed.

## Opsomming

Hierdie studie lewer ’n bydrae tot die navorsing oor die opkoms en funksionering van innovasiestelsels in die landbousektor in ontwikkelende lande. Dit bepaal die huidige status quo van die stelsel met sy onderskeie beperkinge en bied moontlike oplossings om dit te oorkom. Daar is aansienlike uitdagings wat die landbousektor in Suid-Afrika kniehalter. Waterskaarste, klimaatsverandering en toenemende druk op hulpbronne is slegs ’n paar van die struikelblokke wat oorkom moet word. Landboukundige aktiwiteit is geweldig uiteenlopend en wissel van hoogs doeltreffende landbouondernemings tot voedseltuine en bestaansboerdery. Aangesien Suid-Afrika se bevolking boonop voortdurend groei, moet voedselproduksie beduidend verhoog. Ten einde hierdie uitdagings die hoof te kan bied en voedselsekuriteit te verseker en te verbeter, moet nuwe oplossings gevind en innovasies geïmplementeer word. Hierdie studie ondersoek die vermoë van die Suid-Afrikaanse Landbou-innovasiestelsel om die opkoms en implementering van innoverende oplossings te ondersteun en langdurige verandering van die landbousektor en die algehele voedselstelsel moontlik te maak. Die navorsing het verskillende metodologieë gebruik, onder meer literatuuroorsig, kwalitatiewe onderhoude, sosiale netwerk-ontleding en inhoudontleding. Die eerste vaktydskrifartikel beeld die Suid-Afrikaanse Landbou-innovasiestelsel uit. Gebaseer op innovasiestelselteorie en die toepassing daarvan in die landbou, asook kwalitatiewe onderhoude met verskeie belanghebbendes, is ’n sosiale netwerk-ontleding gedoen en die resultate word in visuele vorm aangebied. Die volwaardigheid van die innovasiestelsel en die vermoë daarvan om die bestaande uitdagings aan te pak en dit die hoof te bied, word bespreek. Die tweede vaktydskrifartikel beskryf die vermoë van die Suid-Afrikaanse landbousektor om ’n langtermynoorgang na groter volhoubaarheid te ondersteun. Die konsepte oorgangsteorie, die veelvlakperspektief en strategiese nis-bestuur word aangebied en bespreek. Faktore wat ’n oorgang na ’n meer volhoubare landbou- en voedselstelsel in Suid-Afrika beperk, is in onderhoude met verskeie belanghebbendes by landboukundige innovasie uitgewys. Potensiële oplossings om hierdie beperkinge te oorkom word beskryf en hersien.

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## List of Acronyms and Abbreviations

| | |
|---|---|
| AIS | Agricultural Innovation Systems |
| AKIS | Agricultural Knowledge and Information Systems |
| ARC | Agricultural Research Council |
| DAFF | Department for Agriculture, Forestry and Fisheries |
| HEI | High external inputs |
| IDC | Industrial Development Corporation |
| ICT | Information and Communication Technologies |
| IFOAM | International federation of organic agriculture movements |
| NARS | National Agricultural Research Systems |
| MLP | Multi-level perspective |
| PGS | Participatory guarantee system |
| SNA | Social Network Analysis |
| SAAIS | South African Agricultural Innovation System |
| SNM | Strategic Niche Management |
| TIA | The Innovation Agency |

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# 1 Introduction

The world of the 21st century is a place facing much turbulence and many challenges. The research presented here was undertaken in the context of climate change, food insecurity, social inequality, and exploitation of natural resources on one side and the enormous opportunities and difficulties of meeting these challenges on the other.

7.3 billion people currently inhabit our planet, and that number is expected to grow further over the coming decades (United Nations, 2015). Oehman et al. (2013) have introduced the concept of 'Planetary Boundaries' in order to describe the constraints to the resources humans claim upon, be it in non-renewable resources, biospheres or the Earth's capacity to absorb human waste flows. Furthermore, economic growth in industrialised countries over the past decades has been fuelled by the resources taken from the developing world leaving a state of social inequality between the so called nations of the global North and South (Sachs, 1999).

Gardiner (2006) defines climate change as a "perfect model storm", which he describes as an event where various factors, each of which would be harmful on their own, are coming together and are therefore increasing the risk of negative consequences exponentially, and threaten the ability of people to behave ethically. The fact that consequences of actions affecting the global climate are borne at different times and locations and by different actors than where and by whom they were caused makes it challenging to hold anyone accountable (Gardiner, 2006).

The overall challenge of keeping the earth in a sustainable equilibrium also manifests itself in the ability to feed our people. The global demand for food will rise due to increasing incomes in some economies and the continuing growth of the global population. The abovementioned ecological challenges - like climate change and resource depletion - will threaten the world's food supply. Therefore "(r)ising food production must be decoupled from unsustainable utilization of water,

energy, fertilizers, chemicals and land. This will require a multi-faceted agro-ecological intensification of food production" (Oehman et al., 2013).

South Africa is often called the world in one country. Although this observation originates from tourist brochures it is, I would argue, also true in the context of the above challenges, especially for the agricultural sector. There is a dual agricultural economy with small-scale communal farmers who struggle to make a living on one side, and well-developed commercial operations on the other. Both, however, grapple which the challenges presented by climate change and increasing resource pressure. Extreme weather phenomena, water scarcity, and rising input costs are affecting farmers' ability to achieve economically viable yields. At the same time, the South African population is expected to almost double in the next 40 years requiring more food and other agricultural products (Goldblatt, 2010).

Therefore – more than ever – innovative solutions are required to meet these challenges. As Pauli (2010) states: "(a)t a moment in history where peak oil and peak food are clearly hovering, we can draw practical ideas and inspiration from ecosystems as we witness their ability to apply creativity and evolution in overcoming challenges to survival".

But change is not just achieved by offering innovative solutions in terms of technology or processes. These solutions also need to be implemented and adopted by their users. Existing institutions, businesses and structures can either actively promote or hinder these adoption processes. In order to overcome certain barriers to innovation, or to activate catalysts for their implementation, it is important to understand the environment where innovation takes place.

This research aims to make a contribution to a better understanding of the agricultural innovation system in South Africa by identifying its stakeholders and analysing their interests and interactions. Barriers to innovation processes will be identified and suggestions as to overcome these will be made.

## 1.1 Problem Statement

### 1.1.1 Key problem

Challenges like population growth, food security, water scarcity, and soil degradation are not only faced on a global level but also have important impacts on agriculture in South Africa. The South African population grows at a rate of approximately 2 per cent annually and the population of currently 50 million people is expected to reach 82 million in 2035. This expanding population will eventually need double the amount of food as today (Goldblatt, 2010).

At the same time natural resources are limited – degrading soils, water scarcity and rising input costs make sustainable farming more and more difficult. The concept ‘sustainable’ has a dual meaning here. Firstly, it refers to a type of agricultural activity, which does not harm the environment and the long-term availability of natural resources. But secondly, farming also needs to make long-term economic sense and therefore has to be able to sustain the livelihoods of those people involved. This is especially true for small-scale and subsistence farmers, who often face disadvantages in regard to accessing funding, markets, information, or inputs.

Innovative solutions are required to address these challenges. Innovation here does not only refer to new products or technologies, but also to new ways of generating and disseminating knowledge, collaborating, or financing agricultural enterprises. Some of these innovative solutions are already available elsewhere in the world, some are hidden in almost forgotten indigenous knowledge systems, and some still need to be found.

The process of finding, adapting, and implementing innovations requires the coordinated activities of many agents and stakeholders. There are a variety of South African institutions involved in helping to get new solutions off the ground. Government agencies, the Industrial Development Corporation, the CSIR and the Innovation Hub, as well as several local and international non-profit organisations are just a few. However, according to Nicola Jowell, former manager of the SAB Foundation, innovation often gets stuck between these institutions. There is currently not much coordination of the innovation process from idea generalisation

to realisation and commercial implementation. According to her, an ecosystem of support by the trinity of government, the private sector and academia is needed (Jowell, 2013).

Other problematic areas are the access to funding, markets, and technical skills. While knowledge transfer usually takes place through the agricultural faculties of universities many small-scale farmers do not have access to these. Also, the issue of the dual economy in agriculture and the power imbalances between commercial and subsistence farmers need to be addressed (Jowell, 2013).

Ad-hoc innovation can only solve the existing problems to a limited extent. What is required is a fundamental change in the way food is grown, produced and distributed. Such fundamental changes usually take place over a long period of time and by overcoming various limits and obstacles along the way. The environment within which these changes take place has usually been determined by earlier conditions and is often not conducive for innovation and new solutions.

### 1.1.2 Research rationale

Although the theory of innovation systems has received a significant amount of attention during the past decades, much of it has been focussed on manufacturing sectors in developed countries. The emergence and functioning of innovation systems in the agricultural sector and/or in developing countries is still largely under-researched.

The agricultural innovation system in South Africa has not yet been researched. But in order to overcome the challenges described above it is necessary to know the stakeholders and role players, to understand their interests and interactions, and to identify barriers and interruptions in the long-term transition process towards a more sustainable agricultural sector and food system.

### 1.1.3 Research objectives

The following research questions then need to be answered.

How does the agricultural Innovation system innovation in South Africa support or limit the implementation of innovation?

Which factors can enable innovation for the transition to a more sustainable agricultural system in South Africa?

The research was conducted in two distinct phases and is presented in two individual journal articles. Each of these articles addresses a separate sub-question.

Firstly, the research identifies the system actors of the South African Agricultural Innovation System (SAAIS) and describes their positions within the system, their roles and functions as well as the interests and relationships between these various actors and stakeholders. The emphasis is placed on the fact where relationships exist, their nature and extents, as well as hierarchical concerns. The objective is to provide a comprehensive overview and description of the SAAIS within the theoretical framework of innovation systems. The current agricultural innovations landscape will be mapped, stakeholders and their functions identified, and their relationships and interactions analysed and described.

Secondly, the research identifies barriers and limitations to innovation and lasting change within the South African agricultural sector. The latest international research in the regarding these constraints was then reviewed and recommendations are made as to improve the innovation enabling factors for transition to a more sustainable agricultural system in South Africa.

## 1.2 Research design and methodology

### 1.2.1 Research design

The research approach for the first part of this thesis consists of a literature review of the theory of innovation systems and their application in agriculture and in the South African context. This will set the theoretical framework for the empirical research. As systems cannot be explained by just looking at theoretical concepts, observing and analysing practical implications is also necessary (Assefa et al., 2006). Specific methodologies are useful to analyse complex systems, which are

characterised by a degree of unpredictability and emergent properties. Qualitative data such as key informant interviews are useful in this context (Pereira, 2013). The method of social network analysis was then employed to identify relationships and interactions within the innovation system.

The second part of this research was based on a review of the literature on transitions and related concepts. Qualitative interviews were held about the limits and barriers to agricultural and food system innovation and the main themes were identified with the help of content analysis. The latest trends in international research concerning these themes were determined in a second literature analysis.

Below is a graphic presentation of the research design.

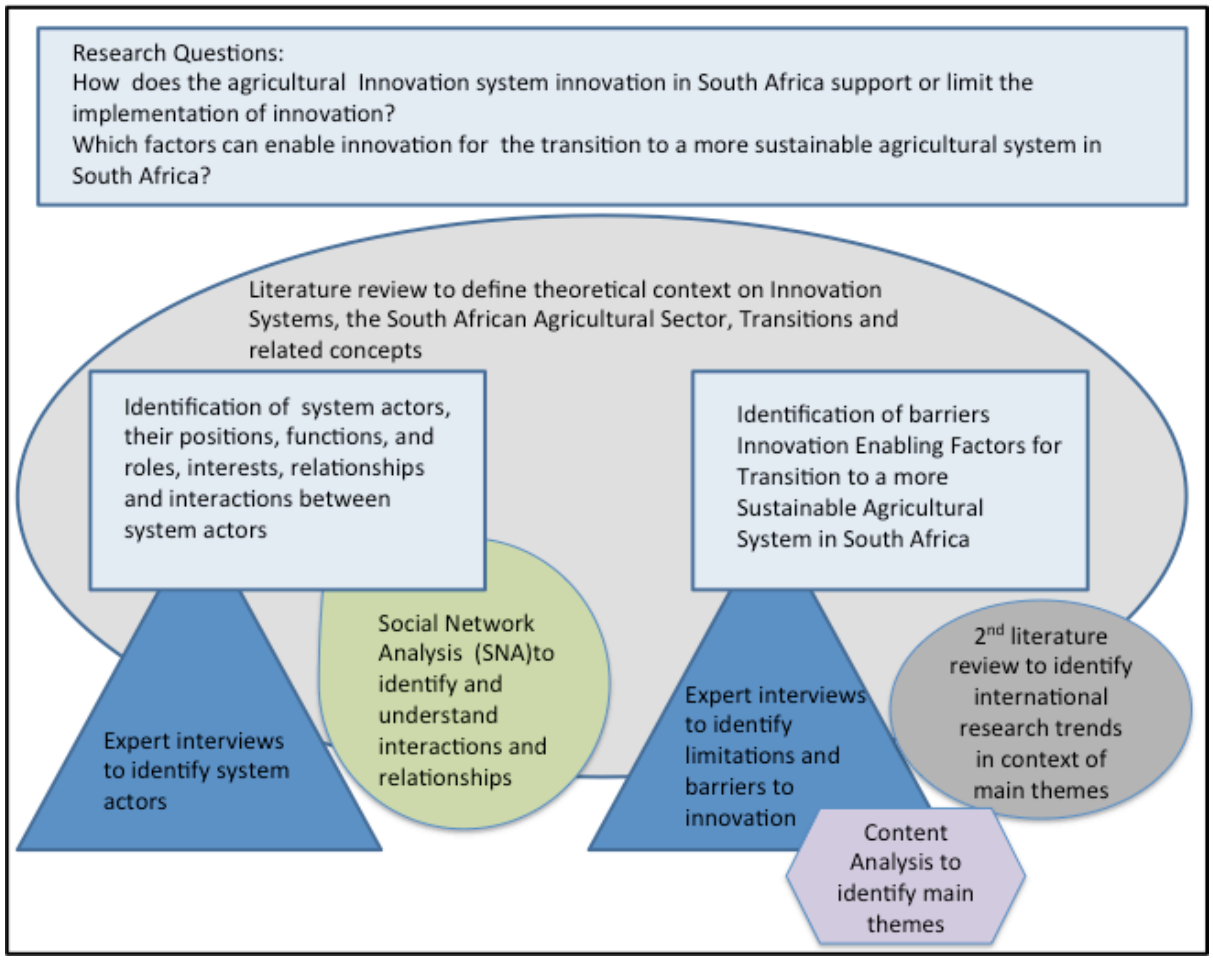


Figure 1: Research Design

### 1.2.2 Research methodology

#### 1.2.2.1 Literature review

Hart (1999) defines the literature review as the "selection of available documents … on the topic, which contain information, ideas, data and evidence written from a particular standpoint to fulfil certain aims or express certain views on the nature of the topic and how it is to be investigated, and the effective evaluation of these documents in relation to the research being proposed" (Hart, 1999).

A thorough review of the recent literature on complex and innovation systems as well as socio-economic transitions and the multi-level perspective sets the theoretical background. Literature on the agricultural sector in South Africa gives initial direction for the empirical work. The purpose of this literature review is to provide an overall theoretical framework and to set the context for the research (Mertens, 2010). It determines the theories and concepts that can be applied to the area of agricultural innovation, which research methods have so far been used, and who the main contributors to the body of knowledge are (Bryman, 2012).

Following the empirical work in part two a second literature review was undertaken to identify latest research trends in the context of the identified barriers and potential innovation enablers.

#### 1.2.2.2 Interviews and content analysis

Initial research indicated that there is only limited literature available on the subject of the SAAIS. Therefore it was deemed necessary to draw on the expertise and experience of various stakeholders through qualitative research to address this literature gap. This qualitative method focuses on context and words rather than numbers, and is driven by interpretation and induction (Bryman, 2012).

In order to identify the interview subjects a relational approach was chosen. A small group of actors was identified who represent elements present in every innovation systems (namely knowledge generation, dissemination, and governance). Through a snowball sampling method these representatives did then

nominate further stakeholders who are active within the innovation system. In total 38 interviews were conducted.

Semi-structured, interviews with representatives from the various institutions and actors were held. The objective was to achieve detailed and rich answers on the topic and to allow the interviewees to elaborate on connections, interactions, and their own perceptions of the respective elements of the innovation networks (Seidman, 2013).

The content of the interview feedback was then analysed to identify the perceived limitations to innovation and transition for sustainable agriculture in South Africa.

#### 1.2.2.3 Social Network Analysis

A social network is a structure, which consists of various actors. Some of these actors are connected by singular or multiple relationships. Social network analysis (SNA) is a method to study these relationships. The method “offers a means not only to characterize, measure, and map relationships between actors, but also to analyse the changes in those relationships and the knowledge flows contained therein”. SNA offers a holistic understanding of a system’s structure and the interdependence amongst the system’s components (Spielman et al., 2009).

SNA is a method used to model complex systems of social entities. It depicts social relationships as networks of individual actors (nodes) and the relationships between them (ties or edges). This method emerged from modern sociology and is used to represent the various relationships between the members of complex social systems at various levels. Furthermore it can provide information about network structure and positioning of actors within the network (van der Valk and Gijsbers, 2010).

There are two essential elements of social networks: actors and relations. Actors can be persons or organisations. Relations are defined as a certain kind of contact or connection between two actors. There are various features which need to be decided when setting up a Social Network Analysis, e.g. how are the boundaries of the network defined, which actors belong to the network and should be part of the analysis, which relation to analyse and at what level (Knoke & Yang, 2008).

# 2 The South African Agricultural Innovation System

## 2.1 Introduction

Agricultural systems are under strain. Continued population growth, the effects of climate change, resource depletion and environmental degradation are just a few factors contributing to a situation requiring new approaches.

This is the case at global as well as local level and South Africa is no exception. A country characterised by water scarcity, environmental and climate stress, and ever-rising demand for food, South Africa also remains a deeply divided country, even 20 years after the end of apartheid. The duality of the South African society, with wealth and a growing middle class on one side, and devastating poverty for a large part of the population on the other, is also reflected in the agricultural sector. Big commercially run farms provide input for most of the formal food and retail industry, while small and emerging farmers struggle to feed their families from the land and to enter formal markets.

Innovative solutions are needed to address these challenges. And innovative solutions can only be born, grown and implemented in an environment, which supports them.

### 2.1.1 Objective

This paper (and chapter) presents an analysis of the innovation environment in South Africa's agricultural sector and its readiness to address the challenges faced. In order to determine how the agricultural innovation system is supportive or limiting for the implementation of innovation, the following questions were addressed:

1. Who are the actors within the South African Agricultural Innovation System (SAAIS)?
2. How are they connected and how do they cooperate?
3. Does the SAAIS have the typical characteristics of a modern Agricultural Innovation System as described in the literature?

It is the overall objective of this paper to contribute to the understanding of the local context in agricultural innovation system research. This is done by demonstrating the current structure of the innovation system and by identifying weaknesses and strength of the current actors and in their relationships with each other.

### 2.1.2 Approach

Sections 2.2 and 2.3 are a review of current literature about the theoretical concepts of complexity, systems theory, and innovation system theory. The main concepts in this field are presented and discussed. Section 2.4 provides an overview of the South African agricultural sector and it's challenges.

Based on this theoretical framework, a Social Network Analysis (SNA) for the Innovation System in South Africa's agriculture was performed. The results are discussed in section 2.5, followed by the presentation of the conclusions in section 2.6.

## 2.2 Complex Systems

Environments, in which agricultural innovation takes place, are characterized by many role players and affected parties, such as farmers, input suppliers, government and research institutions, retail, and consumers, to name but a few.

These stakeholders maintain various relationships and interact in diverse ways. Their connections are important in determining the behaviour of the whole system. It cannot be analysed or predicted by looking at the features of the actors in isolation. Their histories, links, hierarchies, etc. are as important as influences from technological, market, policy, cultural, and other socio-economic factors. All this indicates a complex environment, which is described by Morin as a situation where 'a tangle of actions, interactions, and feedback' can be found and which is difficult to explain (Morin, 2008).

It is important to understand and recognize the properties of complex systems in order to identify and analyse them in real life entities, such as the SAAIS. Below

the most prominent characteristics to complex systems are presented and discussed.

### 2.2.1 Characteristics of complex systems

Complex systems consist of a large number of actors or components, which in themselves can be simple or complex (Cilliers, 2000; Katz, 2006). On one hand is their behaviour often directed by own objectives and they can act independently from the other system components, unaware of the impact on them or to the whole system. On the other hand interdependency, interactions and relationships between the various components are essential characteristics of the system. These interactions are dynamic and non-linear and they manifest themselves in many feedback loops (Heylingen et al, 2007; Cilliers, 2000).

Complex systems are usually open to the environment, so exchange does not only take place between the actors inside the system but also with stakeholders on the outside. Due to this openness it is often difficult to define the boundaries of a complex system and to understand it outside of the context of its environment (Cilliers, 2000).

The diversity of agents and decentralised nature of the interactions also determine the self-organising character of complex systems. There are often various possible outcomes as a result of an action. The system behaviour is emergent and cannot be predicted from analysing its parts independently (Baranger, 2001). Too much central control limits the potential of the structure and can hinder its success. Control mechanisms should rather be located at various levels of the system (Cilliers, 2000; Spielman et al., 2009).

It is difficult to simulate or model complex systems because they do not have clear boundaries and cannot be compressed into entities with fewer components and interactions. Therefore models can only be generated based on certain limitations and assumptions (Cilliers, 2000). The application of network theory can be useful to get a better understanding of system structure, its components and their relationships. But predicting system behaviour is difficult as it arises from the various interactions and relationships, which are characterized by an interplay of competition and cooperation between the actors (Cilliers, 2000; Baranger, 2001).

### 2.2.2 Complex adaptive systems

In the context of innovation, the notion of complex adaptive systems is of special interest. Innovation usually takes place within environments influenced by legal, economic, political, social and environmental systems. These are constantly evolving and changing and therefore influencing the innovation systems. This special kind of a complex system has the ability to react to these developments and to re-organise itself. It can, therefore, appear unpredictable and new features can emerge in the process (Pereira, 2013). A complex adaptive system is characterized by the ability to change itself in order to adapt to changing environments or to influence the environment to better fit the needs of the system (Baranger, 2001).

The concept of complex adaptive systems is most relevant for understanding innovation processes and systems as these are characterised by many heterogeneous agents who all have their own objectives and strategies. The combination of cooperation and competition between system actors, the impact of external conditions and trends all influence the way the system is forming itself and evolving over time (Spielmann et al., 2009; Katz, 2006).

## 2.3 Agricultural Innovation Systems

The realisation that innovation takes place within systemic structures has made the concept of innovation systems increasingly popular and much has been published about the topic since 1990.

### 2.3.1 What is innovation?

Many definitions for the concept of innovation can be found in the respective literature. According to Anandajayasekeram (2011) as many as there are supposed experts in the field. But some of the most important features can be described.

An innovation is something new, which gets introduced into a social or economic process. It is a solution to a problem or a response to a need, which is not only found, but also disseminated, widely accepted and actually used. These solutions

can be technological, institutional, organisational, process or service related (Anandajayasekeram, 2011).

There are various sources of innovation, and research or new knowledge is just one of them. Unexpected occurrences or incongruities, changes in perception or demographics can be others. The starting point is a market demand (Drucker, 1998; Sumberg, 2005) or a need, which must be satisfied. However, articulating the needs, which require innovative approaches in the agricultural field, can be problematic.

For innovation to be effective and to get accepted, input from various sources is required, especially from those who will later use it. Ideas need to be shared and combined into new approaches. Also, the dissemination and implementation almost always occurs in cooperation of various partners and the exchange of ideas and sharing of experiences are very important here as well. In that context innovation can be interpreted as a social process, which originates from needs and existing knowledge. Due to its social nature innovation networks can be a useful vehicle to support such partners in finding and trying out new solutions (Hall, 2007; EU Scar, 2012).

### 2.3.2 Innovation systems – national, sectorial, functional

According to Spielman, an innovation system is defined by the actors involved in the process of innovation, their interactions and actions, as well as the socio-economic environment conditioning their behaviours and values. The latter are determined by a “larger, more complex system of interactions among diverse actors, organizational cultures and practices, learning behaviours and cycles, and rules and norms” (Spielman et al., 2009). Other definitions refer to networks of private and public actors involved in the processes of knowledge creation, exchange and application as well as systems of production, marketing, and finance (Pant and Hambly-Odame, 2009).

Hall and Clark (2010) argue that innovation systems are characterised by flows of knowledge and resources among its components, as well as across its boundaries. New knowledge is continuously flowing into the system, causing the actors to change and adapt their behaviour resulting in a constantly evolving

system as a whole. Not only new knowledge, but also the interactions between the innovation system members and those of other systems influence the character of the system. These interactions can be formal or random and are subject to complex economic, social and political forces. The above shows that the processes of innovation und the systems within which they take place are complex and adaptive (Katz, 2006).

The notion of innovation systems is very wide and covers various issues and topics. It can be viewed on a national, sectorial or technological level. Although all three perspectives play a role in the context of agricultural innovation in South Africa, only the national and sectorial view will be analysed in the empirical part of this study.

National innovation systems refer to the “social capability for technical and institutional change” of individual countries and have been described as centrally important in the literature. However, since the emergence of ‘globalization’ the study of innovation systems needs to be complimented by other perspectives (Freeman, 2002).

Malerba argues that different industries or sectors show other characteristics regarding the production, technology, knowledge and innovation and in the way change occurs within those sectors. “A sectorial system has a knowledge and a technological base, and key links and complementarities among products, knowledge and technologies, which greatly affect the creation, production and use of the “sectorial products”. Its members display different behaviours, structures, competencies and learning processes.” (Malerba, 1999)

A third way to view an innovation system is technology specific. Due to the fact that technologies are often not limited to geographical regions or to industries such systems can impact on various nations or sectors (Hekkert et al., 2007).

### 2.3.3 The historic development of the Agricultural Innovation Systems Approach

Innovation and active learning have always been present where agricultural activity took place, and various systems to facilitate these processes have

developed over time. This paper considers the development of such systems since the 1960's.

National Agricultural Research Systems (NARS) follow a linear model of knowledge production by research and diffusion through a governmental extension system. This perspective does not distinguish between innovation, knowledge and inventions, and is based on the assumption that knowledge can only be supplied by scientific research. Although this system has been criticised for viewing farmers as mere receivers of technology from research organisations, it is still dominating many agricultural sectors in the developing world (Assefa et al., 2006).

The concept of Agricultural Knowledge and Information Systems (AKIS) addresses issues around the adoption of new agricultural practices. It can be defined as a combination of actors, organisations and networks that work together in order to promote processes of knowledge creation and dissemination. It represents a shift of focus from research and extension institutions to links and communication between various role players. However, the approach has been criticised for focusing on generation and the use of knowledge without taking the influence of other system elements, such as the increasingly globalised and changing context of agriculture, into consideration (Assefa et al., 2006).

A more flexible framework for studying innovation in agriculture was required, one "that highlights the complex relationships between old and new actors, the nature of organizational learning processes, and the socioeconomic institutions that influence these relationships and processes" (Spielman et al., 2009). The application of innovation systems theory to the agricultural sector led to the Agricultural Innovation Systems (AIS) approach. Sumberg (2005) defines an AIS as a set of interrelated individuals, institutions, private companies, public agencies and other organisations, which work together in order to generate, diffuse and utilise knowledge and new technology. This framework focuses more on behaviours and practices, which influence organisational change and development (Sumberg, 2005). Innovation management is given more emphasis than knowledge management, as the innovation process does not necessarily originate from formal research. "Rather, AIS underscores that it is only within the innovation

system that knowledge and information from various sources interact to bring new phenomena desired by the system actors" (Assefa et al., 2006).

### 2.3.4 Challenges and limitations of the AIS approach

There are various areas, which are not yet fully covered by the innovation systems theory. Due to the fact that this concept emerged from technology studies in industrialised countries, it does not explicitly address issues of innovation in the developing world. Spielman et al. (2009) state that the tools currently used are limited and suggest employing econometric and statistical analysis, social network analysis and comparisons across countries as useful approaches for further analysis. Spielman further states that there is "little evidence to suggest that the application of the innovation systems framework to developing-country agriculture is, in fact, providing real solutions to many of today's challenges" and that insufficient understanding of these systems could result in insufficient funding, non-appropriate training and education, and a diaspora of good scientists from the countries where they are needed most (Spielman, 2005).

Additional to the challenges in analysis is the issue that AIS in developing countries often do not exist or are in their infancy (Pant and Hambly-Odame, 2009). The relationships between the various components is poorly understood and often not very developed. Interaction between these components is crucial to functioning innovation systems, and their existence and structure can be reviewed to analyse the effectiveness of agricultural innovation systems. If these interactions and relationships are hierarchical, bureaucratic and rule-bound, then functioning of the system is likely to be constrained and ineffective (Sumberg, 2005). Innovation systems need to be facilitated and governed in order to ensure on-going resilience and the ability to persevere. As they are such diverse entities with stakeholders from public and private sector, formal research and individual practice, big agri-business and consumers, such facilitation can be very challenging. Therefore building and strengthening of innovation capacity at all levels of the system needs to be emphasized and become more central in the work regarding AIS (EU Scar, 2012; Hall, 2007).

The areas where agricultural innovation for developing countries is needed most are subsistence farming and poverty alleviation for the rural population. The literature on AIS currently does not address these issues sufficiently. Small farmers often lack access to innovation networks and systems and thereby to markets, commercial and technical information as well as to financial resources. It has also not been extensively studied whether applied innovations actually do benefit the rural poor (Spielman et al. 2009). The exclusion of small farmers and local and tribal communities from the innovation process also contributes to the risk of losing the extensive indigenous knowledge held by those groups (Pant and Hambly-Odame, 2009). A further constraint in that context is that the demand for innovation for small-scale farmers and poor populations is not getting articulated. The need to give voice to farmers and to include their needs and views into the innovation process at an early stage is more and more recognised, but not yet realised (Sumberg, 2005).

### 2.4 The Agricultural Sector in South Africa

Agriculture in South Africa takes place in very challenging conditions. The natural resources are limited and often subjected to extreme weather. Only 12% of the country's area can be used for rain-fed crops and merely 3% can be classified as fertile land. Most of the land is suitable for grazing and so it is not surprising that livestock is by far the largest sub-sector in agriculture (Goldblatt, 2010; Vink and van Rooyen, 2009).

While the contribution of agriculture to the South African GDP, with 2.5% in 2008, is relatively small and therefore carries the risk of being overlooked when prioritising resources and budgets, it plays an important role in the context of employment, exports and related industries. When considering integration into the latter the contribution to GDP is closer to 14% (Goldblatt, 2010).

Reliable statistical data about the Agricultural Sector in South Africa, the number of farms and the production of food, are not easy to come by. While there were approximately 60,000 commercial (white) farmers in 1994 the numbers had reduced to 45,000 in 2002 (Bernstein, 2013). The statistics for current commercial farms vary between 45,000 (Vink and van Rooyen, 2009), 35,000 (DAFF, 2012)

and 28,000 (Visser, 2013). Similarly, the estimates for small scale or emerging farms vary from 35,000 (Vink and van Rooyen, 2009) to 230,000 (DAFF, 2012).

However, some clear trends are emerging. Commercial farms are concentrating, forming fewer entities with higher outputs, thus benefiting from economies of scale and higher efficiencies. Approximately 5% of commercial farms produced about 50% of the overall commercial farm output in 2002. This trend is likely to continue. At the same time farm employment has reduced from 1.2 million in 1990, and 940,000 in 2002 (Bernstein, 2013) to 530,000 full time employed farm workers in 2011 (Statistics South Africa, 2012). This development is in stark contradiction to the ambition of the National Development Plan to create 1 million new jobs in agriculture by 2030 (National Planning Commission, 2012).

### 2.4.1 Food Security

The role of agriculture is often emphasized in food security discussions. Especially the importance of commercial farming is brought to the forefront in this context as these enterprises are producing food in high volumes. But can agriculture alone combat hunger?

The term food security describes a situation where people of a country or society have enough food for a healthy and active life. “Food security as an umbrella term includes: (i) the availability of food that is nutritious and safe; (ii) an assured ability to procure and acquire food of good quality in a socially acceptable way …” (Labadarios et al. 2011).

South Africa is seen as a ‘food-secure’ country, one that can produce sufficient calories to feed the whole population. However, more than half of the population is at risk of being hungry and 25% suffer from hunger regularly (Oxfam, 2014).

Stunting is a condition in children, which is a result of poor nutrition and is a clear sign of food insecurity. It causes slower development, reduced cognitive functioning and is an indication for the mortality of children under five years. In a study conducted in 2007 is was discovered that nationally 5% of the South African children suffer from stunting and in some tribal areas even up to 23% (Labadarios, 2007).

The main causes of food insecurity are low income, unemployment and poverty. People simply do not have enough money to buy food, and most subsistence farmers are not able to grow sufficient produce to feed their families. The structure and power relations in the South African food system contribute to this situation. Power is held by few organisations and accessing their outlets can be challenging for people living in rural areas, both from a financial as a logistical point of view (Oxfam, 2014). These are the outlets commercial farm are connected to, yet poor people cannot access their produce.

Agriculture cannot solve this problem alone. Agri-processors and food manufacturers, logistical and retail companies would need to be involved in finding new approaches that allow poor people to either produce or buy the food they need.

### 2.4.2 Environmental Challenges and Climate Change

South Africa is one of the water scarcest countries in Sub-Saharan Africa and is subject to severe draughts. As a consequence of changing rainfall pattern and rising temperatures it has been getting drier during the last 30 years. Although only 1.5% of South African land is under irrigation, this land is using 63% of all available surface water (Bernstein, 2013). There is no surplus water in the country and this could constrain future development in the agricultural sector. If farmers continue to use today's farming practices they would have to double the water use in order to meet food demand by 2050. Water management practices and water use efficiency then need to be the focus of agricultural innovation if a crisis is to be avoided (Goldblatt, 2011).

As mentioned before, only 12% of South Africa's land has fertile soil. However, some farming practices such as overuse of fertilizer, irrigation, or poorly managed tillage can lead to erosion, acidic or salty soils which are less fertile and less absorbent. More than 5 million hectares are already affected by soil degradation (Goldblatt, 2011).

Climate change multiplies these risks and will impact negatively on various agricultural activities. Higher temperatures, more intense and infrequent rainfall, and a shift in seasons can result in a reduction of arable land, increases in certain

pests, and a general higher risk and un-predictability of farming activities and outputs (SANBI, 2013).

### 2.4.3 Dual Economy

The South African agricultural sector needs to be seen in its historical context. Policy during the apartheid area created an environment where most small-scale African farmers could not participate actively in agriculture as they were denied ownership of land, as well as access to finance, information and markets. Policies and technologies promoting increased productivity targeted mainly white farmers and their implementation resulted in labour reduction and losses of jobs. One of the challenges agricultural innovation has to meet is the dual needs of small-scale African farmers as well as a minority of (mainly) white commercial farmers who play a vital role in national food security and thus remain important to South African agriculture (Thirtle et al., 2000; Metelerkamp, 2013).

However, a clear differentiation of the various farmer categories, especially for smallholder farmers is not easy to find. Definitions found are by racial characteristics, land size, or output. The typology provided by the Department of Agriculture, Forestry and Fisheries is followed in the paper. This typology defines smallholders as farmers who produce agricultural products for their own as well for commercial use. A significant part of the crops gets sold, but they have not yet reached an income, which would make them liable for VAT or personal income tax. There are an estimated 225,000 such farmers in South Africa (DAFF, 2013). People involved in agricultural activities who mainly produce for their own consumption are considered to be subsistence farmers. The 2011 Census included a count of households engaged in agricultural activity for the first time and the survey revealed that 2,9 million households are engaged in agriculture. Of these 30.3% (878,700 households) do have no income at all and 55.4% (1,606,600 households) have an income of less than ZAR 3,200 per month (Statistics South Africa 2013). It can therefore be assumed that for approximately 2,5 million households in South Africa rely on their own agricultural production to fully supply or at least supplement the food consumed in the household. As none of this produce ever reaches formal markets, the relevance of these farmers for food security is hard to assess. But it is clearly significant, and statements that

95% of the country's locally produced food comes from commercial farms (Lebone, 2012) need to be interpreted with caution in that context.

While commercial farmers have access to various networks of knowledge and innovation, small-scale farmers seldom do. Therefore it is seen as one of the biggest challenges to find new solutions and technology for those who need them most (DAFF, 2008).

Several initiatives have been put in place to reform the landscape of land tenure and to support disadvantaged farming communities, but progress is slow and the majority of projects are failing. By 2010 only 5% of the 85.5 million hectares, which where owned by white farmers, have been transferred through land reform (Goldblatt, 2011; Bernstein, 2013). Vink (2014) suggests two measures to improve the likelihood of success of land reform projects. One would be farmer support programs and extension services, which need to be accessible for all resources involved in agricultural activity, no matter how small. And the other involves land tenure and property rights, which allow farmers, access to finance in order to build sustainable businesses.

## 2.5 Social Network Analysis of the South African AIS

### 2.5.1 What is social networks analysis?

Social network analysis is a method to model complex systems of social entities. It depicts social relationships as networks of individual actors (nodes) and the relationships between them (ties). This method emerged from modern sociology and is used to represent the various relationships between the members of complex social systems at various levels. Furthermore it can provide information about network structure and positioning of actors within the network. (Van der Valk and Gijsbers, 2010). Given that Innovation Systems can be seen as complex systems this method will be used to model the SAAIS.

Social network analysis is based on the assumption that actors within social systems are connected to other actors and that these connections or relations have an influence on their respective actions and behaviour. "Central to the theoretical and methodological agenda of network analysis is identifying,

measuring and testing hypothesis about the structural forms and substantive contents of relations among actors. … The central objectives of network analysis are to measure and represent these structural relations accurately and to explain both why they occur and what are their consequences" (Knoke 2008)

#### 2.5.1.1 Actors, relations and attributes

Actors and relations are essential elements of social networks. The combination of these elements constitutes the network. In SNA actors are represented by nodes and relations by edges. These terms will be used interchangeable.

Actors can be individual persons, small or big organisations, or even nation states. Actors are characterized by attributes, such as title, size, age, opinions and behaviours. Relations are connections, contacts or ties between a pair of actors. While much social research focuses on the analysis of attributes of certain agents, SNA focuses on the relations between dyads of them. Relations are emergent properties of complex social systems and can be influenced by many more factors than individual characteristics (Knoke and Yang 2008; Scott 1991).

#### 2.5.1.2 Path length and Centrality

The concept of path length measures the distance of nodes to each other. Directly connected nodes have a path length of 1, if there is a node between them, the path length is 2, and so forth. The shorter the paths the better the information flow.

The notion of centrality measures how central an actor is within the network, which can be used to assess the importance of that actor in the network. This study focuses on three different measurements of centrality: degree centrality, closeness centrality and betweenness centrality. As will be shown, a high degree centrality does not necessarily mean high values in the two other measures (Golbeck, 2013). The node with highest centrality is most engaged in network and thus has better access to information flows due to the many connections is has. On the other hand it may not be linked very well to nodes, which are further out in the network and therefore lack access to new information. "Strong ties enable you to build up trust and exchange tacit knowledge, while weak ties are more likely to provide you with valuable new information" (Van der Valk and Gijsbers, 2010).

#### 2.5.2.3 Density

The concept of density describes the general level of connectedness of a network. The number of edges or connections, that can possibly exist in a network, gets compared to the number that actually exists. In a perfectly dense network all nodes would be directly connected to each other and the graph would have the indicator 1.0. The higher the density of a network the more actors are linked to each other, and the easier knowledge and information can flow and learning can take place (Knoke and Yang, 2008; Scott, 1991).

### 2.5.2 A social network analysis of the South African Agricultural Innovation System (SAAIS)

#### 2.5.2.1 Data Collection

One of the challenges in executing a social network analysis is the determination of the boundaries of the network. The decision on these is informed by theoretical information regarding the significance of the players for the functioning of the system (Scott, 1991). In order to analyse the SAAIS a relational approach was chosen to specify the boundaries of the system. In a snowball sampling method a small group of actors was identified based on the three elements present in every innovation system (Anandajayasekeram, 2011):

1. Knowledge generating, adapting and diffusing entities
2. The individuals and organisations involved in using and commercializing of this new knowledge, and
3. Governing institutions, conventions and norms for these processes

This small group consisted of representatives from research councils and universities, South African government departments, organized agriculture, and private industry. These representatives were then asked to name the organisations they work and interact with, and to describe the character of their relationships. In a next step interviews with these newly identified network actors were conducted and the same questions were asked.

### 2.5.2.2 Stakeholder groups to be included into the SNA

Through this process the following stakeholder groups could be identified as constituting the South African Innovation System for Agriculture (see table 1)

Table 1: Stakeholder groups represented in the SNA

| | |
|---|---|
| Farmers | Farmers – Commercial |
| | Farmers Commercial – Organic |
| | Smallholder Farmers - Commercial |
| | Smallholder Farmers – Organic |
| | Organised Agriculture |
| Governmental Organisations | Department for Agriculture, Forestry and Fisheries |
| | Department for Trade and Industry |
| | Extension Services |
| | Department for Science and Technology |
| | Department for Economic Development |
| | Department for Higher Education and Training |
| | Department for Environmental Affairs |
| | Department of Energy |
| | Department for Rural Development |
| | Department for Water and Sanitation |
| | Provincial Government Institutions |
| | Municipalities |
| | Development Agencies – National |
| | Development Agencies – International |
| Research Institutes | Research Institutes – Universities |
| | Research Institutes – Other |
| Private Sector | Innovators |

| | |
|---|---|
| | Innovation Intermediaries |
| | Agro-Processors / Food Industry |
| | Input Suppliers / Agri-Business |
| | Logistics Companies |
| | Fresh Produce Markets |
| | Retail – Conventional |
| | Retail – Organic |
| | Banks |
| | Venture Capital Companies |
| | Other Private Industry |
| Civil Society Organisations | NGOs National |
| | NGOs International |
| Other Institutions affected by agricultural innovation | Consumers |
| | Tertiary Education Institutions |

#### 2.5.2.3 SNA findings

A total of 38 interviews were conducted (see Appendix for the details). The interview partners were asked to describe their own role in the innovation process, to name the partners they work and interact with, and to explain how they perceive the functioning of these partners. The results relating to the mutual interaction were quantified and visualized as shown in figure 2. The visual interpretation highlights a centre and a middle sphere. The actors in the centre sphere show the most connections and seem to be the most engaged in the innovation system, the ones outside the two spheres are the most distant and least connected.

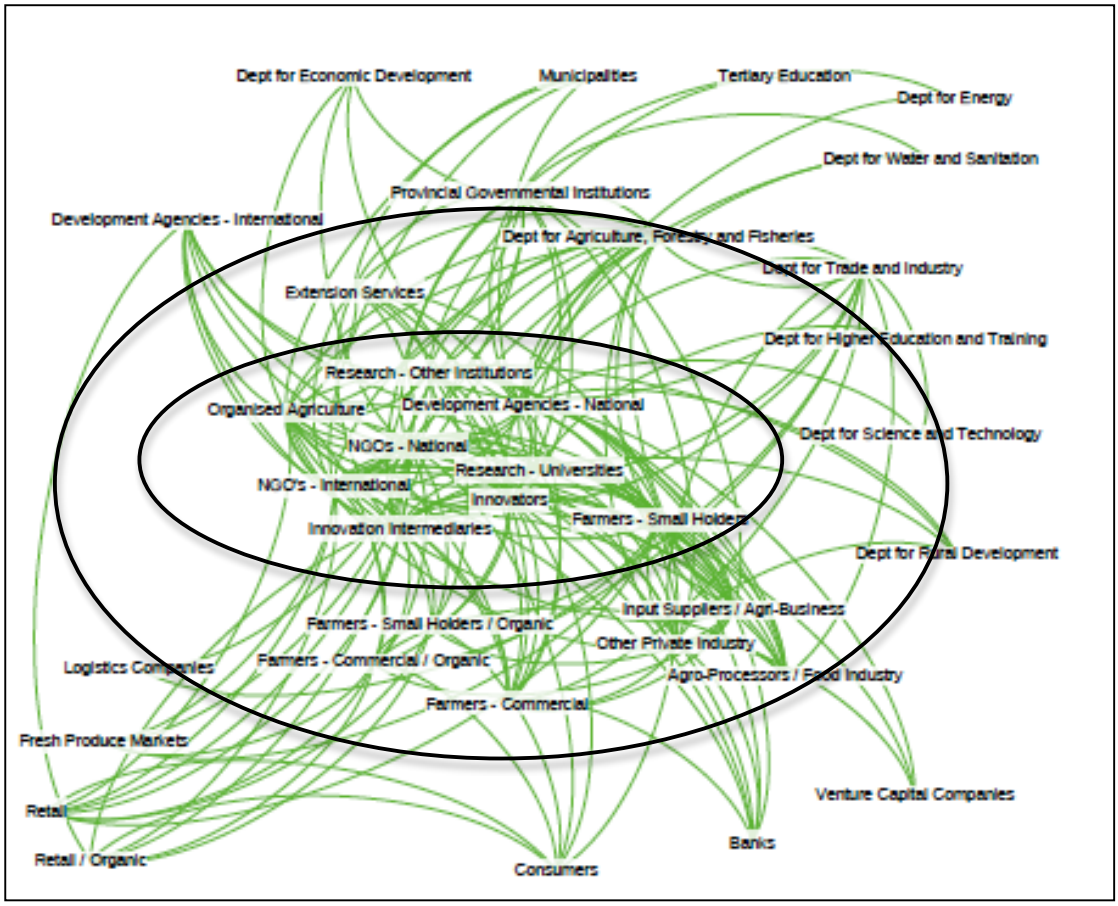


Figure 2: A graphical presentation of the SNA results

The statistical evaluation supports this finding. Table 2 shows the statistical results of the three centrality measures mentioned in section 2.5.1.2.

Degree centrality describes the numbers of edges of connections an agent has. A higher degree indicates a higher centrality of the actor.

Closeness centrality shows how close a certain node is to all the other ones in the network. The lower the value the more central the node.

Betweenness centrality indicates the importance of a note in the information flow from parts of the network to others. It measures the shortest paths through the network (Golbeck, 2013).

| | | Degree | Closeness | Betweenness |
|---|---|---|---|---|
| Farmers | Farmers – Commercial | 12 | 1,67 | 2,97 |
| | Farmers Commercial – Organic | 14 | 1,7 | 10,55 |
| | Small Holder Farmers - Commercial | 17 | 1,55 | 26,29 |
| | Small Holder Farmers – Organic | 11 | 1,73 | 5,25 |
| | Organised Agriculture | 23 | 1,32 | 36,74 |
| Governmental Organisations | Department for Agriculture, Forestry and Fisheries | 14 | 1,58 | 2,32 |
| | Department for Trade and Industry | 12 | 1,67 | 13,18 |
| | Extension Services | 12 | 1,67 | 3,99 |
| | Department for Science and Technology | 2 | 2,23 | 0 |
| | Department for Economic Development | 4 | 1,94 | 0 |
| | Department for Higher Education and Training | 1 | 2,44 | 0 |
| | Department for Environmental Affairs | 0 | 0 | 0 |
| | Department of Energy | 2 | 2,23 | 0 |
| | Department for Rural Development | 4 | 2,05 | 0 |
| | Department for Water and Sanitation | 3 | 2,08 | 1,11 |
| | Provincial Government Institutions | 15 | 1,55 | 21,97 |
| | Municipalities | 4 | 2 | 0,16 |
| | Development Agencies – National | 22 | 1,35 | 82,36 |
| | Development Agencies – International | 8 | 1,76 | 2,24 |
| Research Institutes | Research Institutes – Universities | 18 | 1,47 | 38,38 |
| | Research Institutes – Other | 18 | 1,47 | 39,6 |
| Private Sector | Innovators | 20 | 1,41 | 30,99 |
| | Innovation Intermediaries | 19 | 1,47 | 28,3 |
| | Agro-Processors / Food Industry | 10 | 1,7 | 2,12 |
| | Input Suppliers / Agri-Business | 15 | 1,55 | 4,35 |
| | Logistics Companies | 2 | 2,23 | 0 |
| | Fresh Produce Markets | 4 | 2,08 | 0 |
| | Retail – Conventional | 8 | 1,91 | 1,18 |
| | Retail – Organic | 7 | 1,97 | 1,22 |
| | Banks | 7 | 1,85 | 0,56 |
| | Venture Capital Companies | 3 | 2,05 | 0 |
| | Other Private Industry | 15 | 1,58 | 13,44 |
| Civil Society Organisations | NGOs National | 23 | 1,32 | 61,68 |
| | NGOs International | 22 | 1,35 | 36,72 |
| Other Institutions affected by agricultural innovation | Consumers | 7 | 2 | 0,87 |
| | Tertiary Education Institutions | 2 | 2,44 | 0 |

Table 2: Three centrality measures – legend: green: high centrality; yellow: medium centrality; orange: low centrality

## Farmers and organized agriculture

Farmers are relatively well connected within the SAAIS. While they do not cultivate direct relationships with most of the agents in the system, they do have very short connections to them, thus information and knowledge can reach them in a quick and undistorted way. Although the number of farmers is very high and they are often located in great distance from each other by the nature of their business, they are very well connected. This is mainly due to the very high degree centrality of organized agriculture. Organised agriculture comprises of commodity organisations, which present farmers producing specific commodities, as well as local farmer's associations, the most prominent of which are AgriSA and the African Farmers Association of South Africa (Interview 29). Due to a wide local network these associations can reach farmers even in remote areas. (Macascill,

2013). These organisations play a very active role and are one of the few actors within the system with direct connections to the primary producers. This direct contact is very important in the context of creating and disseminating innovative solutions. The cultural aspects of ways of thinking, and ides generation at grass root level play an important role here (Interview 13).

Governmental organisations

Many of the interviewed parties perceived governments' support for agricultural innovation as relatively weak. The results of the SNA support that perception. None of the government departments falls into the centre sphere with the highest number of connections, even the ones directly linked to agriculture such as the Department for Agriculture, Forestry and Fisheries (DAFF) and Extension services do only have direct connections with a limited number of stakeholders. There are many government departments affecting agriculture and these are all somehow connected to the system, although in many cases only weakly. However, little evidence of cooperation and coordination between these departments could be found when it comes to agricultural innovation. In order to foster innovation in the agricultural sector close cooperation between the departments of Agriculture, Water, and Energy is absolutely vital.

Although there is a lot of interest in agricultural development on government's side, stakeholders find it difficult to cooperate with certain departments, as practical mechanisms are currently not in place to partner with the various organisations (Interview 7). Concerns regarding capacity and capability of some government departments with regards to implementing complex agricultural innovation initiatives were raised during various interviews (Interview 9), and improved cooperation with private sector institutions was suggested to improve this situation (Interview 6).

Especially the effectiveness of extension services and their readiness to support farmers in implementing innovative methods and technologies was a concern for many stakeholders. The area of agricultural extension has not received sufficient funding and support during the last 20 years and significant improvements are needed (Interview 1; Interview 20). The currently dominant top-down approach to

extension services was criticised and a more participatory and inclusive method suggested (Interview 8). These problems are known to the respective actors within DAFF, but funding the employment of a significant amount of new extension officers and equipping them with the right technical abilities, skills and know-how is challenging (Interview 32).

There is currently no existing legal framework for extension services. A new extension policy was recently developed in cooperation with private partners und the support of an International NGO, but is still under discussion within DAFF

Research institutions

Naturally, research institutions play a central role in every innovation system. The data collection and analysis has shown that this is the case in the SAAIS as well.

There are not too many players in this stakeholder group. Although there are 10 universities in South Africa just two of them (University of Pretoria and Stellenbosch University) count for more than 60 per cent of the research activities and for the respective staff. The largest provider of research in the field of agriculture is the Agricultural Research Council (ARC) and there are four more national research institutions as well as some (smaller) private ones (Liebenberg, 2004).

Since 1997 government funding for research started to contract. The numbers of research staff have declined and as a result research institutions and universities are struggling with their revenue models and challenging budgets. As a result they turn to private industry in order to fund research projects. While the link with industry provides a good opportunity, issues of intellectual property and commercial positioning remain challenging for researchers (Interview 1).

Private sector

The private sector segment consists of various different actors and might deserve a separate SNA altogether. The sub-groups identified in this study are innovators and institutions directly related to innovation; input suppliers and agri-businesses, and retail and logistics companies.

Innovators are institutions of the private sector that invent new solutions and/or implement those for commercial use. Innovation intermediaries are organisations who fulfil brokerage and networking services to connect people with an interest in any given innovation project. Both are amongst the best-connected actors within the innovation system. This is not surprising as they perform a core function in the innovation process. Although they seem so well connected, there is still a challenge to find cooperation and contacts for their activities. Often then cannot rely on existing networks but have to create new ones for every new innovation (Interview 24).

The centrality of the agri-industry, with input suppliers, agri-processors, and food producing companies is represented in the middle sphere. They are only connected to a limited amount of players. However, their market strength and power position is very strong. Therefore they have a big influence in the markets they operate in and can often dictate which innovations are actually succeeding commercially and will get accepted in the working field (Interview 3).

Retail and logistics do play a rather passive role in the SAAIS. They are not very centrally positioned and do only focus on a limited part of the population. Although their organisations are often very centralized and efficient, they do not serve the needs of all South African consumers of agricultural products (Interview 37).

Civil Society Organisations

NGOs and Civil Society organisations are surprisingly prominent in the SAAIS. They are amongst the most connected actors and play an active role in innovation development, diffusion and dissemination.

Unfortunately the sector is very fragmented and better cooperation between the various organisations would have a very positive effect. There are many initiatives and their work could be much more impactful if they could put their resources together (Interview 13). However, civil society organisations sometimes seem to struggle to work together. One of the reasons could be that they often follow individual causes and therewith related ideologies. Religious ideas, pro or against organic or genetically modified crops come to mind. Competing for funds

unfortunately also limits the willingness for cooperation of NGOs with each other (Interview 4).

Other Organisations

Customers and consumers of agricultural products play virtually no role in the innovation system. However, potentially they could have the power to influence production and technology choices as has been seen in other parts of the world.

The same can be said for institutions of tertiary education other than the research universities. Although there is a huge need for skills development, they were not mentioned by the actors that were interviewed.

### 2.5.3 Discussion of the results

The individual interviews with the various stakeholders did provide more than just information about their connectedness and relationships within the SAAIS. Some important characteristics of the system cannot be learned from looking at the SNA diagram or interpreting its results. Below is a discussion on the most important issues, which were mentioned.

#### 2.5.3.1 Commercial versus smallholder and emerging farms

While in general agricultural business the commercial farmers seem much better connected amongst each other and with private industry, this does not appear to be the case when it comes to innovations in the field. There are more programmes and initiatives aimed at smallholder farmers. However, it is not apparent from the empirical work in this research whether these initiatives achieve long lasting results. The feedback from some of the interviews even indicates the opposite.

The South African agricultural system is modelled towards industrial agricultural systems, and the government policy is mainly promoting large commercial farming operations. When farmers look for innovations, which they would like to implement, they look at those farming models for guidance. This is the way of farming which is seen as innovation and progress, and it does often not support emerging and small-scale farmers (Interview 3). Therefore, innovative technology is often not suitable for them and would need to be adapted. But small farmer's

voices are often not heard or taken into consideration when researching innovative solutions (Interview 17; Interview 35).

Also, the current market and logistics infrastructure supports big commercial farms with large outputs. Markets are controlled by few very powerful players und smallholders lack opportunities to get their produce to market or to participate in storage facilities (Interview 9).

#### 2.5.3.2 Conventional vs. more sustainable farmers and respective retail outlets

As said above, the innovation system is mainly targeting commercial farming methods with high external inputs (HEI). Practices like environmentally friendly, more sustainable, more organic, shorter value chains, and local markets, are not really seen as innovation in South Africa although all of these would be at the benefit of smaller farmers (Interview 3). Although it does not become apparent from the SNA metrics, farmers and retailers who are specialized in organic and sustainable farming have given feedback that they feel isolated and not supported by the prevailing agricultural system. Although various initiatives are undertaken to change that and to found public private partnerships in order to promote more sustainable agro-ecological ways of farming, they claim to receive little recognition and backing from government (Interview 17).

The facts that the sector is very fragmented, organic farming initiatives are often done in isolation, there is no real farmers association for organic producers, and there is no official regulation for the sector results in a situation where the sector is very small and remains difficult to grow (Interview 11).

#### 2.5.3.3 Impact of power and influence

Stakeholder groups, like input suppliers, agri-processors, food producers and conventional retailers do not appear specifically impactful within the SAAIS based on the position and their connectedness within it. But they do require a special mention. There are only a few of these organizations and they often dominate the market segment they operate in or even the whole market.

Suppliers of seed, fertilizers and machinery as well as processors and grain mills were already highly concentrated by the end of apartheid. With the mergers of some companies and vertical integration of some others this concentration has increased even more. According to Bernstein (2013), the three major suppliers for grain seed shared among them 90% of the market and in 2009 Monsanto controlled 50% of the market for maize seed.

A similar situation is found in food processing and retail. The four major food producers account for more than 80 per cent of the processed food market and the major supermarket chains for more than 68 per cent of retail food sales (Bernstein, 2013).

This gives these organisations a unique position when it comes to innovation. They can push certain new products or processes into the market, orchestrate the respective marketing campaigns and sometimes cause unintended negative consequences for farmers and consumers, such as high prices, dependency on single suppliers, or unfair contractual conditions. One representative from the retail sector observed the contradiction that buying a loaf of white bread in a supermarket is more seen as progress than growing healthy vegetables in the own garden. As a consequence the quality and nutritious value of the consumed food is low while the food cost is high, and profits are shared by only a few very powerful players (Interview 12).

#### 2.5.3.4 Funding

Funding was highlighted by almost all stakeholders as one of the major challenges and constraints to innovation and its implementation. Therefore a separate SNA was done showing the funding streams for innovation in agriculture.

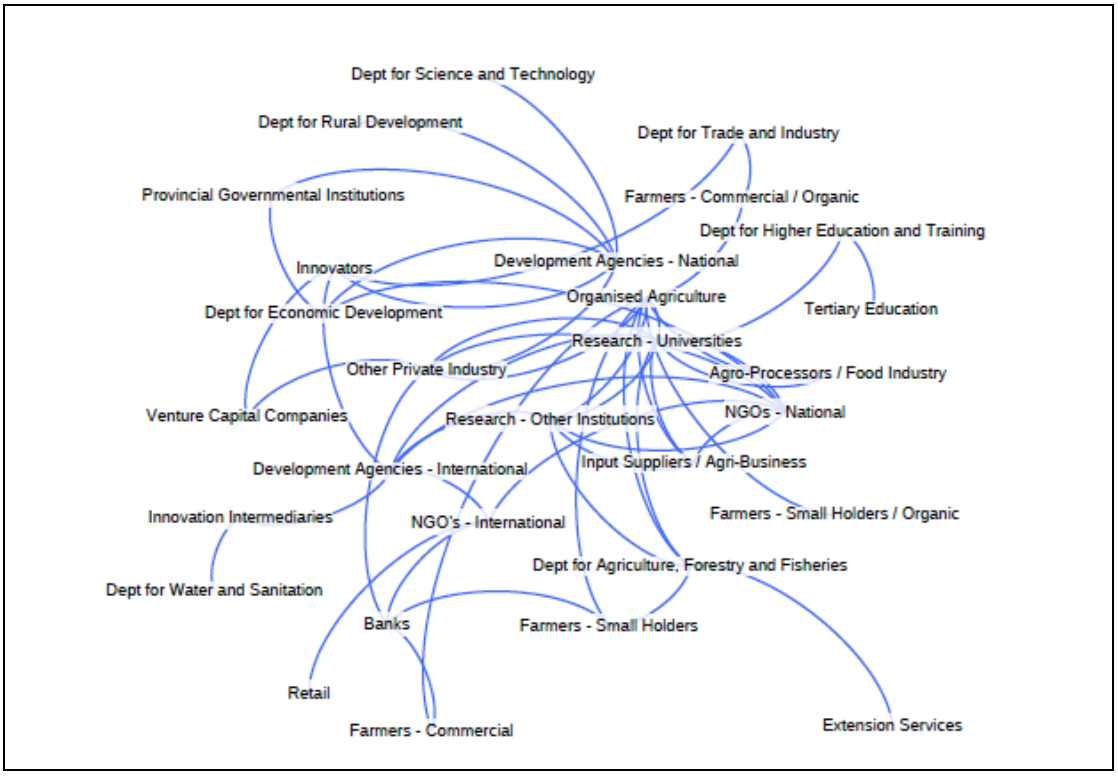


Figure 3: Funding streams for agricultural innovation

The result shows that the same actors who are most active in the network are also the ones with the most varied sources for funding. However, the diagram does not reflect the amount of the funding these organisations receive.

The departments of energy, environmental affairs, as well as municipalities, logistics companies, consumers, organic retail, and fresh produce markets were not mentioned at all with regards to funding innovation activities in the agricultural sector.

The challenges mentioned were plentiful. Emerging farmers who work on communal land can often not finance their operations, as they cannot offer the land as collateral (Interview 4). The research funding of universities is reduced in favour of educating more students and sufficient funding links with private industry cannot always get established (Interview 5). Funding for research from private enterprises comes mainly from agri-processors and input suppliers, which give them an even more powerful position than already described (Liebenberg et al., 2004). Governmental and development institutions do often fund the early stages

of innovation but innovators and entrepreneurs often struggle to finance the phase of start up commercialization (Interview 16).

### 2.6 Conclusions and limitations to the research

Innovation and agriculture have been inseparable in history. However, the challenges faced by the South African agricultural sector require more radical and disruptive changes and new approaches. These challenges include environmental, resource and climate related issues as well as social inequality and the dual economy, which is characteristic for the South African society.

Based on an analysis of innovation systems theory a social network analysis of the SAAIS was performed and the outcomes compared to the conventional understanding of well functioning innovation systems.

Historically, innovation systems have evolved from national agricultural research systems, which focus on formal research and linear one-way dissemination through extension services, to agricultural knowledge and information systems, which takes a more open approach by including more actors and organisations in the knowledge dissemination process. The concept of agricultural innovation systems does not only focus on knowledge but also on other system elements such as values, environmental factors, international influences etc.

The research showed that the SAAIS is a complex system, which is characterised by various stakeholders with different – and sometimes contradicting – objectives who interact with each other and form a multitude of relationships. The presence of a National Agricultural Research System can be strongly noted. However, the evolution towards a fully developed AIS is not complete yet. Due to the fact that the public extension services system has basically collapsed in many parts of the country even the linear diffusion of formal research is difficult. Organised agriculture and private providers do fill this gap to an extent but in a rather ad hoc and not very structured manner. The orchestrated cooperation to promote knowledge dissemination, which is characteristic for an AKIS, cannot be found. With regards to the characteristics of an AIS, most of the players are present and active within the SASIS, but the relationships and the cooperation between them,

which are typical for an AIS are not very developed. Focus is still very much on formal research and less on innovation, invention and their dissemination.

Various elements of an AIS are emerging, such as innovators, private industry, and civil society organisations. Yet, the linkages and cooperation between them appear weak and need to be strengthened in order to fully un-lock innovation potential.

The powerful position of the agri-industries, food processors and retail companies does not support equal cooperation and networking between the various stakeholders, and both farmers and consumers remain at the periphery of the innovation system and have little influence. Government institutions play a relatively weak role with regards to their position within the network as well as their perceived functioning. Attempts are made by other actors in the network to compensate for this.

There are also come limitations to this research. Simulating complex adaptive systems is only partly possible, as they can actually not be condensed into entities with less complexity. Therefore an SNA based on the input of just some of the system actors has limitations. The snowball sampling technique did only allow showing some of the actors of the network, but not all of them. So a full network representation cannot be granted. Therefore information about communities within the network, such as clusters or cliques, cannot be obtained from the sample data.

The information on funding is purely based on the feedback received in the interviews. As this was a relatively small sample base of 38, there may be other funding mechanisms, which were not covered here.

A high number of connections does indicate a central position within the network and a relative ease of access to information and knowledge, but that does not necessarily imply impact or power although there would be a high potential for it. However a low number of connectivity does indicate that the potential impact the organisations could have within the innovation system is not achieved. Additional research regarding the role of power within the SAAIS is recommended.

Dynamics within the stakeholder groups, such as competition or cooperation between their members, have been ignored in this research and will need attention in future studies in order to fully understand the functioning of the SAAIS.

# 3 Innovation Enabling Factors for Transition to a more Sustainable Agricultural System in South Africa

## 3.1. Introduction

The world of the 21st century is a place facing many turbulences and challenges. The research took place in the context of climate change, food security, social inequalities, and exploitation of natural resources on one side, and the need for change in the way agricultural activities are currently undertaken on the other.

The global demand for food will rise due to increasing incomes in some economies and the continuing growth of population. Ecological challenges like climate change and resource depletion will threaten the world's food supply. Therefore "(r)ising food production must be decoupled from unsustainable utilization of water, energy, fertilizers, chemicals and land. This will require a multi-faceted agro-ecological intensification of food production" (Oehman et al. 2013).

South Africa is often called 'the world in one country'. Although this statement originates from tourist brochures it is also true in the context of the above challenges as well, especially for the agricultural sector. There is a dual agricultural economy with small-scale communal farmers who struggle to make a living on one side, and well-developed commercial operations on the other. Both, however, grapple with the challenges presented by climate change and increasing resource pressure. Extreme weather phenomena, water scarcity, and rising input costs are affecting farmers' ability to achieve economic yields. At the same time, the South African population is expected to almost double in the next 40 years requiring more food and other agricultural products (Goldblatt, 2010).

Therefore fundamental change is required in the way food is grown, distributed and consumed.

This paper (and chapter) intends to improve the understanding of the environment needed to enable such a change in the South African context. It specifically aims to answer the following questions:

1. What are the main limitations and barriers to innovation and change in the prevailing food system in South Africa?
2. What is the latest research in that context in order to overcome these limitations and to enable innovation and long-term change?

In order to achieve that, a literature review about transitions theory and related concepts as well as latest views on food regimes informs sections two and three of this paper.

Interviews were conducted in order to identify blockages and limiting factors to change in the agricultural system. Based on the interview feedback, a second literature review focussed on the five prevalent factors in order to identify latest research trends in these fields.

### 3.2 Socio-Economic Transitions

Sustainable Development implies the gradual transformation of certain aspects of society or even of society as a whole. Such processes can be very complex and are affecting various dimensions. The transitions perspective is providing a theoretical framework to understand such societal transformations. Transitions are usually medium- to long-term change processes that lead to new ways of consumption, production, changed opinions and behaviours by all major actors, and often to new power relations between those actors (Spaargaren et al., 2012).

Transitions are often driven by crises or problems, which the current order cannot resolve. In order to address or abolish the crisis, inventions are made and innovations are developed, which address the underlying problems to an extent or even fully. The process of embedding the new solutions into society reshapes the modes of existence, technology, and power relations (Swilling and Anneke, 2012,1).

According to Perez (2002) economic development takes place in a cyclic or wavelike process. The beginning of a new cycle is characterized by the emergence of a new technology or a variety of them. These innovations do often have the ability to influence a variety of economic areas. Gore (2010) refers to past inventions around steel, railroads and electricity. In the context of today's economy as well as agriculture, technologies such as renewable energy and ICT can play such a role.

The level of innovation is low during the early stage of a cycle, but investment and additional actors are soon attracted to the field, which can then lead to a rush and even to over-investment. Perez also describes how new technological solutions can clash with existing practices, strategies, business models and organisational structures. The development then gets "blocked" until a new "techno-economic paradigm" has emerged and the new technologies can reach their full potential. At the same time, investors looking for short-term gains cannot easily find these in an 'over-subscribed' market. A shift towards longer-term investments into productive assets takes place. Only competitive technological solutions will be successful in the long run and while they establish themselves in the new regime the process of growth slows down (Perez, 2002, 2007).

Technological revolutions are characterized by the appearance of many new processes and products, and by a rapid growth of new infrastructures and industries. ICT and renewable energies can be seen as the central technologies in the current economic development cycle, which Swilling names the 'green-tech revolution' but the related innovations and opportunities can not yet get fully utilized. The development process seems to be stuck in the current paradigm and the current financial crisis can be seen as a sign for such a 'blocked' development. To drive this transition further it is required to 'discipline' finance capital and release more productive capital (Swilling, 2013).

It is difficult to manage such transitions. They can usually be explained in retrospective but not easily planned in advance (EU SCAR, 2012). The Multi-Level-Perspective does not only offer approach for the analysis of long-term technological transitions but also a way of 'managing' emerging innovations within a limiting regime.

### 3.2.1 The multi-level perspective for analysing sustainable transitions

The multi-level perspective (MLP) views socio-technical systems as consisting of three levels: niches, regimes, and landscapes. The three (hierarchical) levels are influencing – and are influenced by – innovation processes. Each level consists of a certain set of components, and the processes, values, actors are considered to be more stable, and more inflexible, the 'higher' the level (Geels, 2011).

The MLP states that innovations emerge and 'germinate' in niches. However, in order to be able to take root and grow, they often need to 'fight their way' into an existing system of structure, knowledge, institutions, and processes – the socio-technical regime. These provide the structure for an existing system. They consist of an established set of rules, values, and institutions and determine the behaviour of system actors. Existing regimes can be characterized by a state of 'lock in' which can make them appear inflexible and resistant to change, i.e. innovation. "… (E)ach technological revolution irrupts in the space shaped by the previous one and must confront old practices, criteria, habits, ideas and routines, deeply embedded in the minds and lives of the people involved as well as the general institutional framework established to accommodate the old paradigm. This context, almost per definition, is inadequate for the new" (Perez 2002).

Therefore innovation within a given regime usually only occurs in incremental steps. Niches, however, are seen as 'protected spaces' where innovation can emerge and develop without being limited by regime rules. Concepts, which can be successfully developed within a niche environment, can then be introduced to the existing regime. The third (and highest) level of this concept is the socio-technical landscape, which presents the broader context where niches and regimes are embedded, such as macro-economic conditions or political systems. Innovations influence processes and actions at all three levels which then results in societal change (Geels, 2011).

Genus and Coles (2008) argue that transitions take place when the existing regime shows problems or signs of crisis. These trigger key innovations, which address the weaknesses or problems of the regime in the long-term, early adoption is taking place and the innovation can contribute to technological

transition within the regime. However, increasing pressures from the landscape or societal sector, such as climate change, civil society movements or consumer pressures, can trigger regime changes as well (Van den Bergh et al., 2010).

So, if socio-technical systems fall apart due to landscape pressures, a whole new 'eco-system' for innovation emerges.

It is important to interpret such crises as "windows of opportunity" and to use them to leverage progress (Gore, 2010). In order to do that – so the argument of MLP – niches need to be developed and protected, so innovations can occur and take root before exposing them to the regime realities. The concept of strategic niche management addresses this requirement.

### 3.2.2 Strategic niche management

Strategic Niche Management (SNM) is based on the assumption that sustainable innovation processes can be facilitated through the creation of protected spaces or technological niches. These spaces should allow for learning, experimentation and the parallel development of related technologies. (Schot and Geels, 2008). This is a purposeful process including "the creation, development and controlled breakdown of niches for promising new technologies … and concepts" (Aday, 2007).

It is assumed that niche participants spend significant effort, financial capital and time in order to develop, test and improve the emerging innovations. Furthermore, the co-evolution of complementary technologies and the processes of learning and network creation are seen as important potential outcomes of niche operation. Technological niches should create an environment where focus is not only on particular technologies but also on the interconnectedness between them and with the social system, which they will ultimately alter. While niches are considered crucial to bring about regime changes, they cannot exist in isolation but need to be in constant interaction with external agents and processes as well, so any developments within the regime can be taken into consideration when adapting the novelty for practical use (Aday, 2007).

### 3.2.3 Criticism to the Transitions Theory and MLP

Although the abovementioned concepts are useful to analyse and understand socio-economical processes of change, different authors have highlighted various weaknesses and discussion points.

One criticism of the transitions theory is that the main emphasis is on technological innovation and change, while behaviours and values of human actors only change as a result of technological developments. There is currently very little focus on transitions, which are initiated and caused by human agents rather than technology. Although the co-evolution of society and technology is supposedly in the centre of this approach, it actually describes societal changes as secondary to technological ones (Spaargaren et al., 2012; Genus and Coles, 2008).

Long-term transitions do not occur very often and therefore are not easily analysed. Representative data about processes, agents, und relationships between them are difficult to come by, and transition processes can usually only be explained by a variety of causal factors. Transitions theory and the MLP can therefore not stand in isolation but will always need to be complemented by other – multi-dimensional – methodologies and theories (Geels, 2011).

It is also argued by some (Smith et al., 2010; Schoot and Geels 2008) that the concepts of MLP and SNM focus too much on niches and providing protection from the prevailing regimes in contrast to an early exposure of innovations to the regime in order to test them against risks and competitive solutions. Although niches might be often useful for fostering innovation, there are other enabling factors required to allow new solutions to blossom and grow. Section 2.5 of this paper will address some of these factors.

Furthermore, "… the role of places and spatial scales in these transition processes has not been an explicit issue of concern" (Smith et al., 2010). Global development and technological revolutions do not occur evenly across geographies. Especially development in Africa illustrates this. The global development cycle affecting most of the Western nations and Asia did not benefit African countries in the same manner. National conditions, political situations and

policy choices had a significant impact on the utilization and implementation of technologies, which have emerged during the last 50 years (Swilling, 2013).

## 3.3 Transitions towards a more sustainable agriculture – what does that mean?

### 3.3.1 Food regimes

As stated in the previous section, transitions are caused or called for by crises or problems within the existing regime. When looking at the history of agriculture and food, Swilling and Anneke (2012,2) distinguish three different food regimes so far:

- First food regime: 1870's to 1930s: "By the end of the twentieth century, there were approximately 437 million farms in developing countries which sustained the livelihoods of 1.5 billion people and provided food for two-thirds of the human population" (Swilling and Anneke, 2012,2). Agricultural products, such as livestock, grains, spices, tropical fruit and vegetables were imported from colonial countries.
- Second food regime: 1950's-1970's: The USA become a global agricultural power by deploying new technologies, such as industrial hybrid seeds which replaced the traditions of seed exchange and seed banks, mechanized irrigation, and chemical fertilizers and pesticides, and through these technologies boosting productivity of agricultural activity in a massive way. At the end of this process about 40% of the farms in developing countries were dependent on these so-called green revolution technologies.
- Third food regime: The 1970's/80s were characterized by declining yields, rising food prices and, at the same time, increased food demand from an emerging middle class in developing countries. During that period globalization, neoliberalism, deregulation and privatization have led to the replacement of state-centred agricultural models with privatized agricultural structures. Large multinational corporations and supermarkets dominate trade for inputs as well as agricultural produce.

### 3.3.2 Current food regime in crisis?

There are various signs that the current food regime is in a state of crisis and that a more sustainable system is needed.

Although the high energy input (HEI) agriculture resulted in doubling farm yields since 1960, a lot of harm was done on various levels. Ecological damage, groundwater pollution, and soil degradation will have a long-term negative effect on future production capabilities. All agricultural activity depends on soils and their quality for nutrient extraction. While maintaining nutrient availability in soils is a condition for long-term agricultural production current developments indicate various degradation processes, such as erosion, pollution, and salinization. An assessment in 1990 came to the conclusion that 23 per cent of the soils globally were degraded, and the situation has probably gotten worse since (Swilling & Anneke 2012, 2).

The resources required to produce inputs for the current industrial agricultural practices are scarce, finite and their use often contributes to an increase of greenhouse gas emissions and therefore climate change.

Another problem with the current food regime is the recent turbulence in the global food markets. Although agricultural yields are still growing, the growth rate is declining and not in line with the expected increase in food demand for the coming decades. Amongst other things this is caused by lower quality soils and has led to an increase in global food prices. Due to the influence of international corporations, agricultural produce became more and more commoditized and is often subject to speculation. Therefore, additional to a general upward trend of food prices, these also became less and less predictable (Swilling and Anneke 2012,2; EU Scar, 2012).

The increased role of multinational business has led to a situation where agri-businesses, retailers and food processing companies have more power than ever before when it comes to orchestrating and organising many parts of agricultural and food related value chains and the related networks. At the same time the influence of farmers and consumers is decreasing (Spaargaren et al., 2012).

Conventional agriculture, which is currently prevailing in many countries, will not be suited to feed the people of coming generations and to preserve their ecosystems at the same time.

### 3.3.3 Agro-ecology as a possible forth food regime

Sustainability in agriculture needs to be approached in a holistic way. Various dimensions need to be addressed, such as the environmental, economic, social and institutional point of view. Only if all these levels are in balance, the system is truly sustainable (Aday, 2007). Or “(i)n other words, agricultural systems are considered to be sustainable if they sustain themselves over a long period of time, that is, if they are economically viable, environmentally safe and socially fair” (Lichfouse et al., 2009).

Swilling and Anneke (2012,2) argue that rather than focusing on yield growth alone, it is necessary to completely reconstruct “the way food is produced, distributed and consumed”. They propose that an ‘agro-ecological’ approach as an alternative which addresses many of the weaknesses in the current food regime.

Agro-ecology is a science as well as a set of practices, which aim to identify and evaluate alternatives to current agricultural practices. The approach searches for a food system, which enables increased production, fair distribution of food to all while at the same time maintaining or even restoring the soils. It represents a growing, yet alternative body of practice and knowledge, which aims to work with nature rather than against it, acknowledges the potential role of small farms in a future food system and understands agricultural contexts as complex (Swilling and Anneke, 2012,2).

Altieri emphasizes the importance of cultural and social circumstances. He describes agro ecosystems as “communities of plants and animals interacting with their physical and chemical environments that have been modified by people to produce food, fibre, fuel and other products for human consumption and processing” (Altieri, 2007). A change towards more sustainable farming practices in the long-term will only be possible when farmers are actively participating in the development of these practices, if changes are ecologically sound and keep agricultural activity viable from an economic view as well.

As can be seen from the above, the challenges faced in a move to a more sustainable agricultural regime cannot be solved through technological innovations alone. As discussed in section 3.2 any new technology occurs within a socio-technical network of institutions, infrastructure, knowledge, values, and skills (Aday, 2007).

Innovative technologies are needed in order to boost productivity and at the same time address environmental problems and resource scarcities. But these technologies can only have an impact if their emergence is accompanied by other changes within the wider system, such as changes in consumer behaviour, the removal of barriers to trade and markets, improving rural infrastructure and addressing supply chain problems. The relation of agriculture and society, existing economic models, the food system as a whole, and the existing marketing networks need to be questioned and re-invented. All these elements are part of the prevailing regime and landscape in the sense of the MLP approach discussed in section 3.2 and require an interdisciplinary approach from various fields such as ecology, economics, agronomy, sociology and politics. (EU Scar, 2012; Lichfouse et al., 2009).

### 3.4 The current food regime in South Africa

The South African food system does pretty much reflect the global situation. Industrial farming and high input practices dominate the sector. The food value chain is organized around this well-defined commercial agriculture. Corporate input suppliers, agri-processors and retail companies are highly concentrated and can dominate their respective markets. On the other hand the smallholder value chain, which essentially works on the localized level, is not very effective (Interview 37).

Intensive farming methods have already significantly impacted the natural environment. Continued use and overuse of synthetic fertilisers, herbicides and pesticides have reduced soil fertility, caused acidic and salty soils as well as soil erosion and water pollution. Especially the latter is concerning as South Africa is one of the most water scarce countries in the sub-Saharan region and faces extremely variable rainfalls (Goldblatt 2011).

Although South Africa as a country is perceived to be 'food-secure', so producing sufficient food in total to feed its population, more than half of the South Africans are at risk of being hungry (Oxfam, 2014).

These are all indications that there are considerable problems within the current South African food system which need addressing and for which more sustainable solutions need to be found. However, during the interview process major concerns were raised about the limitations for developing such solutions.

The sector of organic or agro-ecological farming is still very small. Actors criticize the lack of interest and support from government departments and the institutions of organized agriculture. As the result, farmers do not grow this sector even if many consumers would actually prefer sustainable grown produce (Interview 22).

On the other hand organic or near-organic farming is not new in South Africa. Traditional farming methods did not require chemicals and co-planting practices were the norm in the past (Interview 29). So, putting an effort into preserving the traditional and indigenous knowledge is important and can save time, effort, money and environmental damage.

### 3.5 Current blockages for a transition

Are there signs of transition to a more sustainable, agro-ecological agricultural sector? During the empirical phase of this research 38 participators of agricultural activities were asked in which areas they perceive challenges for change, and what would be required to overcome them. In a snowball sampling method a small group of actors was identified based on the three elements present in every innovation system (namely research, dissemination and governance). These representatives were then asked to describe the limitations and bottlenecks they experienced during innovation processes. Furthermore they were asked to nominate other stakeholders within the innovation systems to be included into the interview process.

The next section presents the results of this survey for the 5 areas, which were named the most. Based on the empirical feedback a literature review was done for

each topic in order to determine the latest research and potential solutions for the respective issues.

The following 5 areas were named the most:

| | total count | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Market Access for Small Holder Farmers and Localised Food Markets | 19 | | | | 1 | 1 | | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | | | | 1 | 1 | 1 | | 1 | 1 | | 1 | | 1 | |
| Collaboration and Networking | 18 | 1 | | | 1 | 1 | 1 | | | 1 | | | 1 | 1 | | | 1 | | | | | | 1 | | 1 | 1 | 1 | 1 | 1 | | | | | 1 | 1 | | 1 | 1 | |
| Funding and Finance | 16 | | | | 1 | 1 | | 1 | | | | 1 | | | | | 1 | 1 | | | | 1 | 1 | | 1 | | 1 | | 1 | 1 | | | 1 | | 1 | 1 | 1 | | |
| Governmental Focus | 15 | | | 1 | | | | 1 | 1 | 1 | | 1 | 1 | 1 | | | | 1 | | | | 1 | 1 | | | | | 1 | 1 | 1 | | 1 | | | 1 | | | |
| Implementation & Commercialisation | 12 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | 1 | | | | | | | | 1 | | | | 1 | | 1 | | | | 1 | |

2.1.1 Table 3: Main limitations to innovation in South African agriculture

### 3.5.1 Market access for smallholder farmers and localised food systems

Interview feedback

The challenge of market access for smallholder and emerging farmers was named as crucial for a transition of the South African Food system by more than half of the people interviewed for this research. Although there are about 10 times more small-scale farmers in participating in the South African agricultural sector than there are commercial farms, the infrastructure for marketing, logistics and technology transfer is solely aimed at the commercial sector.

The complete supply chain from seed to shelf, including access to finance, needs to be redesigned. Currently neither the majority of the producers nor the majority of the consumers are in a position to participate successfully in food supply chains. The value addition of food production is currently channelled into corporate industries instead of poor and/or rural communities (Interview 9).

Cold chains, transport and storage facilities are designed for big lot sizes and input suppliers are selling their products in truckloads rather than batches. What is required are collection points, and bundling or un-bundling opportunities for agricultural produce as well as inputs (Interview 4; Interview 33).

"The established commercial companies make no effort to create tailored products, supply chains, or systems for this mass of small emerging farmers in SA and potential agribusinesses. There is no service-provider potentially geared to service those people – all of them are trying to service 30 000 commercial farmers but not the 300 000 or more emerging ones – this affects all areas - input, technology, finance, storage, access to information, soil testing … Fundamentally that is very there is a big gap … this group is not seen as a worthwhile market" (Interview 9).

The same problems arise with regards to technologies, which are mostly developed and aimed at big commercial farming operations and are not relevant to the challenges of smallholder farmers. Potentially relevant technologies range from mechanization to ICTs and effective water management.

Technology implementation is left to market forces and these traditionally aim at big companies with sizable wallets (Interview 16).

There are actually many relevant technologies available in the international arena, but the buying power at and the distribution costs to remote rural areas do not justify their commercialisation. Alternative systems are needed to make sure that information about and access to these technologies find their way to smallholder farmers, and that they can get adapted to local conditions if necessary (Interview 4; Interview 28). If that can be achieved, there is a lot of potential opportunity for smallholder farmers to increase their productivity and for emerging providers of the respective technologies to build sustainable enterprises.

What may be a starting point to address the above problems are smaller localized agricultural systems. Smallholder agriculture can only work in value chains, which are aimed at local and regional customers and consumers (Interview 27). There are already some examples throughout South Africa where such systems work well. However, these models cannot scale up to a bigger size. If they do work well they can be replicated in different places, and small circular economies can get created. One important condition for the success of such model is the consciousness of consumers who want to re-connect with the origins of their food (Interview 8).

These challenges were not only stated during the empirical interviews, but are also represented in the literature.

The prevailing food system in South Africa is characterized by economies of scale, capital concentration, a disconnect of production and consumption of food – both in the time and space, and a reliance on expert systems (Feagan, 2007).

All of these characteristics form barriers for smallholder farmers to participate successfully in the food system. They require access to supply chains, which can deal with small batch sizes for both produce and inputs and which can level out the currently high transaction costs for market activities. Furthermore there is a need for improved infrastructure and access to capital and individualised support services, which can meet the needs of people with often low education and limited literacy (Baloyi, 2010; Collier and Dercon, 2014).

Suggestions to address the abovementioned dilemma include the consolidation of the individual small farmer activities and transactions in order to achieve the economies of scale required to participate in the current markets. Cooperatives and contract farming structures are some of these models. Furthermore, technologies can be adapted for smallholder needs both in the field of mechanization as well as information via mainly mobile applications (Collier and Dercon, 2014). Also, the formal processes to ensure food quality and safety and the related certification requirements, which are currently designed for big commercial operations, need to be adapted for smallholder farmer needs (Baloyi, 2010).

One of the emerging patterns is the formation and evolution of regional or short food supply chains. This topic has received a lot of academic interest during the last 10 years. The concept is based on the view that more localised food systems emerge from a shared community centred vision and can better address current inequalities in agricultural and food systems. Consumers are moving closer to the origin of food and often build direct contacts and commercial relationships with the producers of the food (Renting et al., 2003; Feagan 2007). “Here attention to inequality is given particular emphasis on the producer side, focusing on the

manner by which small-scale local producers might survive in an agricultural system where both market and state forces have long worked against them. Producer survival strategies, such as networks with other local farm and non-farm actors such as retailers and consumers, take on particular importance" (Donald et al., 2010).

An example for a local food system is the 'shared' or community-supported agriculture (CSA). It is a concept where farmers and local residents share the risk of farming through pre-funding the agricultural activities by either buying a share in the operation or by contributing money prior to receiving produce in return. Additionally to the risk sharing these arrangements can bring people into a closer relationship with their food and the way it is produced and contribute to building more resilient rural communities (Feagan, 2007).

### 3.5.2 Cooperation and Networking

Interview feedback

Enabling change and transition requires new ways of working. Existing business models are being challenged and may not work anymore. One important area in this field is the way people and organisations are working together. The Futures Company (2014) has identified various design principles for the sustainable operation of the future. Among these are shifts to a more open and connected way of working. What is required are networked operating models where all different parts are linked and can exchange information and which are more open to inputs from the outside of the organization and for exchange with other organisations.

The feedback from the interview process reflects this development also for the agricultural sector in South Africa. The uncertainty and complexity of factors influencing agricultural activity require a very different way of working. Attaching more value to relationships, networks, values and stakeholders becomes very important (Interview 26).

Unfortunately, this is not yet the case in many instances. There is even a certain adversity seen when it comes to collaboration. Institutions perceive the environment they work in as competitive and tend to compete for finance and

other resources instead working together (Interview 1). While there is awareness that there could be a lot of value in connecting and aligning initiatives towards change, there are also many perceived risks. Loss of funds, influence, and future opportunities are but a few (Interview 9).

If initiatives could be bundled and organisations would put their resources together, their influence could be so much bigger. More public examples are needed which make the value of cooperation more visible and transparent so people actually trust in it (Interview 13).

One approach to address this challenge is networks. They do exist in many industry sectors, but are not very developed in the field of agricultural innovation. This has been mentioned as a major stumbling block when trying to implement initiatives as the creation of contacts and relationships with various parties can be very time consuming and difficult (Interview 24).

On the other hand there are various initiatives supporting collaboration and cooperation. They just often seem to exist in isolation and are not very known to the relevant people in the sector. Some examples are innovation clusters, which provide spaces for regular interactions (Interview 21), platforms which bring industry players together in order to create synergies out of their activities and pilot farms which demonstrate various innovative methods and technologies and can be adopted by farmers (Interview 25).

Literature review

There are various theoretical concepts addressing the need for better cooperation.

The paradigm of open innovation for example is based on the assumption that organisations cannot entirely rely on internal sources for innovative ideas. The idea is that a solution to the problem at hand has already been found by someone else somewhere. And companies and organisations need to open up and include external actors and partners into their innovation process in order to access these solutions (Anandajayasekeram, 2011). Open innovation proposes that good ideas and solutions can originate from both inside and outside the organisation and that the widely distributed knowledge sources needed to solve existing challenges

need to be identified and leveraged (Chesbrough, 2008). The concept of open innovation is still fairly new and while it has great potential for fast-tracking the implementation of new solutions many companies still need to make the shift and adaptation to organisational and regional conditions may be required. Also, the concept is not sufficient to ensure continuous innovation as it builds on existing solutions only (Anandajayasekeram, 2011).

Innovation intermediaries play a more and more important role in the context of open innovation. They help to facilitate the innovation process and to coordinate the activities of the various stakeholders involved. Innovation intermediaries broker transactions between two or more parties. They help finding support, funding or advice as well as information about potential partners for the innovation (Agogue et al., 2012). Klerxx and Leeuwis (2007) see three main functions for innovation intermediaries: the articulation of demand, brokering of innovation networks and the management of the innovation process. Despite the general recognition of the importance of their role, services are often immeasurable, invisible and difficult to show in absolute terms. This can result in an unwillingness to pay for such services by the stakeholders in the innovation process. "As determining the impact of innovation intermediaries is inherently difficult, additional systematic analysis (both quantitative and qualitative) of the effects of the support tools of innovation intermediaries on innovation routines of agricultural entrepreneurs is therefore desirable" (Klerxx, Leeuwis, 2007).

Another approach to accommodate and implement cooperation in the context of innovation is the use of an innovation platform. An innovation platform is a space (physical or virtual), which allows a set of actors to get together in order to communicate, cooperate and share tasks to achieve a common goal (Van Rooyen and Homan, 2010). It is a forum, which creates an environment for sharing and discussing ideas, to think and talk and to listen and learn (Anandajayasekeram, 2011). A well functioning innovation platform is characterised by open communication and information sharing, participatory processes on the basis of trust and a diversity of members' skills, capacities and resources. An innovation platform is a flexible entity with an evolving membership. The design needs to take into consideration that the role of some members may change over time or may be

temporary. One of the key challenges is to enable interactions and to build links between the various actors and to facilitate and coordinate these interactions. This can be a time and resource intensive task and requires high quality resources (Nederlof et al., 2011),

### 3.5.3 Funding and Finance

Interview feedback

In order to enable the agricultural potential in Africa access to finance is key. Financing innovation initiatives is always difficult. This is even more the case in the agricultural space. Primary agriculture is considered very risky due to its exposure to increasingly volatile weather patterns and other influences. Many emerging farmers farm on communal land or land received through land reform. They do not have title deeds, which allow them to use the land as a collateral for finance. Alternative and innovative financing mechanisms for emerging farms and respective innovations around them are called for (Interview 4).

Research funding has contracted since 1994 and research institutions are struggling to find alternatives in the private or international field. While at the same time there is more need to research to solve emerging problems (Interview 5).

Especially private funding for innovation is difficult to come by. Venture capital funds tend to focus on Information and Communication Technologies (ICT) and other highly technological innovation and not agricultural activities. Also private investors tend to prefer investments into growing companies and not innovative start-up organisations. Part of this gap is covered by development organisations such as the Innovation Agency (TIA) and the Industrial Development Corporation (IDC) but often their funding stops at an earlier stage than the private capital companies are willing to step in. This timing gap results in the failure of many promising initiatives (Interview 7; Interview 16).

Literature review

There are developments to change the view on finance for development and tendencies to move from philanthropy to impact investment. These new sources of

finance could possibly fill some of the gaps left by government funding and private investment.

Research has shown that there are two financial factors, which limit innovation in general and its implementation: high cost for innovation and the lack of access to funding. The classical form of financing – debt – is often not available for initiatives, which do not generate income in their early stage; and innovation often needs to be financed by the funders own funds or turn to private equity and venture capital funding. However, the availability of finance has tightened since the financial crisis in 2008. Banks have tightened the conditions for access to credit and venture capital providers are focusing more on maintaining healthy portfolios than taking on new and risky investments (Pelly and Kraemer-Eis, 2011).

Agricultural innovation, however faces additional challenges. While low population densities and highly dispersed business entities with little aggregation characterize rural economies, agricultural activity faces higher risks than most other economic sectors and is therefore less attractive to investors. When it comes to financing innovation in agriculture the literature identifies several challenges, which are unique to the sector.

Agricultural production is seasonal with long cycles between expenses for inputs etc. and income from produce sold. Therefore classical loan funding products are often not applicable. What is required are longer term financing tools (Collier and Dercon, 2014).

Secondly, financing agricultural innovation is often characterized by high transaction costs due to high distances, inefficient markets, sub-quality infrastructure and low population density (International Finance Corporation, 2012). Agricultural activity is very diverse and required individual solutions rather than standard financial products.

The risks related to agricultural activities are a third attribute. These lie in environmental conditions, such as erratic weather pattern, diseases, flood or droughts, as well as markets with volatile prices, infrastructure limitations and limiting trade policies (GIZ, 2011).

Fourth, agricultural activity is characterized by low transparency. Reliable data on yields, weather or crop cycles or market information such as pricing is often not accessible (GIZ, 2011).

Lastly, land tenure and property rights are can be problematic too. There are two different property regimes existing in parallel in South Africa “namely the system of individualised common law (Roman-Dutch) land ownership, which is predominantly based on civil law principles, and the system of communal land tenure, which is predominantly based on the shared use of land by communities in terms of indigenous law principles” (Pienaar, 2013). Communal land rights are currently not registered in official systems in a sufficient and reliable way and cannot be used a collateral for funding of innovation initiatives.

The controversies outlined above become even more severe for smallholder farmers and most of the financial products aim at commercial farming operations while actually the majority of farming enterprises is of a small-scale where low value subsistence crops are grown (International Finance Corporation, 2012).

The challenges described above require a specialized approach to finance but often there is insufficient knowledge at financial institutions about local environmental and agricultural characteristics. As a consequence financial institutions often find it difficult to develop suitable financial products for participants of the agri-value chain, which take these characteristics into consideration (GIZ, 2011).

In order to meet the challenges and obstacles discussed above, various innovative approaches have emerged recently. These relate to risk mitigation, the generation of new funding streams, and legislative changes.

With regards to risk mitigation there are various emerging insurance products, which can significantly help to reduce the risk of default for financial service providers. These products can relate to protection from crop failure and the effects of extreme weather as well as personal health and incapacity. Other risk management tools cover commodity price risks, but these are still very limited in use. Especially related to innovation is the risk to pay back credit or loans. In order

to address these risks there are some new ways for guarantees or the “use of movable collateral and a more flexible approach to credit requirements.” Often these tools will be part of a bigger package (International Finance Corporation, 2012).

While the funding opportunities for innovation activities appears scarce ‘ Leading Group’ have identified various potential source for ‘new funds’ for agricultural innovation. These include national taxes (for example on financial transactions or fat and sugar products), funds from carbon emission allowances, or public private partnerships, which help channelling private funds into innovation and infrastructure (Leading Group on Innovative Financing for Development, 2012). Especially the blending of private and public funds deserves mentioning. This would require “the transformation of a significant percentage of national and (regional) budgets from grants and subsidies into revolving financial instruments, invested by market-oriented professionals. Future models of public financing intervention must also involve a better combination of grants, equity co-investments, loans, guarantees and fiscal incentives. The structuring of those financial interventions to reflect the risk profile and potential return – financial, social and environmental” (Pelly and Kraemer-Eis, 2011).

Impact investing is another new potential source for funds. Investments which are looking for positive impact on environment and society while at the same time seeking financial return have received increasing national and international intrest. The main focus of impact investments is to mobilize capital into enterprises and initiatives, which aim at positive social impact, such as infrastructure or social challenges (Giamporcaro and Bakker, 2012; Van Wyk, 2014).

Investment into agricultural projects can be seen as one of the most effective and efficient ways to reduce poverty and to improve food security. Some studies show an up to four-fold reduction in poverty as a result of investments in agriculture compared to other sectors. And while agricultural investment is widely recognized for its social impact, especially when aimed at small and medium sized enterprises, it also has the potential to provide profit and growth for the financial sector (International Finance Corporation, 2012).

A further emphasis should be on legislation. When it comes to funding agricultural innovation, the responsibility can often fall between various ministries or other legal entities. “As a result, the subject is frequently pushed to the side making agricultural finance a »policy orphan«. To be effectively advanced, agricultural finance needs a strong and dedicated institutional advocate, possibly the Central Bank” (GIZ, 2011). Legislation needs to cover a variety of financial needs and to accommodate different customers. Land tenure systems should enable long-term leases or ownership, so the security required for collateral and planning can be ensured.

### 3.5.4 Government focus

Current government policies support industrial, large scale farming models. Big agricultural enterprises are being promoted and this finds its way into the mind of the farmers. There is also considerable support for new green revolution in Africa and South Africa. Although the green revolution with its high input methods did in many instances achieve higher production rates has made a positive contribution to food security in India, it is known today that it also destroyed many things in the process, such as traditional and indigenous knowledge and that the resilience of the farming system has been weakened (Interview 8).

As long as the governmental focus is on high input farming, GMO, and industrial farming methods, agro-ecological practices will indeed only be able to exist in niches.

What is needed is advocacy, dialog and more cooperation between stakeholders of the sustainable farming initiatives and governmental departments. The engagement with government needs to be increased on many levels. Initiatives like innovation forums and conferences were suggested (Interview 15) and a starting point should be made with the ministries, which do show an interest in the topic, such as some departments at the Department for Trade and Industry.

Much of the traditional African agriculture is already organic or near organic. One of the challenges is the system of certification. This has come through the trade and retail organisations. It is virtually impossible for farmers to deliver high value

organic produce to formal retail without going through a costly certification process.

In addition to that there is currently no legislation or standard for organic production in South Africa. While a draft regulation has gone through various discussion rounds and has been in existence for several years it has still not been published As a possible interim solution a set of voluntary standards was developed on the base of the current draft regulation (http://www.saoso.org/Organic-Standards.php accessed 15/4).

Some producers adhere to a participatory guarantee system (PGS), which was created by the international federation of organic agriculture movements (IFOAM) in order to overcome the challenges of formal certification. PGS seeks to provide a reliable guarantee for the quality of organic produce. However, the assessment is done on a participatory basis with the involvement of consumers, farmers and other stakeholders. This system is mainly aimed at local food systems and small farms (Interview 8).

However, if the various initiatives to increase the reach of sustainable and organic agricultural production do want to achieve scale the participation of government is required and pathways to the respective departments need to be found.

### 3.5.5 Implementation and Project Management

Interview feedback

Although there are many promising ideas and concepts available to change the current way of agricultural practice, the realization and implementation of these ideas is problematic. The success of innovation depends on many things. There could be a good idea but no need in the market or no entry because the barriers are too high. Or the timing is just wrong (Interview 5).

People, who need innovations the most often don't know about them. What is needed is an institution to drive practical innovation, to find what new practices are available nationally and globally and what does it take to get it used in practice (Interview 4).

According to a representative from an innovation intermediary it is one of the most challenging parts of the innovation process to find someone to take ownership of the process and to see it through. There are no or very few organisations focussing only on that, so it often reflects as additional responsibility. Doing something out of the norm is difficult, managing complex tasks and bringing together various stakeholders and interest groups is hard for many people (Interview 37). What is required is a pro-active nature of someone who is able to speak to researchers, specialists and farmers alike and who can take on the challenges of implementation (Interview 1).

Literature review

The implementation and project management of innovation is non-linear and multidisciplinary in nature. As the discipline is more focused on practical application there is no universal theoretical basis or theory of project management. “With some notable exceptions, however, the traditional innovation literature largely ignores project management and the intricacies of managing innovation in project based firms. In addition, the project management literature, considerably expanded in recent decades, largely ignores innovations” (Filippov and Mooi, 2010).

There are various challenges for innovation projects. On one side they are volatile and risky and are characterized by a failure rate between 60 and 90%. On the other they take place in a multidimensional environment that is characterized by multiple stakeholders who act in a free and not always predictable manner and “whose actions are interconnected such that one agent's actions changes the context for other agents” (Harkema and Baets, 1999).

Required is a holistic approach, which embraces complexity by involving all elements, affected by such an innovation, whether they are endogenous or exogenous to the immediate system the innovation relates to.

The fact, whether a technology or a new process works or not, is not an intrinsic property of the innovation but depends on the way it is embedded in a specific socio-technical network and includes skills, knowledge, organizations and infrastructures. Traditional, linear project management approaches, which focus

on controlling the efficient management of schedule and costs as well as technical issues, are often insufficient when faced with complex, uncertain and knowledge-based challenges (Peters, 2011).

Additional to the traditional tasks of implementation, such as the management of cost, schedule and technical issues, complex innovations require the assessment of context and complexity and incorporation of social system dynamics as well. It is important to take the conditions and specifics of the affected social systems into consideration, to facilitate learning and change processes.

A further requirement emerging from the complexity in the context of implementing innovation projects is flexibility, openness and agility. Most innovative solutions come from a convergence of existing ones in new applications. Therefore, co-operation of different players from different industries, government agencies, or NGOs who are working in global networks is essential (PMI, 2011). Rigid processes and systems would constrict and limit the realization of new approaches rather than support them. Self-regulation is an important feature of complex systems and some kind of order or organization arises from the behaviour and adaptation of the stakeholders rather than from external control mechanisms (Harkema and Baets, 1999).

### 3.6 Conclusions

Industrial farming and high input methods on one hand and numerous smallholder and emerging farmers on the other characterize the existing food regime in South Africa. There are various issues in the prevailing food regime. These include environmental problems, water scarcity, and effects from climate change as well as social inequalities, which lead to food insecurity for parts of the population.

Based on the realization that current practices cannot meet the challenges faced by the South African food system, this paper focused on the ability of the South African agricultural sector for long-term change.

The concepts of transitions, a multi-level perspective to socio-economic development and the strategic management of niches form the theoretical foundation for this work. While societal change is often caused by problems in the

current system it is also limited by it and the existing conditions. Therefore it is argued that innovation and new solutions need protected spaces in order to occur and develop.

During an interview process with 38 actors within the agricultural sector five limiting factors to change and transition of the agriculture and food system were identified. Possible ways to overcome them were researched in a literature review on the identified topics.

The following themes emerged:

1. Market access for smallholder farmers and localized food systems

Although the majority of farmers in South Africa is operating on small farms the agricultural system and related markets are modelled around big commercial operations, thus excluding small-scale farmers from opportunities to sell their produce and to purchase input and obtain information at affordable prices. Shortening supply chains, local food production and consumption and community-supported agriculture are emerging models, which can address this.

2. Cooperation and networking

Although many innovative ideas and solutions are addressing universal problems, they are often developed in isolation. Organisations and stakeholders are reluctant to cooperate and share information and knowledge in order to protect perceived resources, such as funding, intellectual property or influence and power. Obviously, it is important to operate within legal conditions in that regard, but cooperation the various actors is required in order to solve the complex problems in question and new and more open ways of working are required. Concepts like open innovation, innovation intermediaries and innovation platforms can be starting points to achieve this.

3. Funding and finance

The current finance landscape is not very conducive for agricultural innovation that will lead to long lasting change. The sector is considered to be very risky and land

tenure issues limit the use of land as a collateral for funding. New risk management tools and insurance products, new funding streams like taxes and private sources as well as the emerging field of impact investment address this.

4. Government focus

The main focus of policy is aimed at conventional farming operations. High input agriculture, GMO and industrial farming methods are favoured over more sustainable agricultural approaches. More dialog and engagement between government organizations and the other stakeholders working on innovative solutions would be a starting point to shift the focus towards alternative ways.

5. Implementation and project management

There are limited skills currently to take innovative ideas and concepts through to implementation and practical use. Traditional project management approaches can only partly solve this. What is required is a combination of techniques, which address the complexity and multidisciplinary nature of innovation implementation.

These five challenges are interlinked and solving one of them could improve the situation for the others too. Therefore it is important to address them together. For example, it could be easier to obtain funding if proper project implementation can be relied upon.

# 4 Conclusions to thesis

This study evaluated the ability and readiness of South African Agriculture to support and enable the emergence, implementation and dissemination of innovative solutions in order to move to a more sustainable agricultural system.

The current reality indicates many unsustainable practices. Issues like climate change, population growth, resource scarcity, significant economic exclusion and food insecurity are not sufficiently addressed by the current agricultural and food system in South Africa.

The results of this research were presented in two articles, which explored different aspects of the characteristics of the South African Agricultural Innovation System and its capability to bring about the innovations and long-term change required to address these issues in a way that is economically and ecologically sustainable.

The first article presents an analysis of the structures, stakeholders, and institutional capabilities to support innovation.

Innovation takes place under complex conditions. It is characterized by large numbers of actors who interact with each other and with their environment. These actors form systems, which are characterized by emergent behaviour and are therefore difficult to predict

Innovation systems theory and it's application to agriculture has evolved over time. National Agricultural Research Systems (NARS's) focus on formal research and linear dissemination of the results. Agricultural Knowledge and Information Systems (AKIS) widen this view to include more actors into the dissemination process, but innovation still mainly originates from formal research institution in this view. The notion of Agricultural Innovation Systems (AIS) recognises the complexity of innovation, the various roles of multiple stakeholders, the importance of feedback-loops, and two-way communication, as well as intangible factors such as values and culture.

The South African Agricultural Innovation System (SAAIS) is still stuck in the structures of a NARS in many ways. Most innovative ideas originate in formal research institutions and universities and their dissemination through a relatively weak public extension system is challenging. Although the elements of AKIS's and AIS's do exist, they are not yet fully developed. Many of the actors are still working in isolation. Channels of communication and cooperation are emerging but not yet efficient.

The role of government institutions in orchestrating these activities needs to be strengthened and the respective capacities need to be improved in order to fully un-lock innovation potential. Organised agriculture and private providers do fill this gap to an extent but in a rather ad hoc and not very structured manner. Both, producers and consumers of agricultural products and food reside at the periphery of the SAAIS while agri-industries, food processors and retails companies hold significant power which is often not supportive for the cooperation and networking between stakeholders, which would be required for new inclusive practices to succeed.

The second article evaluates whether agricultural innovation in South Africa takes place within an enabling environment and whether there are certain conditions limiting such innovations.

Innovative approaches emerge within the context of a certain environment or regime which can be limiting or deterring the emergence and dissemination of the new idea or practice. On one side innovations require niches to grow and develop without the influence of existing limitations. An the other side, they also need ways to grow into existing regimes – and even to break them down - in order to overcome challenges or crises borne by this regime.

Five limiting factors to agricultural innovation in South Africa were identified in this research and are seen as characteristic for the existing agricultural sector. These are

1. Market access for smallholder farmers and localized food systems

2. Cooperation and networking

3. Funding and finance

4. Government focus

5. Implementation and project management

These five challenges are interlinked and solving one of them could improve the situation for the others too. Therefore it is important to address them together. For example, it could be easier to obtain funding if proper project implementation can be relied.

Overall, it can be said that the South African agricultural system is modelled to support large industrial HEI farming methods. Sustainable and organic farming practices only exist on the fringes of the system. And despite many initiatives to help smallholder and emerging farmers, they often operate outside the formal markets.

Various areas would need to be addressed in order to change that situation. The role of government is important here. A shift of focus towards more sustainable, agro-ecological and organic practices would be required. The importance of cooperation and networking between the various stakeholders within the innovation system needs to be recognised and actively promoted. While new funding and risk management models will be innovations in themselves, they are also essential to enable other innovative solutions with regards to agricultural technologies and processes.
Further research should focus on

- Methods to strengthen innovation capacity and capability, especially within public organisations
- Dynamics, cooperation, and competition within stakeholder groups of the SAAIS, and

- The role of power and influence possessed by the various stakeholders within the system.

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## Appendix – Interview list

Interview List

| | Organisation | Group | Name | Date |
|---|---|---|---|---|
| 1 | ARC | 13 - research other | Jasper Rees | 08-Jul-14 |
| 2 | EBS | 24 - other private industr | Peter Harris | tbc |
| 3 | Independent Researcher | 13 - research other | Tracy Ledger | 15-Jul-14 |
| 4 | Grain SA | 30 - organised agriculture | Jane McPherson | 16-Jul-14 |
| 5 | Wits | 12 - research universities | Ela Romanowska | 20-Jul-14 |
| 6 | Royal Haskoning | 24 - other private industr | Imran Shiran-Kotz | 24-Jul-14 |
| 7 | Innovation Hub | 15 - SA Developmen agen | Boitumelo Semete | 05-Aug-14 |
| 8 | Ifoam | 20 - International NGO | Konrad Hauptfleisch | 05-Aug-14 |
| 9 | Private consultant | 24 - other private industr | Andrew Makenete | 12-Aug-14 |
| 10 | Weleda | 29 - farmer small holder c | Elizabeth Wertheim- | 12-Aug-14 |
| 11 | Wensleydale | 28 - farmer commercial o | Sue Jackson | 18-Aug-14 |
| 12 | Organic Emporium | 33 - retail organic | Debbie Logan | 14-Aug-14 |
| 13 | AgriSA | 30 - organised agriculture | Dirk Hanekom | 19-Aug-14 |
| 14 | KoppertSA | 23 - Input supplier | Frank Enthoven | 22-Aug-14 |
| 15 | UKZN | 19 - SA NGO | Max Mudhara | 09-Sep-14 |
| 16 | TIA | 15 - SA Developmen agen | Caiphus Ramoka | 08-Sep-14 |
| 17 | Food & Trees for Africa | 19 - SA NGO | Quinton Naidoo | 08-Sep-14 |
| 18 | ARC - Tech transfer | 13 - research other | Vuyisile Phehane | 15-Sep-14 |
| 19 | AgriSA | 30 - organised agriculture | Willem Basson | tbc |
| 20 | US | 12 - research universities | Nick Vink | 06-Oct-14 |
| 21 | Biogold | 21 - innovators | Virash P Rambaran | 06-Oct-14 |
| 22 | Green Road | 19 - SA NGO | Helen van Zyl | 07-Oct-14 |
| 23 | Fair Trade | 20 - International NGO | Arianna Baldo | 09-Oct-14 |
| 24 | Mysmartfarm | 21 - innovators | Wolfgang von Loeper | 09-Oct-14 |
| 25 | Green Cape | 10 - Provincial governmer | Chris Millson | 10-Oct-14 |
| 26 | Hichert and associates | 24 - other private industr | Tanja Hichert | 23-Oct-14 |
| 27 | Pico Team | 22 - innovation intermedi | Joe Ramaru | 24-Oct-14 |
| 28 | DTI - Agroprocessing | 2 - DTI | Bhekithemba Dlamin | 27-Oct-14 |
| 29 | AFASA | 30 - organised agriculture | Alfred Mahlangu | 28-Oct-14 |
| 30 | MMNU / Rainman | 12 - research universities | Raymond Auerbach | 05-Nov-14 |
| 31 | IDC | 15 - SA Developmen agen | Sibongile Zulu | 11-Nov-14 |
| 32 | DAFF | 9 - Extension Service | Jeffrey Ngaka | 12-Nov-14 |
| 33 | Technoserve | 20 - International NGO | Mandla Nkomo | 13-Nov-14 |
| 34 | WWF | 20 - International NGO | Inge Kotze | 20-Nov-14 |
| 35 | Reos Partners | 22 - innovation intermedi | Dineo Ndlazi | 13-Nov-14 |
| 36 | UP | 12 - research universities | Refilwe Ngoato | 05-Sep-14 |
| 37 | SA Foodlab | 22 - innovation intermedi | Kenneth Carden | 27-Nov-14 |
| 38 | FNB | 17 - Bank | Jan van Zyl | tbc |